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Algae's Resourcification

Investigating the possible resourcification of algae in Europe and Denmark

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Abstract:

Algae's interest in the past decade has grown rapidly, with several actors showing this interest within their plans. Drawing on critical resource geography insights on the social production of resources and a conceptual framework built on top of it, this thesis has as its aim the comprehension of to what extent algae's transformation into a resource is occurring within Europe and Denmark. This result is accomplished by operationalizing the conceptual framework into categories called conditions. These conditions, when they occur at the same time, favor the occurrence of resourcification, the phenomenon that in this work I will study regarding algae. Ultimately, the condition will serve to analyze the selected literature, both academic and non, and respond to the research questions ultimately. This work contributes to the studies around resources and their production, testing a new theoretical and methodological script to approach the process.

Key words: Critical resource geography, resourcification, resource making, algae, seaweed.

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List of Acronyms and Abbreviations:

DVFA: Danish Veterinary and Food Administration
EC: European Commission
FAO: Food and Agriculture Orgnization
GHG: Green House Gasses
IMTA: Integrated Multitrophic Aquaculture
OED: Oxford English Dictionary
USD: United States Dollar

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Chapter 1. Introduction

In recent years, demand for algae biomass has increased in western diets, with direct human consumption or food application as the main end (Araujo et al., 2021; FAO, 2021). The recent recognition of algae's potentialities by institutional and private actors shows how interest in society is growing with regard to the topic (Filbee-Dexter et al., 2022, Araujo et al., 2021). Currently, the algae sector in Europe is made up of 225 companies spread around the 23 countries, registering a 150% increase in number of producers in the last decades (Araujo et al., 2021). It was estimated that between 2007 and 2015 the sector more than doubled, with a worth ranging around the 6 billion USD (Ullman and Grimm, 2021).

It has been discovered that algae, due to their high growth rate and photosynthetic functions, could help with many different challenges, ranging from environmental to social and economic ones (Piwowar and Harasym, 2020). If roughly 0,3% of the ocean surfaces were used to produce algae, it would be enough to produce as much biomass as the global land agriculture produce over a year (Ullman and Grimm, 2021). Other recognized benefits were the creation of an increasing number of jobs and the tackling of climate change (Araujo et al., 2021).

The FAO (2021), in "Seaweeds and Microalgae", its latest work on Algae, provides an overview of the algae sector. While recognizing algae's potentialities, it also describes their contribution towards the development of a global aquaculture sector involving seaweed. On a similar note, the European Commission (2022) released a plan called "Blue Bioeconomy – Towards a Strong and Sustainable EU Algae Sector", recognizing the potentialities that algae have and aiming at increasing production, use and consumption of algae products in the EU. Both institutions demonstrated great interest in unlocking algae's potentialities, as multiple challenges could be approached and tackled with them. Inside these two documents, a great interest is manifested by private actors, like the Seaweed for Europe Coalition and Lloyd's Register Foundation. In their documents, the former entities stress the potential importance of algae for society, laying out possible solutions and prospects to support algae acceptance in Europe and the globe in general.

In Denmark's case, a long history of algae production is attested, as companies and universities have been involved in studying both seaweed and microalgae for an extended period of time (FAO, 2018).

With more than 10 units of production shared between macro and microalgae, the Danish algae industry is prosperous and includes some historical companies with more than 100 years of experience (ibid.). Recently, the government introduced algae in its aquaculture plans and guidelines for commerce, showing a similar tendency to that of the EU and the FAO (Ministry of Food, Agriculture and Fisheries, 2014; DVFA, 2020).

The growing interest towards algae can be framed within resource geography's discussions around resource making subjects which focus "on the practices and political projects through which specific parts of complex, heterogeneous physical worlds are rendered into knowable exploitable resources" (Himley et al., 2022). The majority of these works focuses on why an item becomes a resource and who is responsible for this process, with the key focus being on the abstraction process that make resources as such (Himley et al., 2022; Bridge, 2009). As a consequence of such activity, the present work seeks to answer the call for reflection on the conditions behind the "social emergence of resources" made by Hultman et al. (2021).

1.1 Aim and Research Questions.

This work aims at comprehending the dynamics revolving around algae within Europe and Denmark and see to what extent a process of resourcification is currently happening. While attempting this, the reasons behind the occurring of this process and the identity of the main actors involved will be explained. This aim will be achieved by operationalizing a specific conceptual framework by relating it to a selected literature of resources. The result of this relation will result in the conditions that will be employed in the following analysis to investigate how conditions for resourcification of algae are occurring. With this aim and method of analysis in mind, the research questions this thesis seeks to answer are:

- How are the conditions occurring/did these conditions occur in Europe and Denmark?
- To what extent can we assert that resourcification is happening in Europe and Denmark?

Sub question:

- Why is resourcification happening now?
- Who is involved in the process and why?

1.2 Structure of the Thesis

The work is divided into six chapters, the one presented here is the introduction. The second chapter begins by describing the history of algae within Europe and by showing how, albeit the sector is small, it has nonetheless a long history, to then move on to an explanation of what the potentialities that make algae attractive for public and private actors are. The third chapter will explain the conceptual framework this thesis is built on, while focusing on why resourcification happens to then move on to the how this process unfolds. The fourth chapter concerns the methodological framework, where the conceptual framework is related to a thematic tool, along with a contextualization of the thesis within critical theory's philosophy. The chapter continues with the data and case selection, ending in a description of the method employed in the fifth chapter. In the fifth chapter, which is divided into 4 sections, the analysis is carried out and the investigation around algae's resourcification is conducted.

Chapter 2. Background

This chapter will serve as a showcasing, and justification of my interest for it, of algae's sector growth around and the world and Europe in particular. Especially the interest that both private and public actors are revolving around it.

2.1 The Algae Industry's History

Before diving into the potentialities of algae, it is important to clarify what they are, so as to make the following pages easier to comprehend. The algae that will be addressed here are mainly of the macroalgal type, also known as seaweed, rather than the microalgal one. The difference between these two is given by the number of cells, for the macroalgae are multicellular aquatic photosynthetic plant-like organisms, whereas the microalgae are small and unicellular aquatic photosynthetic plant-like organisms (look at figure 1 and 2 as a visual reference). (FAO, 2021) This distinction is important as the word seaweed is often also associated to microalgae or even, erroneously, to the completely different seagrasses, which are a different plant. In this work I will use algae as an umbrella term for both and use their specific names when I will address one of the two.

Figure 1. Seaweed. (NOAA, 2021)

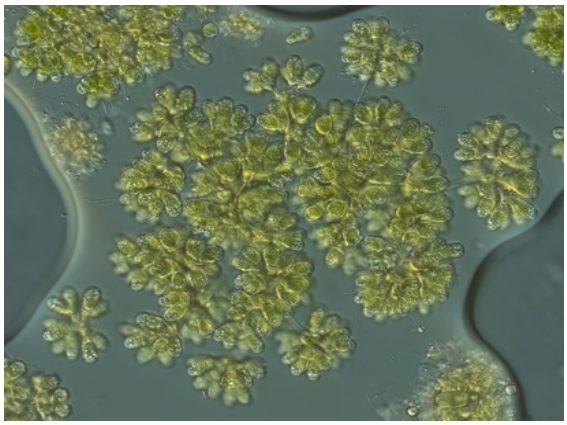

Figure 2. Microalgae. (CSIRO, 2021)

Historically, seaweed has been a core part of coastal communities' practices, the most common usage of them being in medicine, fertilizing and industrial processes (Delaney et al., 2016). Records of seaweed use and commerce can be dated back to the 17/18th century in Europe, as France and Norway used algae to produce glass by using them as combustible material instead of wood (ibid.).

However, one of algae's main traditional uses has always been as feed for livestock and as fertilizer to improve nutrient deficient soil. (ibid.)

Around Europe, the use of seaweed was a key component of society, especially in countries facing the Atlantic Ocean. Seaweed was focal in Ireland for example, as it enabled small landholders to increase the production of crops beyond their land's normal rate (ibid.). Other key uses were for medical purposes, since some seaweed species contain high levels of potash and iodine which make them useful sources for chemical components, and for construction (ibid.). Moreover, algae have always been used for human consumption, but this perception of them as food has always been limited to coastal communities, for example in East Asia, where it is a popular dish (ibid.).

As a matter of fact, in 2019 Asia was responsible for 97,4% of the total seaweed production, while Europe was only responsible for 0,8% (FAO, 2021). This percentage is the result of wild collection and cultivation, used for mainly two reasons: the production of alginate acid and of feed stock for animals and agriculture (FAO, 2021; Delaney et al., 2016). The first one is important for different sectors, ranging from the food industry to gel agents altogether, pharmaceutic means for gastric alkalis and dental impressions, but also in textile and water-related applications, showing a great usefulness despite the existence chemical synthetic competitors (Woodward, 1965; Delaney et al., 2016). The industry is still characterized by a great amount of human labor, as manual harvesting and collection of seaweed is going on nowadays, mechanical harvesting being a more recent phenomenon that is typical of the alginate industry (Delaney et al., 2016).

2.1 Algae's Potentialities

Algae's attractivity has grown in the recent years due to its vast potentialities which could be applied to reach different goals. In fact, seaweed has the potential to help reach several sustainability goals and cope with some of world's biggest societal challenges (Lloyd's Register Foundation, 2020). Seaweed could contribute to restoring oceans while providing nutritious food and many jobs to multiple coastal communities around the world (Ibid.). The contribution they provide is thus mainly social, economic and environmental. The contribution of algae is presented here from the perspective of business actors (Lloyd's Register Foundation and Seaweed for Europe), and

intergovernmental bodies (the FAO and the UE), along with some academic papers that share the interest in the growth of the algae sector.

The first great potential that seaweed have lies in their richness of minerals, vitamins and polysaccharides, which makes them a nutritious and healthy food (Seaweed for Europe, 2020). Coastal communities, as shown in the previous section, have always consumed seaweed for these reasons. Today, with the increasing request for plant based/low carbohydrate diets, the demand for seaweed is growing (FAO, 2021). Considering also the continuous increase in the world population's growth rate (projections show the global population reaching 9.7 billion people in 2050), the consequent food demand will have to be satisfied without further aggravating the level of carbon emissions while using the same land (Lloyd's Register Foundation, 2020).

Algae are seen as a potential solution for this problem, since the combination of their nutritional aspect with their environmental component is one of the main narratives revolving around them and their publicization. Furthermore, the biomass productivity of many algae is way higher than other land plants, making them suitable for an easy and fast farming process (Ullmann, 2021). Considering that land agriculture is one of the main causes of Green House Gasses (GHG), algae's capability to cope with them is of great appeal (Piwowar and Harasym, 2020). The appeal of algae also consists in the fact that, being marine resources, the environment in which they grow is an oceanic one, which represents a vast space that still needs to be exploited. Projections shows how just 0,3% of the ocean surface could provide the same amount of biomass that global land agriculture produces in a year (Ullmann, 2021). Mass recognition of algae, especially seaweed, as a super food is growing and so its potential benefits.

Environmentally-wise, algae are appreciated for their regenerative nature, as they contribute to maintain biodiversity and provide ecosystem services (Seaweed for Europe, 2020). Algae work as biofilters by cleaning the oceans and provide habitats and food to marine species (Lloyd's Register Foundation, 2020). Their action as a biofilter is relevant, as algae can absorb from surrounding waters nutrients and mitigate eutrophication processes while treating wastewater (FAO, 2021). Furthermore, algae can serve as a natural protector of shorelines by dissipating waves and reducing costal erosion (Seaweed for Europe, 2020). Their role as a bio fertilizer was mentioned in the

previous section and relies on the high levels of macro and micro elements, like metals and other components that soil can easily absorb, which it contains (Piwowar and Harasym, 2020).

Out of all the benefits that algae can provide, the one concerning carbon sequestration is the most appealing. In fact, Algae could play a massive role in a post fossil world, where chemical and plastic materials will be put aside in favor of biomass ones (Lloyd's Register Foundation, 2020). Algae, like every other plant, are a photosynthetic microorganism that absorb carbon during this process, producing biomass as a result of photosynthesis (Piwowar and Harasym, 2020). It is no coincidence that projects of marine reforestations are starting to exist around the world. The restoration sector aims at restoring marine biodiversity with passive, through the removal of degraded factors, and active, through plantation in heavily damaged areas, restoration projects (Filbee-Dexter et al., 2022). The increasing regulation for environmental protection and the establishment of marine reserves can favor this trend (Ibid.). This contribution to environmental problems can be applied to the aquaculture sector too. Seaweed's role as a biofilter can help the aquaculture sector by increasing its sustainability and economic revenue (FAO, 2021). Integrated Multitrophic Aquaculture (IMTA) can help channel the previously mentioned food potential within the current aquaculture sector by increasing its sustainability and generate more revenues.

Another great impact that algae can have on society is the economic one. As a matter of fact, algae farming can create new sources of livelihoods for coastal communities, not to mention it can represent a valuable alternative to fishing practices (Lloyd's Register Foundation, 2020). A large portion of the algae farming industry is labor intensive, with seasonal and part time jobs that can help nonskilled workers to earn a salary (FAO, 2021). It is estimated that in Europe, thanks to seaweed production, between 11,000 and 37,000 jobs could be created by 2030 (Seaweed for Europe, 2020). Other important figures concerning algae regard possible revenues they could generate. For example, in 2019 14.7 billion USD were generated by that year's seaweed production (FAO, 2021). For Europe, such revenues were estimated to be around 350 million euros in 2018, with a potential revenue believed to reach the 3.0/9.3-billion-euro mark by 2030 along the seaweed value chain (EC, 2022; Seaweed for Europe, 2020).

Chapter 3. Conceptual Framework

The chapter focuses on explaining why and how, according to critical resource geography, the social production of resources occurs. The first section focusses on explaining the why, starting by introducing the key concepts that critical resource geography uses to approach the production, with a great emphasis towards the perception of nature in society. The second section explains the how social production happens. There, the concepts on which the analysis builds on are presented and elaborated to create the conditions of resourcification.

3.1 Social Production of Resources

This thesis is based on critical theory's ideas of confronting society and comprehend it to enhance its transformation by discovering what are the dynamics behind it (Guba and Lincoln, 1994). The aforementioned principle underlies this thesis, as I seek to analyze the dynamics behind the social production of algae as a resource and the interests revolving around it. This critical paradigm is a crucial one, as it aims at identifying how resources are created and what their impact on the world is (Ibid.). Understanding resources and the process revolving around them, as the following section will explain, can help us understand a lot about society (Bridge, 2009).

Understanding resources means comprehending the process that allows them to be labelled as such (ie. why one item can be a resource, whereas another cannot). As per Neil Smith's (1990) insights on the production of nature, the becoming process of resource is explained as the result of particular forms of production. The current production system we live in is the capitalistic one, wherein the main determinant behind the becoming of an item into a resource is its profitability (ibid.). The process which allows a resource to become profitable will be explained in the upcoming section 3.2, here the explanation will revolve around why profitability is the driver of the process and what this search for profitability has generated.

Before diving into the explanation of the different forms of production Smith refers to, it is important to define two things: what the resources mentioned throughout the text are and what this definition tells us about society. The definition I will refer to is the one found in the Oxford English Dictionary. The OED's definition will be my operative one, as this dictionary is widely

accepted as the “most complete record ever assembled of the English language” (Harvard Library, n.d.). According to the OED, resources are defined as “the collective means possessed by a country or region for its own support, enrichment or defense”, including the “stocks or reserves of money, materials, people, or some other asset, which can be drawn on when necessary” (Furlong and Norman, 2015; Himley et al., 2022, p.3). This definition follows a utilitarian approach which sees resources as a means to an end, one that can be reached by removing such resources from their context and using them to satisfy social needs (Himley et al., 2022).

The term natural is commonly associated with the word “resources” and represents the components of a non-human world that people can use for different reasons: mere satisfaction of needs, exchange or making profit (Smith, 1990; Himley et al., 2022). Since definitions are the reflection of how society perceives reality, in this case the previous definitions are a product of Capitalism and all its relations, as will be shown hereafter. The difference between resource and natural resource showcases the common understanding that society has of resources, not to mention the triumph of the abstract capitalistic definition of this term over the other more “naturalistic” one (Bridge, 2009).

According to Smith (1990), this perception of resources is the result of different modes of production, which are built on each other and can explain the reason why the previous definitions represent society’s perception of resources and their role in it. There are three types of production: general, through exchange, and capitalist, the last one being the one which defines the world we live in.

The perception of general production varies across the globe, as different cultures have different needs. The important aspect of this type of production, on which the other two are also based, is the fact that society plays an active role in shaping the resources, as the satisfaction of needs can be achieved by producing means to satisfy it (Smith, 1990). This triggers a process of production of new needs. Basically, while humans are able to create new means of increasing productivity that, in turn, create new needs, thereby initiating a vicious cycle that still goes on today. As will be shown later, one of the aspects of the resource making process is directly tied to this idea. Harvey (1974, p.272) synthetizes this perception perfectly, as he refers to resources as “materials available in

nature that are capable of being transformed into things of utility for man". This definition stresses how nature is nothing but a mere container of means of satisfaction for humans.

The transition to the next type of production, the exchange one, occurs once humans develop the necessary knowledge to control nature and the development of surplus (Smith, 1990; Himley et al., 2022). This new form of production is matched by a far more complex and layered society. Such a transition encapsulates the triumph of a new perception of nature which stops being seen as united with mankind and starts to be used as a commodity to exchange, essentially as a mean to an end (Smith, 1990). For example, while the Incas saw in silver and gold two materials for ornamentation, the conquistadores had a completely different perception: they associated gold and silver with wealth and money (Richardson and Weskalnys, 2014). Even though this is an antiquated example, such dynamics are still the same today.

Different sets of values underlie the different perception that society has of the same materials. As was the case with gold in the Americas, such perceptions of objects/nature can rapidly change, thereby showcasing a reconfiguration of the view of resources engendered by the general-to-exchange shift in type of production. Use-value does not disappear but is instead replaced by a more convenient/expensive way of employing a certain use-value that matters (Smith, 1990).

The current form of production is the capitalistic one and it's a direct result of the expansion of the production levels and of the transformation of society which occurred during the industrial revolution (ibid.). In this case, mankind's perception of nature is more complex: it is not seen as existing independently of humans (primary nature), but rather as being a product of anthropic activity (secondary nature) (ibid.). Here, the initial mechanism of creating new means to sustain society's material needs has expanded to the point that this expansive process must continue endlessly for capitalism to survive (ibid.).

The new nature that emerges from this process becomes a means of production itself, which is used to satisfy a singular need, profit. There is an ontological and epistemological change in the perception of nature, as the initial primary nature disappears and is replaced by both the use-value one and the secondary nature, which represents the perception of nature based upon exchange value(ibid.). Given the change in what nature is and how we perceive it, we can speak of a new ontological and epistemological way of comprehending nature. Throughout the years the

aforementioned capitalist spread across the world, thereby standardizing the perception of nature across the globe (Smith,1990). According to this worldview, resource exploitation is necessary for growth and development, framing them resources as a means to an end (Himley et al., 2022). The transformation of nature into commodities and the exchange of items of similar value is now a common reality, where resources are removed from their initial relation and context so that a new representation of them can triumph (Bridge, 2009).

The combination of these two natures, represents how the capitalist form of production sees nature and where the social dimension of resources stems from. In a capitalistic society, primary nature is intended as nature in its use-value sense, where resources are what they are in their physical state. Conversely, the new secondary nature sees resources as the result of market relations that dictate their exchange value (Smith,1990). This dichotomic perception of nature, born of the constant search for profit, characterizes this form of production. Such a type of production is adopted on a world scale, thus making this perception of nature the dominant one (ibid.).

In short, the perception of nature influences society's perception of resources, as the latter are part of the former, while the aforementioned definitions are an offshoot of this dominant perception of nature and an of great heuristic value as to why resource making, and its social process takes place. In the words of Bridge (2009, p.1220), "Resources are a relational understanding of the non-human world", as they represent the relationship that society has with them. Put simply: to ensure its survival, capitalist society willingly perceive nature solely in terms of use or exchange value, thereby transforming it into a resource.

The current state of society is a material one in which the economy, in different social and geographical contexts, is built upon processes of transformation of natural resources into commodities. Naturally, such a paradigm affords resources a key role in society (Bridge, 2009). An example of this turning of items into meaningful resources can be seen in the case of tar sands. This kind of resource has always been there, but neither the technology nor the will to extract them was existent, meaning that there was no way to fulfill its potential and that, most importantly, they could not be put into systems of resource making (Kama, 2020; Himley et al., 2022; Richardson and Weskalnys, 2014). Even though the profitability associated with tar sands was foreseen, they were not yet ready to be exploited.

The combination of socio, technical, and political practices allows the becoming of a marginal resource into a core part of society, as happened with coal during the industrial revolution. When it comes to unconventional fossil fuels, like tar sands, a series of techno-scientific experiments and geological prospects are necessary before they can be seen as profitable and worthy of extraction (Kama, 2020). This is what happened with the Athabasca tar sands in Canada. In 1875/6, geological surveys were requested by the government with the aim of generating knowledge, so that extractive and lucrative projects could be pursued in that area (Simpson, 2019).

As the upcoming section will show, the capability to abstract a resource from its initial state and reconfigure it in a different way through technological development, expertise, or simple change of perception, can turn a marginal resource like silver and gold (as was the case for the Incas) into a key component of society and production (as the Spanish conquistadores did). Another example could be made by taking coal into exam. The main reason behind coal becoming a resource lies neither in its chemical properties nor in its physical ones, but rather in its "capability" of being readily available during the creation of the first engines and of solving the problems that the manufacturing industry had. Ultimately, it was this last element that made coal into a resource (Bridge, 2009).

These two simple examples embody the dynamics and dynamism of the social production of resources, called the resourcification process, wherein multiple components combined allows the transformation of an item into a meaningful resource. The dynamism of resourcification is a key aspect, as it encompasses a broad range of components that, when bound together, make the process possible. In fact, there's a relational understanding between resources and humans (Bridge, 2009). The labeling process of items as resources tells us a lot about the society. As a matter of fact, resources are crucial to understanding the contemporary social world, since they shape the process that determines what society is and how it endures across time (Himley et al., 2022).

The combination of the different perception of nature, and the capability to abstract it out of its original context, makes resources subject to a constant extractive action. The increasing extent of resource extraction, known as extractivism, currently involves at least half of the planet involved in transformative process and the allocation of one third of primary productivity solely for human purposes (Bridge, 2009). This illustrates how the continuous, and significant, exploitation of earth is happening over time. The advent of new technologies has increased the extractive rate and the

possibility of framing new resources into novel systems of resource making, resulting in the aforementioned data and a general tendency in "refusing" scarcity.

Such rejection is connected to the tendency that started in the relationship between general production and nature, which is to say the creation of new needs and means to satisfy them. In the current capitalist mode of production, this tendency has evolved into the hunger of resources that capitalism needs to sustain itself. In fact, given the rate of extraction that new technology grants us, natural resources scarcity decreases instead of increasing (ibid.).

Measured price wise, this phenomenon shows how the general perception and reliance on growth increase the availability of resources even though they are physically becoming scarcer. For example, to find 4 billion tons of coal, every year 18 billion tons of material are displaced, showing how are available indeed, but the process to find them is getting harder and maintained profitable only because of the continued development of technology and knowledge (Ibid.). This rejection of the finiteness of resources, along with extractivism and what it is built on, allows society to keep its habits and the capitalist perception of nature to endure. Studying resources, and if they're considered as such, is important to understand society as they are a key component of contemporary social world and how it is organized also depends on them (Himley et al., 2022). Resources are social in the sense that the relational dynamic is biunivocal, as the resources themselves can shape society too.

Around resources and their control there is a whole section of the literature that studies how being abundant resources wise, can be a curse and exploiting, inefficiently, this abundance result in economic, political and social problems (ibid.). The control of resources means power, and in some cases, this means uneven and exclusionary forms of authority. The social production of resources can benefit some and leave behind others, like in the Incas example or the tar sands in Canada. In both cases the becoming into valuable resources for gold and tar, made the local population exploited or sent out of regions, so that capitalist material practice could thrive.

Resource making is often mentioned with cases of resource grabbing, where restricting rules and authority of access, use and management have alienating effects (Furlong and Norman, 2015). Most of the grabs and the perpetration of uneven form of access and benefits of resources, are perpetrated legally as a result of the implementation of laws or codes by the state. Favoring investments from foreign actors is what happened in Tanzania, where large mining capital had to

be favored with protecting laws, which meant the exclusion of local miners and population out of the revenue generated from mining (Emel et al., 2011)

The state is an actor that plays a key role in expanding capitalism as the dominant way of perceiving nature and resources, and in some cases its entire existence is based around their control (Smith, 1990). The State, as the ultimate representation of capitalist society, facilitates the expansion of the capitalist form of production by implementing laws and repressing any competing model of society so that capitalism can spread (ibid.).

As noted, resources are a key part of society: controlling them means power and having power means holding resources and vice versa (Furlong and Norman, 2015). In fact, state making and resources are intimately connected. Usually this relationship, embodied by state power mediated by the control over resources, is called resource nationalism and is a theme that attracts lot of academic interest (Himley et al., 2022). For example, in Israel the creation of a resource out of freshwater was crucial for the consolidation of the state's control over the territory and the construction of a national identity (Bridge, 2014). Water was a scarce resource in those territories, and the creation of a governmental system for water management legitimized the Israeli state (ibid.).

Resource making can also serve as a way of strengthening an already established state: the Canadian senator John Schultz used to see in tar sands an asset that was soon to become one of the most expensive petroleum reserves in the world, a "bank" for the future (Simpson, 2019). As a matter of fact, the state plays a critical role in shaping resource geographies by emanating laws for the legal and non-legal coercion of assets (Bridge, 2014).

A key aspect that stands out when resource making is addressed, is the spatial-temporal component. Foreseeing a resource potential and resource grabbing, are examples of spatial-temporal components of the social production of resources. The space element means that the process of becoming can happen across different areas, countries export and import resources from all around the globe or initiate making of resources of which they benefit without dealing with their production, like with carbon offsetting forests. The unsustainable uses of a country can be counterbalanced with good practices elsewhere, showing the spatial interconnection in resource making cases (Himley et al., 2022).

Resource grabs and state making are example of this spatiality component, one that sustain itself across time. The temporal component embodies what was explained before as the foreseeing of resource's profitability in the past and occurs in the present, like with tar sands or unconventional fossil fuels in general. The becoming of such resources take place across time, from their initial discovery to their final exploitation (Kama, 2020). Understanding the temporal component of resource making, also means dealing with the fact that a resource can be made, but also unmade and re-made across time (Hultman et al., 2021). The change of conditions, technology and discourses around resources, can influence the making process like it happened with the decommission of the nuclear power and now its return (ibid.).

The new perception of nature, which lead to new ontological and epistemological framework for nature as a resource, made the extraction and commodification of resources the normality of our society. Resource making builds on these ideas and together with the spatial-temporal social components, give to the phenomenon its shaping role into society. Ultimately this phenomenon as I've presented it is very dynamic, as it can happen in multiple ways and due to multiple factors, making it hard to find a starting point, reasons why academic interest around It are increasing more and more. In the next section I will present what are the main conditions that facilitate the process to happen, and how I've interpreted them.

3.2 Resourcification Conditions

The reasons as to why resourcification happens, and what this means for society, were presented in the previous section. In this chapter two crucial questions will be answered: how a resource becomes such and how it can become profitable. The case analyzed in this thesis, is in fact heavily dependent on these theories as aim of the thesis is to understand to what extent the selected case can be assert as resource making and highlight how are the conditions happening/happened.

To operationalize my lens, and mobilize it through my case, the enabling conditions for the social production of resources that I will use in my analyses are a combination of Hultman et al. (2021) and Braun's (2020). These two works show the processes necessary for resource making to happen and I will rely on those to create these conditions. In conclusion, the thematic relation of the literature and the final analysis will be carried out.

Hultman et al. (2021) define the social production of resources as resourcification, which from now on will be the term used to address the phenomenon. According to Hultman et al. (2021) and the literature presented in section 3.1, resourcification happens when a different set of processes are put in motion. Consequently, the combination of these leads to the creation of profitable resources.

The first condition that Hultman et al. (2021) highlight is an ontological and epistemological change of assumptions towards a certain resource, which was initially discarded and is now appreciated or that is now exploitable thanks to the fact that there is further knowledge of it and that its potential has been acknowledged, as happened with unconventional fossil fuels (Ibid.).The increase of expertise, know-how and knowledge in general, are a second enabling condition, knowing how to extract tar sands and using it in efficient and productive way is what makes the difference, otherwise it would be just a form of gum that runs down a river (Simpson, 2019; Hultman et al., 2021). Coal, without the existence of machines and industry needing it to work, would have never become a resource according to Zimmerman (Richardson and Weskalnys, 2014). This means that without the availability of the proper technology and the presence of the relative infrastructures, coal like every other resource could not be resourcificated as no resource making system could do it (Hultman et al., 2021).

A huge facilitator, is the enabling of extractions, grabbing or other forms of control of resources, with legislative changes (Furlong and Norman, 2015). Multiple cases show this evidence, for example change of regulations and laws, so that a resource can be introduced into regimes of resourcification, can be seen with the Treaty enforced by the Canadian government to secure control over the Athabasca lands, or in Tanzania with an act to maintain concession over minerally rights for big miners' companies (Emel et al, 2011; Simpson, 2019). Another example can be the creation of carbon sequestration forests, which are part of agreement between countries that push for carbon sequestration agendas' development, so that they can keep polluting while counterbalancing their unsustainable behavior (Himley et al., 2022).

These conditions are important as they set the boundaries in which resourcification can happen and boost its start (Hultman et al., 2021). One of the recurring terms associated with systems of resourcification is the that of value. In fact, a resource to become such must be inserted into a regime of value, where value is not just intended as economic, but value that can also be political,

symbolical or merely practical (Ibid.). The economic aspect remains the main one, to the point that profitability is becoming for some authors like Himley et al. (2022) the decisive condition for resourcification to happen. As the example of the Incas shows, regimes of value are different across cultures, but ultimately the triumph of one societies' imaginary, with its own regime of value, is in the end what counts for the process to take place (Bridge, 2009).

Moreover, and this was presented in the previous section when addressing the use of nature to sustain capitalism expansion and survival, is the discursive process that supports resourcification (Hultman et al., 2021). Legitimation for this process can be achieved not only through legislative processes, but also by adopting a rhetoric that makes it appear to be necessary, understandable and continuative, as occurs with the supportive discourse of growth (ibid.). Finally, a human-environment flux condition shows how humans will resourcify based on a mix of conditions of natural and human assets, like with wine and the relative industrial, touristic and culinary industry that can grow around it (ibid.).

All these conditions presented here, are connected between each other and the emerging of one can favor the rising of another, like with knowledge and technology and vice versa. Braun's work (2020) addresses resourcification, specifically of algae, as the combination of three processes: techno scientific, institutional, and discursive processes. These works have influenced the creation of the components of my framework, the one I will relate with the literature and ultimately analyses my case with, as a synthesis of the two. From the first, I took the conditions and merged some together as I will show next. Whereas from the second the confirmation that these conditions could be applied with algae and how to operationalize the conditions into a more structured work.

In Hultman et al. (2021), seven conditions are mentioned. However, they have been condensed into five here to better fit the literature review and make it more comprehensive. In fact, some of these conditions have similar meanings, causes and implications. Furthermore, when assimilated, four of these conditions appear to make more sense when linked under two more generic terms.

Table 1. Hultman's et al. (2021) conditions and mine.

These conditions are:	My conditions.
a) Epistemological and ontological change b) Knowledge c) Technology and Infrastructure d) Legislation e) Regimes of value f) Supportive discourse g) Flux	- Change of Rhetoric (a+f) - Techno - scientific (b+c) - Legislation - Regime of values - Cluster effect (g)

The rationale between these two instances of merging is as follows: in the case of a+f it is because a change in epistemology and ontology of liminal resources is very much dependent on supportive discourses that legitimate resource extraction and vice versa, as supportive discourses need some elements to base themselves on. (Hultman et al., 2021) In light of this reasoning, rhetoric is the best term to represent this dichotomy. In the case of b+c, the relationship between the two conditions is the same, as the one discussed above, it's one based one reciprocity where b can help the creation of more c and vice versa. G has been renamed "Cluster effect", for the term Flux did not seem to properly convey the sense of immanence revolving around resources. Hultman et al. (2021) believes that "a fish stock becomes a resource if, when, and where there is culinary, industrial, touristic, or conservational interest in that type of fish". Given this example, it seems reasonable to conclude that, for resourcification to happen, there must be a cluster of various types industries that actively contribute to this process.

The creation of these conditions through the merge of the initial ones, is an embodiment of the dynamic and relational nature of resourcification, which I will apply to my case of algae and present through the corresponding sections in chapter 5. Their occurring simultaneously is what makes a resource such, as well as profitable, and this is what analysis will try to ascertain.

Chapter 4. Methodological Framework

In this chapter several matters will be explained: how the present dissertation's analysis builds on its conceptual framework, what the criteria behind certain choices was, and which weakness are contained in this framework. The first section is a description of the research design, with particular focus on the creation of the thematic tool for the relation of the literature and the testing of this dissertation's conditions. The subject of case selection, the type of analysis adopted and criteria behind such a choice will be touched upon. The second-to-last section will present the structure of the analyses by effecting an operationalization of the thematic conditions explained in section 3.2. In conclusion, the last section will feature a critical discussion on the limits of the chosen a methodological approach.

4.1 Research Design and Philosophical Assumptions

This section will provide an explanation of the research design process, with a great attention on the operationalization of the conceptual framework through the thematic tool analysis, which will help me to root my conditions in the resource literature so that the argumentative analyses of my case will rely on stronger conceptual bases. Lastly, the ontological, epistemological and methodological position is addressed.

The thematic tool investigation was carried out through the consultation of a select literature on resources and, with the results of this scrutiny, by creating an argumentative explanation of the case. The definition of the conditions created with the aforementioned tool, on which the analysis itself relies, will allow the data presented in this thesis to be frame within the conditions and show whether they are currently occurring or not. The subsequent paragraphs will serve to operationalize the conceptual framework and lay the conceptual basis for the analysis. For every condition, a subsequent explanation of the data relative to it will be presented and highlight how the reality represented by the data is an embodiment of the conditions.

The thematic tool relation of the literature I will undertake is based on the analysis of 18 academic papers. The coding process, the search for the recurring themes in the literature, will be made following the conditions for resourcification listed in the section 3.2. The whole process of the tool

has been done following Braun and Clark (2006) scheme, where the familiarization and transcription, the coding itself and the analysis has been done through NVIVO, so that the process could be done in a more effective way compared to a manual one, and the results presented in a more comprehensible manner.

The main characteristic of this tool is that by looking at similar narratives, or as in my case the conditions beforementioned, will allow me to fit my conceptual framework in the literature around resources and help me explain and untie the dynamics of my case. This tool fits perfectly inside my methodological framework and strengthen it by putting it in action. Operationalizing the conceptual framework in such way, allows me to have a better argumentative basis. The thematic device is used in a deductive way, as I'll use insights and classifications derived from pre-existing literature (Braun and Clark, 2006).

In order to operationalize my conceptual framework, I've decided to work with a literature that mainly consists of academic papers in peer reviewed journals. This choice was taken as always keeping the aim and research question at the forefront, sot that the analysis of the literature and ultimately the claims I will make respect them. As Lang et al. (2020) evidence in their work, the use of peer review literature also can help its advancements, critique, and a better conceptualization of my phenomenon.

The identification for the literature consisted in typing in the Google Scholar engine for resource making, resource becoming, resourcification, resources in human geography and political ecology journals. The selection was made by examining the abstract, titles and keywords of the texts, and see if they were relevant to my case. A great role was also played by the bibliography of Himley's et al. (2022) book on Critical Resource Geography, some papers were selected by looking at the chapters list of references. The same was done with recurring authors or highly cited books in the other selected papers.

Ultimately, I've decided to stop the search for new literature when I arrived at 18 papers, this choice was not random as both the papers I was using as my guidelines in the approaching of thematic relation, Lang et al. (2020) and Braun and Clark (2006), extensively stated how it is a time-consuming process. This meant that too many papers would have definitely made the conceptualization more

rounded and significant by having a higher census of papers, but it would have definitely taken me longer to scrutinize them, and ultimately synthetize their content. 18/20 papers were my bar, and I was able to reach it, as I think this amount of literature is extensive enough to help me strengthen my conditions. This number is also in my opinion, big enough to give credibility to the tool, but also to provide me a proper amount of time to analyze the literature and make my interpretation consistent with the data extracts, so that I could avoid one of the main pitfalls of this method (Braun and Clark, 2006).

The code development process was conducted following Braun and Clark's (2006) guidelines on how to conduct thematic analysis, figure 3 summarizes their work.

Phase	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Figure 3. Phases of thematic analysis. (Braun and Clark, 2006)

Table 2 visually represents the initial code, which is a direct result of the conceptual framework. On the left side, the conditions for resourcification, inspired by Hultman et al. (2021) and Braun (2020), represent the general themes the code was used for. In the middle there's a series of definitions provided by the authors named before, which offered the key elements that should be looked at when analyzing the data. Lastly, a condensed version of the previous column that synthetize its meanings can be found on the right.

One thing that is important to mention is that while approaching the literature with premade codes, the awareness that a possibly unpredictable result could happen which would force the thesis' premises to be re-negotiated was very much present. In fact, after familiarizing with the literature, one of the conditions was not found. The cluster effect was not found explicitly in the literature during the familiarization process, so it was removed.

Once the code was developed, as represented in its final version in Table 2, the selected literature was reviewed in NVIVO.

Table 2. Coding table

Conditions for Resourcification: necessary conditions for the process to happen	**Code:** elements I looked for during the analysis of the text	**Condensed code**
Valuation System	- To be valuable, a potential resource must be inserted into regimes of value: institutionalized activities, processes, and practices of valuation (Hultman et al., 2021). - Regimes of value are many and multifaceted, and never merely economic. Regimes endow political, symbolic, scientific, systemic, practical, and other values to resources, depending on the valuation processes at play (Hultman et al., 2021).	- Valuation - Utility - Commodification - Resources as part of a system
Technology and Knowledge	- Resourcification processes build on knowledge and stimulate the development of expertise (Hultman et al., 2021). - Resourcification relies upon the availability of relevant technology and infrastructure. Resourcification also triggers and stimulates technological and infrastructural innovation (Hultman et al., 2021). - As technoscientific advancements enhance human capacity to know the oceans through researching and exploring their depths, they also call attention to oceans and marine life as a field of new extractive possibilities (Braun, 2020).	- New scientific discoveries (potentialities or characteristics - New forms of technology to exploit/obtain resources.
Legislation	- National and international regulations are instrumental in legal resourcification (Hultman et al., 2021).	- Laws or regulations for studies or exploitation of resources

	- Regulations draw decisive lines between resource-making contexts, thereby creating attractive loci for initiating and containing resourcification practices, as exemplified in guilds or border trade. Not all resourcification is legal, however (Hultman et al., 2021). - how public and private actors mobilize financial and legal systems to facilitate resource-making (Braun, 2020).	
Change of Rhetoric	- Resourcification alter assumptions about the characteristics and affordances of liminal resources (Hultman et al., 2021). - Resourcification is dependent upon supportive discourses, particularly discourses on the virtue of wealth and the need for economic growth. Resourcification requires arguments to become and remain necessary, understandable, and legitimate (Hultman et al., 2021). - Attention to the discursive aspects of resource-making shows how resources are framed as a response to environmental and social crises and positioned in relation to creating so-called sustainable futures (Braun, 2020).	- Change of narratives around resources - New perception of resources - New framing of resources - New use of resources

The selected literature was at first inserted into NVIVO, after that the codes were sought out throughout the texts, by selecting the sentences and passages that matched them. Following Table 2's codes, the expected results and more proof regarding the dynamism of the phenomenon were obtained.

As expected, the thesis' conditions were found in the literature, but throughout this *corpus* the different themes were mentioned either together or the focus was put solely on one or two of them. Table 2 was helpful in the sense that it facilitates a better framing of the conditions and operationalization of the work at hand. Contrary to what it may seem, the overlapping of conditions was also a positive factor, as it was proving once more how resourcification is a complicated and dynamic process, where multiple dimensions influence each other even at the same time.

The lack of a homogenous way of addressing resources is another relevant aspect that is highlighted by this first relation, thereby proving once more the importance of an interdisciplinary approach to keep studying the emergence of resources in a unified way and inform social change. (Hultman et al., 2021) As the phenomenon has always been approached and labelled in a different way or with a diverse connotation, the papers I've selected embody these characteristics and not all of them had a reference to all the conditions.

Figure 4 represents the final result of the thematic tool, confirming that the conditions the coding was looking for were in fact in the literature.

Name	Files	References	Created on	Created...	Modified on	Modified by	Color
Valuation system	12	52	28 Mar 2023 at 11:18	LD	3 Apr 2023 at 12:08	LD	
Technology and knowledge	10	57	1 Mar 2023 at 17:17	LD	4 Apr 2023 at 18:16	LD	
Legislation	13	40	28 Mar 2023 at 11:18	LD	3 Apr 2023 at 12:19	LD	
Change of Rethoric	15	72	28 Mar 2023 at 11:16	LD	4 Apr 2023 at 17:43	LD	

Figure 4. Thematic tool relation results on NVIVO.

Having been established with the tool, these conditions can finally be defined and become the operative categories that the following analysis will be based on.

Change of rhetoric: resourcification is based on a change in perception about the characteristics and affordance of resources, which is reinforced by supportive discourses. The supportive discourses legitimate resourcification and make it understandable and necessary by arguing the importance of resources in response to crises (social and environmental). Supportive discourses are for example the need for sustainable growth and the virtue of wealth.
(Hultman et al., 2021).

Technology and knowledge: for resourcification to happen, relevant technology and infrastructure must be available. Furthermore, preexisting expertise is required to resourcify and manage resources. The preexistence of such expertise/technology prior to resourcification can trigger the innovation of technology and knowledge.

Legislation: here meant as national or international regulations, plans and documents generated by governmental bodies, that legalizes resourcification. This legislation creates an attractive locus in which resourcification is framed, facilitated and made legal. Private actors can mobilize legal systems too and join public actors in easing resourcification (Hultman et al., 2021).

Valuation: value is the result of the introduction of a resource into regimes of value, like institutionalized activities or processes, that abstract value through culturally and socially contingent frames (Hultman et el., 2021; Huber, 2016). These regimes grant different forms of value like economic, political, scientific, symbolic, systemic or practical ones, depending on the practices that valuates resources (Hultman et al., 2021).

The shaping of the aforementioned method and tool is the product of the ontological, epistemological and methodological conceptions this thesis is based one. The present case study, according to critical theory, is intelligible as soon as its social, political, cultural and economic dynamics are unfolded (Guba and Licoln, 1994). The conditions adopted here are a direct representation of this, as they represent these dimensions, conceptualize them, and connect them, thereby showing what the resulting reality is. As the thesis' aim was not to judge whether a good or bad type of resourcification was happening, but rather simply to comprehend if the phenomenon itself was occurring in this case, the choice of working with solely secondary data was made so as to deal with the case in the most objective way possible (ibid.). The conditions and their implementations respect this objective and situate the desired meaning in culture, social interaction, and economic processes, all the while respecting a subjectivist epistemology (Hathcoat et al., 2019). Methodologically wise, this method and its analysis are a direct reflection of critical theory's previously mentioned assumption, since they reflect the dialectical component by challenging the narrative that the selected documents present in an argumentative way. Accepting the historically mediated structures and transforming them into a more informed consciousness is the final outcome that this conceptual framework, including the method built on it, wants to achieve

(ibid.). As a result of these considerations, speaking of a theory driven method is the best way of describing it.

4.2 Case and Data Selection

In this section the choices behind the following case study will be presented, stressing out its relevance *vis a vis* the conceptual framework and exploring the criteria behind the selection of the academic literature employed for this analysis.

Following Hultman et al.'s (2021) insights on resource temporalities, especially the resourcification cycle (resourcification, de resourcification and re resourcification) a case that presented this component and occurred inside the European Union was chosen. The EU has recently introduced algae into its Blue Bioeconomy plan, with the aim of becoming a leading actor in the sector and exploiting this resource and its potentialities, thus proving existing interest in the topic (EC, 2022). Resources, as was shown is section 3.1, can tell us a lot about society and sharpen what we know around can be a powerful tool to identify better when the resourcification process may lead to controversial results (Hultman et al., 2021).

A European case was chosen because of the previously cited plan that the EU has decided to implement, which proves institutional interest in the subject and creates the perfect environment for resourcification to happen. Thanks to its role, the EU can facilitate or stop the process by implementing specific regulations for resources. This facilitator role that the EU plays, combined with Denmark's long history within the algae sector, poses an interesting case of whether a resourcification process is ongoing or not. Furthermore, being an EU country means following more or less strictly the plans and their implementation that the EU proposes, as is the case with the EU Blue Economy and Green Deal (Araujo et al., 2021; Lähteenmäki-Uutela et al., 2021; EC, 2022). This means that evidence is much easier to find than in extra European countries and that a general tendency across countries, namely the interest in algae, can be established. For these reasons Europe, Denmark and their algae industry were chosen, and in the next chapter the aforementioned conceptual and methodological frameworks will be tested against this backdrop to check if evidence of resourcification can be found.

Historically, Denmark had a long tradition of working with algae before the 1930s destruction of seaweed stocks by fungal disease. In fact, on the islands of Læsø eelgrass used to be the main type roofing material (Delaney et al., 2016). In 1946 the first attempts to commercialize the use of Furcelleran seaweed were made (Woodward, 1965). Throughout the years, from 1942 on, companies working with algae related products were founded, companies that still exist and in some cases are leaders of their sectors, like CP Kelco ApS for the extraction of carrageenan (FAO, 2018).

As the FAO (2018) says, Denmark has always been a leader in seaweed research, with great interest in the topic shown by its industry and academia. Nowadays there are approximately 20 companies that work with algae dispersed around the country, most of which are located on the coastline that faces Sweden (European Commission, 2022). Furthermore, the universities around Denmark are studying seaweed and the possibilities surrounding it: gastronomy, nutrition, biorefineries or crop improvements, along with private companies that are surfing the wave of local, sustainable new resources which are increasing in demand (FAO, 2018). To give some context, between 2009 and 2014 the volumes of production switched from 1 ton to 10, this is clear evidence of increased demand and manufacturing rates (Weinberger et al., 2019).

As these examples shows, there are some interesting elements which could mean that a resourcification process is going on. First and foremost, the foreseen potentiality of the resource, studied for a long time by the research institutes, is now embedded into a regime of resourcification by an increase in technology and knowledge that makes working with seaweed meaningful, and affordable, compared to before. Secondly, a change of rhetoric towards algae is happening across Europe, as the EU interest shows, introducing this resource into different discourses, reshaping its perception and inserting it in new regimes of value that make investments flow at higher levels into the sector. Given these premises, it looks like this is a case of resourcification and with the analysis in chapter 5 an assessment of the extent to which the process is happening will be attempted.

To this end, the argumentative analyses will be based on a combination of policy documents, mostly produced by intergovernmental bodies like the FAO or the European Union, and academic papers or documents written by private entities. The FAO reports from (2018) and (2022), along with the EU implementation plan for algae (2022) are the main sources employed to demonstrate the general interest towards algae on an international level. Moreover, some relevant documents that demonstrate the Danish interest towards algae, such as the Aquaculture Strategy 2014-2020 and

the Veterinary and Food Administration's strategy for 2020-2023, will be taken into consideration (Ministry of Food, Agriculture and Fisheries, 2014; DVFA, 2020).

Grey literature, like Nordregio (2022) and Teresa Camarena Gomez and Lähteenmäki-Uutela, (2020), was selected due to their status. The former is a respected and recognized research institute, the latter is the product of a multi actor network financed by the EU. Like these, the Seaweed for Europe (2020) and Lloyd's Register Foundation's (2020) Seaweed Manifesto were selected to adopt the perspective of the private sector on algae and what the seaweed revolution would be about. The first document was written by Seaweed for Europe, a coalition that is currently trying to accelerate the growth and scale of the seaweed industry to unlock the social, environmental and economic benefits of seaweed, in partnership with the SUN Institute Environment & Sustainability. The second document was written by Lloyd's Register Foundation, an independent global charity that supports research to make the world safer, in partnership with the Sustainable Ocean Business Action Platform of the United Nations Global Compact.

The other selected documents are peer reviewed academic documents which engage with algae and give an academic in-depth perspective of the sector, its potentialities and new related discoveries. The documents mentioned here represent the introduction, and interest, of algae into strategic plans, narratives and legislations for their exploitation by private and public actors. This choice was done following the already cited conceptual framework which reinforces that the state, here intended as the enforcer of laws and regulations, is the main actor that facilitates resourcification

The selection of these documents was made by consulting the bibliography of the policy documents, especially the FAO (2021) and the Teresa Camarena Gomez and Lähteenmäki-Uutela, (2020), along with the EU plan (2022), which were the main source. The websites of the Danish Ministry of Food, Agriculture and Fisheries were consulted too. Scouting the internet with google scholar to find more information was the other method employed to collect data. The keywords used were the following: algae, seaweed, macroalgae, microalgae and tang in combination with EU, Europe, Denmark, Danish, and Baltic.

The focus was on academic and governmental documents as they are the best way to understand the legislative, technological and rhetorical direction a country is undertaking. This literature will

then be presented as the evidence which supports this thesis' claims for the presence of section 3.2's conditions and thus of resourcification.

4.3 Methods and Analysis

This section will present what the method is and how the consequent analyses results from it. In a second part the reasoning behind this choice will be stated. Especially, the application of the conditions I've analyzed with the thematic tool as lenses to look at my case will be explained.

The analytical method is directly modelled on the conditions related to the thematic tool in section 4.1 and heavily depends on them. For every condition that was related to the literature in the tool, there is a corresponding analytical section. In each of these sections, an analytical engagement with the selected data will be conducted through the tool's conditions, using them to assess if that condition is taking place or not and to comprehend how the actors are involved.
The definitions given in section 4.1 serve to frame what the content of every condition is and use them as operative concepts to highlight the dynamics that favor the resourcification of algae.

The final result of the analysis, which is to understand if algae are resourcified, the four conditions, Change of Rhetoric, Technology and Knowledge, Legislation and Valuation Process, must manifest their presence. Operationalizing the conceptual framework with this tool is the best way to comprehend whether resourcification is occurring and how the actors are involved.
As a matter of fact, by employing this method a full understanding of the algae case should be obtained together with the relative answers to the research's questions.

The selection of the method is based in critical geography theory, and builds on the critical component, as its aim is to explain the reality of things through the combination of social, political, economic, and cultural factors. The method and its analysis follow Hultman et al.'s (2021) invitation on performing critical academic practices on resourcification processes. Thus, as the conceptual framework shows and the research design builds on, this method consists in the application of theoretical guidelines which, once operationalized, allow the answers to the research's questions to be reached.

The shaping of the method based on the conceptual framework was carried out to respect this work's theoretical drive and the reach of its aims. Furthermore, as Valentine (2001) explains, the choice of the method is the direct result of the research questions and the information one wants to generate. The chosen method is then a way of meeting the aims of this thesis and of generating data that is interpretable and easy to handle, so that a better and clearer analysis can be carried out (ibid.). As such, this method is the most appropriate one to provide satisfactory answers to the research's questions and to respect the ontological assumption that shaped its aims (Grix, 2002).

4.4 Data Critique and Gaps

Unfortunately, this work contains a few limitations, which may end up being the main cause of critique for the analysis.

A first limitation concerns the data this analysis is based on. The data employed, as stated in section 4.2, is in some cases found in policy documents written by the Danish government or algae companies that are aimed at Danish readers. The language gap is thus a first limitation that may affect data collection. Even though occasionally some documents could be translated in English, just browsing tang (Danish word for algae) and using google translate is not sufficient to scout non-English literature if one is not acquainted with the language they're written in. Using publications by FAO and UE related bodies that address the topic, with a list of government plans, was helpful in this sense. Furthermore, dealing with governmental bodies means respecting long and thorough bureaucratic processes to get materials. In this case, even when following the reports by the FAO or UE, some documents could not be found, since the documents could not be accessed when browsing their websites. This scarcity of material had a negative influence on the aforementioned method too since, instead of just being a tool for testing and placing conditions into the literature, thematic analysis could have been the main method of analysis and use as data the vast range of documents that could be found. This was not possible, as the amount of literature regarding this specific case was not enough for an in-depth thematic analysis, so sticking with the original method was the best option.

A second type of criticism that might be levelled at this work is the lack of primary data. This choice was made consciously and as already stated in the previous section, the whole work has been shaped around the thesis' aims, thereby making a theory driven approach (such as the one found

here) the best one to adopt. Furthermore, other qualitative methods, like interviews, are hard to obtain with government representatives, making key data complicated to achieve. On the other hand, private companies could be easier to approach, but as they're deeply involved in the algae sector, their opinion would be too biased as it would only one side of the matter. Since an objective assessment of whether resourcification is happening with algae in Denmark is the main aim here, doing interviews would have disclosed a new set of information that would have sidetracked the research work from its initial aim.

Chapter 5. Algae as a Resource

The results of the thesis presented here follow the structure that was discussed in the methodological chapter. The argumentative process of this chapter consists in analyzing how the conditions of section 4.1 are taking place. This aim will be reached by analyzing the selected literature using the concept related to the thematic tool. Every section of the analysis is framed within each condition's definition from section 4.1. The chapter starts by proving whether a change of rhetoric is happening in the EU and Denmark, later, it focuses on the subsequent condition: Technology and Knowledge. The last two sections, following the same logic as the first two, present the undergoing Legislative processes on algae and their subsequent valuation.

5.1 Change of Rhetoric

Algae are presented as resources full of potential that different sectors and objectives could benefit of. This view is sponsored by the Lloyd's Register Foundation's (2020) and Seaweed for Europe (2020) and was accepted both by the FAO (2021) and the European Commission (2022) in their respective plans to unlock algae's potentialities.

Algae are edible, and their richness of dietary fibers, micronutrients and bioactive compounds, makes them an attractive food (FAO, 2022; Lloyd's Register Foundation, 2020; Piwowar and Harasym, 2020). Furthermore, their productive rate is much higher than terrestrial plants and they can prosper without any pesticide or antibiotics (Ullmann and Grimm, 2021). These two characteristics make algae an appealing option for the food industry, especially given their role in ecosystem services and the relative environmental benefits it grants. Algae play a key role as a biofilter, by extracting nutrients from surrounding waters and capturing carbon dioxide to transform it into biomass with their photosynthetic process (FAO, 2021; Piwowar and Harasym, 2020).

These potentialities have increased the attention that intergovernmental bodies and business actors have given to algae, as these institutions have started to perceive them as useful solutions to deal with climate change, population growth and new consumer requests for healthier food (Lloyd's Register Foundation's, 2020; Seaweed for Europe, 2020, EC, 2022; FAO, 2021). These new characteristics of algae, as a healthy and highly productive food that can store carbon, make them

seem appealing and full of potential. Moreover, throughout the data a common element that emerges is that algae could increase their affordances. Seaweed's potential as healthy and low-calorie food, combined with their now consolidated use as food additive/supplement in the food industry, allows them to be considered a super food with unlocked potentialities (EC, 2022; FAO, 2021; Seaweed for Europe, 2020). In Lloyd's Register Foundation (2020), it is said that by dedicating only the 0,1% of the ocean to seaweed production (a feat we could accomplish by 2050), we could produce 15 times more algae than at the current production rate. In light of these characteristics, their recognition by the actors shows how a change of perception is currently occurring for algae.

Following the definition of Change of Rhetoric, what was presented here is a new perception of the characteristics and affordances of a liminal resource. These characteristics, or rather potentialities, have started to be recognized by many actors. The possible exploitation of algae's untapped potential is a common aspect that the data mentions. The European Commission (2022) and Seaweed for Europe (2020) directly describe algae as a resource, showing how they are ready to exploit their potentialities. In the European Commission's (2022, p.10) plan, algae are referred to as "promising ocean resources… an enormous potential", whereas in Seaweed for Europe (2020, p.7) the "report shows seaweed will be the resource of the XXI century". The FAO report (2021) and the Lloyd's Register Foundation (2020) are more cautious by not using the term resource when referring to algae, but they still stress the potential that seaweed have and how useful a more developed algae sector could be to face social, environmental and economic challenges.

An interesting element to note is how both private actors, Seaweed for Europe and Lloyd's Register Foundation, are recognized and cited within the intergovernmental documents. In the FAO (2021, p.2), Lloyd's Register Foundation is cited as "The existence of vast marine areas suitable for seaweed farming makes champions of seaweeds envision a forthcoming "Seaweed Revolution" ". The same thing is done in the European Commission's (2022) plan for sustainable algae sector, where in the Seaweed for Europe estimation about the possible production levels and revenue that the EU could have with a bigger algae sector is referenced. "Seaweed for Europe estimated (in their most ambitious scenario) that the European seaweed production capacity could reach 8 million tons fresh weight by 2030 (currently: 0.3 million tons fresh weight per year) to supply around a third of a EUR 9 billion European seaweed market." (EC, 2022, p.25). The recognition of the two private actors by both the FAO and the EU in their plans for the growth of the algae sector, shows how both bodies

in the private and public sector share a newly embraced notion of algae as useful and full of potential resource.

This new perception, based on the enormous potential of algae, frames algae as a useful response to social and environmental crises. The social crisis that, according to this new perception, algae could help cope with is the lack of healthy and nutritious food that 2 billion people are experiencing around the world (Lloyd's Register Foundation, 2020). The Foundation insists on how, with the population set to reach the 9,7 billion in 2050, a new source of healthy nutritious food to cope with the growing demand can be found in seaweed (Lloyd's Register Foundation, 2020). The FAO (2021, p.11) is more cautious, but recognizes the "multiple health benefits of seaweed consumption" and lists these alongside the increased consumption by plant based and low carbohydrate consumers.

The environmental crisis is the other emergency within which algae are framed. In fact, every single one of the aforementioned actors recognize the great potential that the implementation of an algae industry could have in tackling climate change. The European Commission (2022, p.10; p.4) states that "The production of algae mitigates climate change by, for example, mitigating CO_2, absorbing phosphorous and nitrogen" or that developing a strong algae sector "will help to achieve the objectives of the European Green Deal, the transition to a green, circular self-sufficient and carbon neutral EU post Covid-19 recovery and mitigation of economic crisis resulted by Russia's military aggression against Ukraine.". The European Commission sees in algae a way to become greener and create not only a far more sustainable future, but also a new source of revenue.

The same perception is shared by Lloyd's Register Foundation (2020, p.8), which claims "Offshore seaweed production could potentially contribute at scale towards climate mitigation via long- term storage of carbon in the ocean sedimentation" but also that "The blue strategies aim to mitigate and adapt to climate change through the conservation and restoration of these ecosystems as well as through seaweed farming". For them seaweed can help coping with climate change and restore the environment, like for Seaweed for Europe and the FAO, which both refers as a climate change solution.

For the FAO (2021,p.13) "Seaweed and microalgae cultivation can contribute to the urgent need to address climate change through various mechanisms, including, among others, (i) algae-based products (e.g. human foods, animal feeds and fertilizers) that have a relatively low carbon footprint; (ii) capturing or sequestering carbon; and (iii) reducing methane emissions from cattle farming that

uses certain seaweeds as feed supplement", and Seaweed for Europe (2020, p.28) "Research suggests that seaweed could contribute towards alleviating the environmental impacts of climate change by absorbing carbon". In conclusion, all four actors share a perception of algae as a crisis solver solution, and as a consequence they also share the will to exploit this resource.

Following the definition of change of rhetoric, the campaigning for algae as a solution for climate change and food scarcity mentioned above shows the signs of a form of legitimation of exploitation of the marine resource. Speaking of algae as a solution makes their exploitation understandable and necessary (Hultman et al., 2021). Addressing resources like this, is what the definition refers to as supportive discourses, which is precisely what the actors are doing in their papers. With their arguments, they are framing algae as a solution for many challenges and justifying their resourcification of them. Furthermore, these supportive discourses that legitimate resourcification also frame algae not only as a response to crisis, but also as an effective resource to cope with economic challenges.

The actors legitimate the exploitation of algae by arguing how a greater algae industry "could create jobs and improve livelihoods in coastal communities" (Lloyd's Register Foundation, 2020, p.8). The FAO (2021, p.12; p.13) is aligned with the Foundation's view and arguments on the economic contribution of seaweed, stating that "a large portion of the USD 14.7 billion of first-sale value became wages or incomes that supported the livelihoods of numerous households in coastal communities" and that "Seaweed cultivation makes a significant contribution to community cohesion and women's empowerment". The same arguments are conveyed in Seaweed for Europe (2020, p.25) "A thriving European seaweed industry will create many new jobs, especially if a 30% share of the market is produced domestically. In the high ambition case, the seaweed sector could create up to 85,000 jobs on a full-time employee (FTE) equivalent basis in Europe by 2030", a scenario in which projections estimate a 9.3-billion-euro European demand by 2030. All four actors once more show arguments that endorse the use of algae and make it understandable. The European Commission (2022, p.10), when labelling algae directly as a "promising resource", shows a clear will to exploit the opportunities offered by this resource within its borders. As a matter of fact, in its plan the Commission clearly states that "The goal is to integrate algae into the national policies, be thoughtful of the algae sector's complexities and specificities, and promote its integration into internal markets" (EC, 2022, p.23).

In Denmark's case, some of its ministries have made the first move in the direction the EU is hoping for. Seaweed has in fact been introduced into several plans and documents for its commerce (Nordregio, 2022). The Danish Veterinary and Food Administration (2020, p.3) in its Strategy for 2020-2023, advocates for "A reduced carbon footprint from our food requires that we think out of the box, e.g. by using alternative sources of protein such as insects, seaweed and starfish in animal feed". Here seaweed is meant as food for human consumption, a first sign of the new perception of algae by the Danish government. Along with this strategy, the administration also has also introduced seaweed into the Guidelines on Inspections in the Food Sector. There seaweed meant for human consumption are listed by sector, customer base, and approval registration (DVFA, 2020). Furthermore, the Ministry of Food, Agriculture and Fisheries, in which the previous administration resides, has adopted the Aquaculture Strategy 2014-2020 for the reduction of emission of the aquaculture sector by using seaweed as one of the biofilters. In this document seaweed is referred as "Another nutrient-reducing measure is the production of seaweed" and "both mussel farming and seaweed production are considered as a general means of removing nitrogen and phosphorus", advocating for the use of seaweed as a biofilter in aquaculture (Ministry of Food, Agriculture and Fisheries, 2014, p.10).

The introduction shows the will and legitimation of algae's use by the Danish government, especially to promote the sustainability of their aquaculture sector and the safe consumption of seaweed by general consumers. This change of perception, algae's characteristics as food and an environmental solution, are here embodied by the strategies of the Environment and Food ministries and of its administrations. The algae as a climate change solution argument are not present within these documents, but nonetheless, the supporting discourse is here presented in the form of an alternative form of protein or as biofilter.

A general tendency that both Denmark and the international actors previously mentioned is the recognition of a lack of knowledge and awareness of general consumer for algae. Throughout the data explained so far, the main barrier that the algae industry would face is that "A shift in western diets would be needed for an increase in direct consumption of seaweed as food, and there is an opportunity to increase consumer awareness regarding the benefits" (Lloyd's register Foundation, 2020, p.7).

Some initial signs of acceptance by general consumers can be seen in the food industry, where an increasing consumption of algae biomass in western diets has been registered in the recent years (Araujo et al., 2021). Still, there is a need of raising "Social awareness of algae and algae products needs to be increased to boost the demand and knowledge of the EU Blue Bioeconomy sector through, for example, educational programmes at schools, seaweed cooking shows or by conducting a consumer behaviour and preferences analysis on algae products" (EC, 2022, p.26).

The FAO is on the same note (2021, p.15), highlighting how an "Expansion in seaweed production would need to be accommodated by increases in seaweed demand. One way is to increase seaweed consumption as human foods…". This statement demonstrates how even though the new perception of algae has reached public institutions and private actors, at the consumer level the acceptance of them as food has not yet reached a mass demand even though it has started to grow. In light of the aforementioned arguments, it seems appropriate to suggest that the supportive discourses that the institutional and private actors are reproducing can help cope with this lack of awareness and "educate" consumers in the consumption of algae and its benefits.

Concluding, it is clear that the perception of algae has shifted in the recent years, and its first steps as the base resource for a revolution have been taken. In particular, this has been observable in the EU, where the will to play a key role in this revolution can be found, and more specifically in Denmark, where the introduction of seaweed in plans and documents for their use shows this the trend. A change of rhetoric is underway for algae, with significant strides made by both institutions and private actors to implement the sector and capitalize on its benefits.

5.2 Technology and Knowledge

The recent discoveries regarding algae's potentialities like carbon storage, healthy super food and other social benefits (*e.g.* the creation of jobs), are the result of technological and scientific discoveries. This section will expand on these processes of increased expertise and knowledge that, according to Hultman et al. (2021) and Braun (2020), are triggers of extractive processes. Braun (2020) in particular notes how technoscientific discoveries allow humans to explore oceans, and scout it for resources, as it becomes easier and cheaper to extract its content.

Resourcification has its foundations rooted in the preexistence of infrastructures and competences on how to manage a resource. In Europe, there are currently more than 200 companies involved in the production of algae, mostly born in the last decade. (Araujo et al., 2021). Such activity demonstrates not only the presence of existing infrastructure, but also of growing expertise and interest in algae production. For these companies the main source of production is the harvesting of both wild stocks and aquaculture (Ibid.). The collection of wild stocks is still conducted manually nowadays, with a recent growth in mechanical techniques (Delaney et al., 2019).

Currently, the European Commission (2022, p.15) in its Plan identifies “High production costs” and “low scale production” as two of the main barriers to the growth of the algae industry. For both the Commission and the Danish Ministry of Food, Agriculture and Fisheries, “full value transformation (e.g. via biorefineries) and technology integration (e.g. industrial symbiosis)” (EC, 2022, p.25) and “product and market development” could help reach the algae industry become profitable (Ministry of Food, Agriculture and Fisheries, 2014, p.24). New technologies and expertise to increase production and satisfy the demand of algae is then necessary. The necessity advertised by both the Ministry and the Commission exemplify a trigger for innovation within the algae sector, which without these improvements could not reach its potential. Science and Innovation can help achieve this aim.

Seaweed is currently harvested in the wild or in aquaculture. Around wild harvesting revolves most of the traditional collection of seaweed in Europe, which is mostly conducted manually, implying high costs and low volumes (Araujo et al., 2021). The mechanization of the harvesting infrastructure is the main solution to increase the production levels and satisfy the growing market demand (Barbier et al., 2020). Aquaculture is set to be the best method to produce increased, high quality, traceable and most importantly predictable biomass (Araujo et al., 2021). Seaweed is grown either as monoculture or as part of multitrophic system (FAO, 2021; Nordregio, 2022). Seaweed, with their capacity to absorb carbon dioxide and extract inorganic nutrients from water, makes them perfect biofilters that, if integrated with fish aquaculture, can increase both the economic and environmental benefits from the farming areas (FAO, 2021; Nordregio, 2022; Barbier et al., 2020).

This multitrophic integration is called IMTA and is one of the main discoveries that has recently triggered the integration of seaweed, now seen as a biofilter and source of food, into national plans. The attention towards the IMTA method is attractive as seaweed can filter aquaculture farms’ fecal

residue, feed wastes and other nutrients in just one night (Tullberg et al., 2022). Seaweed's potentials for environmental, economic and social sustainability, thanks to IMTA could be achieved promptly (Hossain et al., 2022). This method, building on seaweed's potentialities, could help to sustain a high-volume production of seaweed, while storing carbon and filtering aquaculture farms wastes. The possible economic revenue, not to mention the other associated benefits, makes it appealing, but a lack of uniform regulations and technical constraints makes it hard to establish at the moment in the European context (FAO, 2021, EC, 2022). The European Commission (2022, p.32) has introduced the IMTA into its Blue Bioeconomy plan, as "The development of combined forms of aquaculture, algae with mussels and fish – IMTA, and seek for synergies and multi-use of space at sea, e.g., combining offshore wind parks and seaweed". Furthermore, a series of studies to increase the expertise and knowledge have been promoted by the Commission (2022, p.33):

- "Shellfish, Algae and Nutrients (2022-2023/4) will assess the potential of shellfish and algae to recycle nutrients and to estimate the greenhouse gas emissions generated by their production, will develop digital maps that must provide complete coverage of EU seas.
- Algae & Climate (2022-2023) will estimate the nutritional yield of various algae species, the proportion of an animal feed that can be displaced by algae, the costs and greenhouse gas emissions of algae production benchmarked against land-based crops, the land area that could be used for inland production of algae.
- The JRC's Biomass Mandate aims to provide data, models and analyses on EU and global biomass supply and demand and its environmental, social and economic sustainability. It covers all sources of biomass, including from algae and all uses."

Along with great interest, the Commission (2022, p.18) shows also concerns about the possible implications of an expanded seaweed aquaculture by declaring that there is a need for "increase knowledge on environmental benefits of seaweed aquaculture, such as carbon and nutrients capture and carbon sequestration". This request serves as trigger for knowledge and expertise so that scientific studies can be conducted in this field. Furthermore, the current status of the sectors is fragmentated with different methods and production standards throughout Europe, creating a difficult environment for innovation to happen and expertise to be shared (Araujo et al., 2021). Monitoring of production happens differently between EU members, leading to a "very fragmented situation due to insufficient occurrence data in the Member states" (EC, 2022, p.45).

Denmark has been a leader of seaweed research for 100 years, with multiple research groups from Danish universities that are involved in seaweed research on biochemical and active compounds, gastronomy, biorefineries and cultivation improvement (FAO, 2018). Manual harvesting is still the primary method of harvesting in Denmark, as mechanical harvesting is still under development (Araujo et al., 2021). Recently, in a comparative study between algae and mussels, conducted by the Danish Technical University, it was shown how both species work efficiently as biofilters in IMTA farms, and how IMTA is the best tool to mitigate the effects of fish monoculture (Holdt and Edwards, 2014).

Another study, conducted between Aarhus, Copenhagen and Roskilde University, have demonstrated how, when applied to seaweed, the implementation of mussel cultivation methods (consisting in five longlines anchored at the bottom of the seabed and on the surface with buoys), can increase the productivity and mitigate carbon more efficiently (Zhang et al., 2022). Furthermore, it was noted how these systems could be expanded into bigger areas without compromising the method's efficiency (ibid.). This study poses the basis for the application of the method on a bigger scale and increase Danish algae production. Other studies focused on the development of IMTA expertise and the sharpening of the integration method. Additionally, it was proved that the integration process can help reduce disease transmission, improve aquaculture's quality production and maintain fish farming while making it more environmentally sustainable (Hossain et al., 2022).

Lastly, following the European Commission's request on further studies on the safety of algae for consumption and other commercial uses, a study conducted by the Danish Technical University of Denmark demonstrated how seaweed poses no risk for consumption. However, a constant control of the levels of mercury, cadmium and lead should be performed continuously and a common regulation within member countries of the EU should be implemented (Monteiro et al., 2019). Danish universities' expertise and contribution towards the discovery and comprehension of algae's potentialities demonstrates their active process in their resourcification.

In conclusion, as the FAO report from 2018 shows, Denmark is a leading country in pilot studies for seaweed aquaculture and the implementation of these project on an industrial scale, so that a higher demand of algae products can be satisfied.

5.3 Legislation

In the recent years some regulations, ranging from food and medicine to environmental conservation and coastal acts, were implemented within the EU and Denmark. The legislation this section will focus on follows the definition stated up here, meaning that all the legislative forms discussed here reflects it. EU and Danish legislations connected with algae will be presented here as part of the facilitation strategies undertaken by both the public and private sector for resourcification.

Resourcification can be facilitated through the implementation of laws that allows the legal and non-legal coercion of assets by governmental bodies (Bridge, 2014). State and governmental bodies, like Denmark and the EU, are the ultimate regulators of what is considered a legal coercion of resources, and the legislations that they favor can either speed up or slow down a resourcification process. As Smith (1990) notes, the state can ease the capitalist form of production's expansion by emanating laws, which can facilitate the adoption of new technology, obtaining extraction licenses etc.

Lähteenmäki-Uutela et al. (2021) highlights how legislation at the EU-level is important as they can impact the final products, but also the primary producers. Chapter 5 of EU Bio Blueconomy plan for algae solely revolves around ongoing and possible future policies that the EU could implement to favor the development of the algae industry. Inside this plan there is the EU4Algae project, aimed at "innovation and market access, contributing to increasingly sustainable production of algae, ensuring safe consumption and boosting innovative use of algae and algae-based products in the EU", which is presented as powerful way to accelerate the growth of the sector (EC, 2022, p.28). This project is said to benefit from business supporting mechanisms that the Commission has created: BlueInvest and Aquaculture Assistance Mechanism (Ibid.). The former is aimed at supporting "innovation and sustainable technology for blue economy" and the latter at supporting implementation of aquaculture in the EU (ibid.). Along with these points, a list of possible policies "to boost" the sector is presented (Ibid., p.34). Here algae, especially seaweed, are framed within different sectors: ranging from the food and animal feed to cosmetics and fertilizer ones. In these sectors multiple standards must be maintained if product wants to reach its customers.

Specific regulations on food safety specifically tailored for seaweed are very few at the moment, but the introduction of algae into country specific plans shows the first signs of governmental interest in the subject (Nordregio, 2022; Barbier et al., 2020). In particular, the regulations in which seaweed are framed concern food, medicine, cosmetics, packaging and now even environmental protection (Lähteenmäki-Uutela et al., 2021; Filbee-Dexter et al., 2021). Regulations here create the perfect loci for resourcification practices, and as was shown previously, the narrative revolving around seaweed addresses it as a super food, a possible solution to climate change, and as the hidden champion of the ocean (Hultman et al., 2021). Seaweed aquaculture is regulated in the Maritime Spatial Planning Directive 2014/89/EU as a possible way of maintaining a good ecological status while promoting economic development (EC, 2022; Teresa Camarena Gomez and Lähteenmäki-Uutela, 2020).

Denmark is moving in this direction, following the EU's aim to achieve the European Green Deal, by implementing sustainable solutions which in some case include algae (EC, 2022). The Danish Ministry of Food, Agriculture and Fisheries (2014) adopted the Aquaculture Strategy 2014-2020 to sustain aquaculture while reducing its carbon emissions. Seaweed was introduced here to reduce aquaculture's emissions and improve the sector's sustainability through the implementation of the IMTA method. In the strategy, seaweed is promoted along with mussels as "Another nutrient-reducing measure", showing how aquaculture could benefit from seaweed's integration in the sector (ibid., p.10). Furthermore, given the increasing interest towards seaweed as food, the Danish Veterinary and Food Administration has released advice and guidance to both customers and producers on the standards, the customer base and the approval/registration that seaweed products must have (Nordregio, 2022, DVFA, 2020). Within these guidelines, seaweed is addressed as result of wild harvesting and consumption products with content of processed animal origins (DVFA, 2020).

The legislations supported by the EU and promoted by Denmark, represent types of plans, documents and regulations aimed at favoring the use of algae. These institutional actions frame algae within sectors, i.e. aquaculture and food, so that their introduction and exploitation can be done within a legal framework. These legislations create attractive loci for investors and private actors to prosper, which at the moment is the biggest barrier for the prosperity of the algae sector.

Following this, legislation that regards the acquisition of farming licenses, which at the moment are low, are expected to grow (Araujo et al., 2021). The Danish Coastal Agency grants a five-year license by evaluating, and revaluating at the end of the licensing period, the impacts of the given activity on the environment (Teresa Camarena Gomez and Lähteenmäki-Uutela, 2020). The licensing process is currently very long, since it can take around 15 months, while only lasting a short period (5 years), thereby making the whole seaweed farming process (or IMTA) unappealing to private companies (Ibid.). This example represents the main challenge that so far both private and public actors have found within the algae sector: a lack of aligned regulations, policies and standards.

Private actors, like Seaweed for Europe and Lloyd's Register Foundation, campaign for a more uniform set of regulations by governmental actors. For the Foundation (2020, p.9) "There is currently a lack of aligned and specific policies, standards and regulations to support a sustainable upscaling of the industry" with Seaweed for Europe (2020, p.34) supporting the "inter alia by targeted regulatory policies adapted to the particularities of seaweed". Both actors manifest a common sentiment that private actors have towards public institutions and their lack of attention to the topic. The European Commission (2022, p.19) recognizes this tendency too: "Regarding more downstream legislation, there are differences between the EU Member States in terms of certain, non-harmonized at EU level, food safety measures such as not exceeding iodine thresholds in algae biomass before commercialization. Such differences between countries have created discords between suppliers and buyers across borders and lead to commercial tensions".

Private actors campaigning for unified regulations are an example of Braun's (2020) mobilization of legal systems that creates more attractive conditions for investments. The tensions the commission refers to, could accelerate the unification of regulations and standards in the sector. Legislation processes easing algae resourcification were presented here, with the introduction of seaweed and algae in EU and Danish regulations that represents this trend. The request by private actors, Lloyd's Register Foundation and Seaweed for Europe campaigning for clear and unified regulations around seaweed, and the EU introducing it into its Blue Bioeconomy plan, are an example of how legislative processes are moving towards a well-defined locus for algae resourcification. The processes are eased in this sense, but the licensing process being lengthy makes it in the Danish case of low attraction for massive investments yet.

5.4 Valuation System

The last condition that makes a resource as such is its introduction into systems of valuation called regimes of value. In order to understand if algae are valuated and how, a premise must be made. Algae, given its role as biofilter in tidal mitigation, carbon sequestration and as marine habitat, represents an ecosystem service (Araujo et al., 2021).

It is hard to ascribe value to these natural systems as they play an important role that does not require labor, thus being value deprived (Huber, 2016). Marx defines value as the necessary social labor time to generate a commodity (Ibid). In this case, ecosystem services do not fit this definition. Therefore, to understand how algae are given value, one needs to understand how these services work. Ecosystem services have multiple use values, which complicates their reduction to a single commodified service (Huber, 2016). The value of these services must then take into account these different use values, while also considering the exchange one.

The valuation (exchange value) of ecosystem services is thus the result of measures and negotiations that capitalists, scientists and regulators develop (Ferguson, 2012). In my case, capitalists are the private actors, i.e. Seaweed for Europe and Lloyd's Register Foundation, that work with regulators, public institutions, and scientists to give some kind of value to algae. Unlike exchange value, use value is the result of moral and cultural frames that society grants to a resource (Huber, 2016). Value contains both economic and social meanings, and the resulting regimes are a representation of this tension (Huber, 2016). All in all, the valuation of algae, achieved through their introduction into regimes of value, is a product of the combination of social frames: changes of perception, institutionalized activities (e.g. legislative work) and scientific works. Moreover, use value affects the exchange one, as without utility nothing can be valuable (Ibid.).
Whereas the use value is the result of moral and cultural frames that society grants to a resource (Huber, 2016). Value contains both economic and social meanings, and the regimes are a representation of their tension (Huber, 2016). Valuation of algae, through their introduction in regimes of value, is then the combination of social frames, like a change of perception, institutionalized activities, like the legislative's ones, and scientific works that help measure their value. Use value affects the exchange one as without utility nothing can be valuable (Ibid.).

The change of perception advertised by private actors allows the abstraction of algae to be based on new premises. If historically algae were only used in coastal communities, nowadays, given the new perception of seaweed as healthy food or hidden champion of the ocean that Lloyd's Register Foundation and Seaweed for Europe are trying to advertise, awareness regarding this resource is changing. The switch from liminal resources to a "promising ocean resource" full of potential waiting to be exploited, has been promoted by the aforementioned actors and has even reached the institutional ones (EC, 2022, p.10). After all, seaweed can help filter aquaculture wastes, store carbon and provide nutritious food too. With its multiple possible usage and benefits, algae could satisfy capitalism's need for constant expansion, all the while providing profit (Smith, 1990). The value that algae have is also the result of changes in technology and knowledge, with great interest revolving around algae and their still undiscovered potential. Algae's most interesting potential consists of in demonstrating their efficiency as a biofilter and as a carbon storage solution.

Algae are currently a great topic of interest for the scientific world: in particular, in Denmark there are several research groups involved in the discovery of new biochemical, gastronomical and cultivation-related improvements (FAO, 2021). The creation of value is here associated with the discoveries and deepening of knowledge that allow a better measurement of algae's value in light of their potentialities and the current know-how on how to exploit them. In its plan, the European Commission has requested more information and data on algae's possible negative impacts and benefits (EC, 2022). This request can significantly boost the scientific value that algae have in the academic community and make them become a more dominant topic in research.

Algae's increased value is the result of their introduction into strategic plans, regulations and scientific studies. The EU's institutionalized activities, like the EU Blue Bioeconomy plan, represent a form of introduction of algae into regimes of value. In the plan, the value attributed to the aquatic resource is multifaceted and ranges from the economic type to the systemic one. Algae are then inserted into IMTA systems for the good management of marine ecosystems or into dynamics of marine reforestation as a key component of a systemic response to environmental degradation. Furthermore, both the EU plan and the Danish strategies for aquaculture are a representation of how value is created by a region's capability to attract and participate in value added activities that the international market demands (Huber, 2016). The two actors here seize an opportunity that the marine environment and algae offer and that until now was not accessible.

The introduction of algae to IMTA projects benefits the expansion and sustainability that the aquaculture sector has and satisfies the increased demand for food, coming from both fish and vegetarians, that the market is experiencing. Another institutionalized process can be the demand for carbon mitigation strategies and the relative market surrounding it. A recent trend in marine reforestation revolves around the discovery that underwater forests can support carbon mitigation strategies (Filbee-Dexter et al., 2021). The valuation process here, as with inland forests, resides in the calculative processes that show how many trees are necessary to absorb enough carbon to realize a significant offset (Huber, 2016). The need to reach zero net emissions according to the Paris Agreement favors the expansion of mitigation strategies, like carbon sequestration, where algae can fit (Himley et al., 2022).

Algae have been inserted in plans and regulations, thereby clearly showing that the resource is in existing, and ongoing, regimes of value. For example, in the case of economic value, one cannot help but notice how its growth is directly proportional to that of public interest towards it. Bearing that in mind, the explosion of algae's economic value has yet to be reached, but great margins of growth have been proved to exist with a possible value of demand ranging between 3 and 9 billion euros in 2030 (Seaweed for Europe, 2020). The economic value of algae was estimated to lie around 350 million € in 2018 in European countries (EC, 2022). Considering the 500 million € worth of imported seaweed in 2016, the demand is relevant, and the possible economic revenue generated from the algae sector is increasing (ibid.). In Denmark the trend is similar, with a value of 1 760 000 USD in imported seaweed in 2016, showing that the interest in seaweed at a national level is vivid, but has yet to reach its peak (FAO, 2018).

As per Bridge (2009), the utility and value of a resource are not fixed in time, but are rather the product of the technology and culture of a given time. In this case, the utility that confers value to algae is the change in perception that is currently ongoing, not to mention the new knowledge and expertise that research is developing around the resource. Culturally wise, the public's perception of algae is becoming more and more favorable, as the increasing demand for algae consumption and its introduction into sustainability and blue economy plans like the EU and Danish ones. This means that now, from a cultural point of view, there is a favorable condition for algae to be accepted by more and more people and thus raise its value as a resource.

As the recent increased demand in consumption of algae shows, the use value of algae as food is becoming more accepted (Araujo et al., 2021). Social and cultural frames of algae as a healthy food and carbon storage solution make the use value and the utility of algae relevant in society. Furthermore, technological processes, like the mechanical harvesting and the IMTA aquaculture, are becoming advanced and efficient enough to support the industrial production of algae. The intersection of technological progress and cultural acceptance creates the perfect situation for algae to prosper and their resourcification process to happen.

In conclusion, the valuation of algae is the result of different processes that make its value grow within society. Without a change in perception, in Europe algae would not be a well-known resource, their great utility would not be considered, and no value would be associated to them. The scientific discoveries and the possible profit they could generate serve in this sense to create the value the resource has.

Conclusion

In recent years, growing attention has started to be given to algae due to their economic, environmental and social benefits. Critical resource geography has aims at comprehending resource systems, with a focus on how and why resources become meaningful, as a key to understand the state of the world. By using the case study above, this works aims at contributing to the expansion of knowledge on the topic, by investigating how the conditions for resourcification are unfolding in Europe and Denmark and assessing the extent to which this process is occurring.

In this article the way every condition of resourcification is currently occurring in Europe and Denmark was explained, demonstrating how the process is in fact underway at the moment. In both Europe and Denmark, the economic, social and environmental potential of algae has been recognized and introduced into plans and regulations for the development of the algae sector. The development of new knowledge and technologies has fostered the growth of the sector, which, however, finds the lack of common regulations between the various EU members to be the main barrier to expansion. It is therefore possible to say that resourcification is taking place, but that it has not yet come to an end. The conditions are happening, but at the moment it is neither possible to speak of a full maturity of the legal system, nor of a full acceptance at a consumer level. Further developments in the technological and scientific fields, but above all in the legal one, are necessary for a full realization of their profitability. The recognition and promotion of algae's potential by institutional actors, such as the EU and the Danish government, together with private actors, such as Lloyd's Register Foundation and Seaweed for Europe, have been cited as the main reasons behind the transformation of algae into a resource. These actors are actively working to implement the use of algae, so as to unlock a new resource that will help generate greater sustainability and profit. The resourcification of algae is happening in response to a growing search for sustainable and profitable solutions that can help tackle climate change.

During the analysis a certain tension between private and public actors for the implementation of a uniform legislation was noted. Future studies on algae and their resourcification could focus on those tensions. It was also noted, on a more theoretical level, that clear and standardized conditions, together with analytical frames, are missing within current resource studies. Causes and reasons behind resourcification are presented, but never in a systematic and analytic way, which

could heavily favor the identification of the process and its subsequent study. Following Hultman et al.'s (2021) work, such a systematic unraveling of the process was attempted.

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