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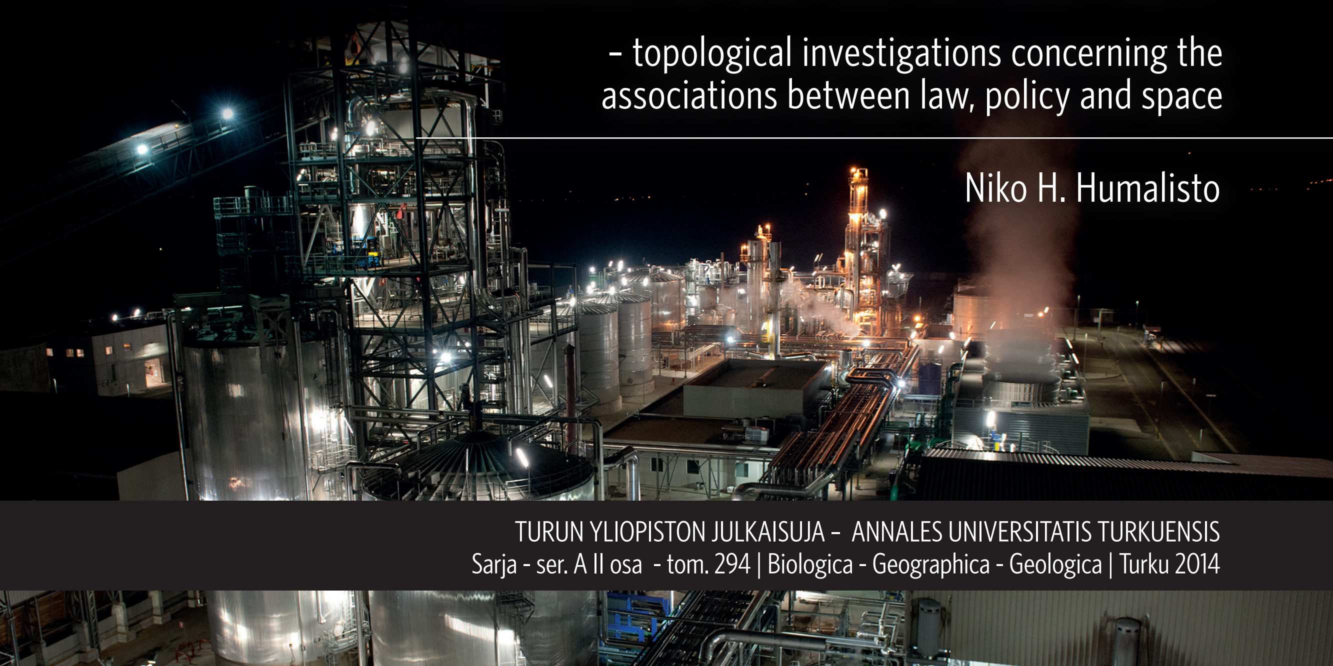
THE EUROPEAN UNION AND ASSEMBLING BIOFUEL DEVELOPMENT

– topological investigations concerning the associations between law, policy and space

Niko H. Humalisto



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This thesis consists of summary, synopsis and the following articles that are referred to in the text by their Roman numerals:

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(IV) Humalisto, N., Joronen, M., 2013. Looking beyond calculative spaces of biofuels: Onto-topologies of indirect land use changes, *Geoforum*, 50, pp. 182–190.

CONTENTS

SUMMARY

Biofuels for transport are a renewable source of energy that were once heralded as a solution to multiple problems associated with poor urban air quality, the overproduction of agricultural commodities, the energy security of the European Union (EU) and climate change. It was only after the Union had implemented an incentivizing framework of legal and political instruments for the production, trade and consumption of biofuels that the problems of weakening food security, environmental degradation and increasing greenhouse gases through land-use changes began to unfold. In other words, the difference between political aims for why biofuels are promoted and their consequences has grown – which is also recognized by the EU policy-makers. Therefore, the global networks of producing, trading and consuming biofuels may face a complete restructure if the European Commission accomplishes its pursuit to sideline crop-based biofuels after 2020. My aim with this dissertation is not only to trace the manifold evolutions of the instruments used by the Union to govern biofuels but also to reveal how this evolution has influenced the dynamics of biofuel development.

Therefore, I study the ways the EU's legal and political instruments of steering biofuels are co-constitutive with the globalized spaces of biofuel development. My analytical strategy can be outlined through three concepts. I use the term 'assemblage' to approach the operations of the loose entity of actors and non-human elements that are the constituents of multi-scalar and -sectorial biofuel development. 'Topology' refers to the spatiality of this European biofuel assemblage and its parts whose evolving relations are treated as the active constituents of space, instead of simply being located in space. I apply the concept of 'nomosphere' to characterize the framework of policies, laws and other instruments that the EU applies and construes while attempting to govern biofuels. Even though both the materials and methods vary in the independent articles, these three concepts characterize my analytical strategy that allows me to study law, policy and space associated with each other.

The results of my examinations underscore the importance of the instruments of governance of the EU constituting and stabilizing the spaces of producing and, on the other hand, how topological ruptures in biofuel development have enforced the need to reform policies. This analysis maps the vast scope of actors that are influenced by the mechanism of EU biofuel governance and, what is more, shows how they are actively engaging in the Union's institutional policy formulation. By examining the consequences of fast biofuel development that are spatially dislocated from the established spaces of producing, trading and consuming biofuels such as indirect land use changes, I unfold the processes not tackled by the instruments of the EU.

Indeed, it is these spatially dislocated processes that have pushed the Commission construing a new type of governing biofuels: transferring the instruments of climate change mitigation to land-use policies. Although efficient in mitigating these dislocated consequences, these instruments have also created peculiar ontological scaffolding for governing biofuels. According to this mode of governance, the spatiality of biofuel development appears to be already determined and the agency that could dampen the negative consequences originating from land-use practices is treated as irrelevant.

TIIVISTELMÄ

Liikenteen biopolttoaineiden edistämisen julistettiin ratkaisevan useita Euroopan union (EU) ongelmia liittyen kaupunkien ilmanlaatuun, maatalouden ylituotantoon, energianturvallisuuteen ja ilmastonmuutoksen hillintään. Varsinkin satopohjaisten biopolttoaineiden kehitys on kuitenkin osoittautunut haasteelliseksi. Vasta kun EU oli luonut poliittisten ja juridisten instrumenttien viitekehyksen kannustamaan biopolttoaineiden tuotantoa, kauppaa ja kulutusta, paljastuivat niiden aiheuttamien maankäytön muutosten ei-toivotut seuraukset kuten ruokaturvallisuuden heikkeneminen, ympäristövahingot ja lisääntyneet kasvihuonekaasupäästöt. Näin ero biopolttoaineiden edistämisen päämäärien ja edistämisen aiheuttamien seurausten välillä on kasvanut. Tämä on tunnistettu EU:ssa, minkä vuoksi Euroopan komissio on ehdottanut, että satopohjaiset biopolttoaineet syrjäytetään asteittain vuoden 2020 jälkeen muilla vaihtoehdoilla. Voimakas poliittisen linjauksen muutos uudistaa globaaleja biopolttoaineiden tuottamisen, kuluttamisen ja kaupan verkostoja, joita EU:n aiemmat poliittiset instrumentit ovat olleet synnyttämässä.

Tarkastelen väitöskirjassa tapoja, joilla EU:n biopolttoaineiden ohjauspoliittiset instrumentit ovat olleet vuorovaikutuksessa biopolttoaineiden globalisoituneiden tilallisuuksien muodostumiseen. Analyyttinen strategiani nojaa kolmeen käsitteeseen. Käytän termiä ”kokoonpano” (assemblage) lähestyäkseni ihmis- ja ei-inhimillisten toimijoiden muodostamaa löyhää, monilla skaaloilla operoivaa kokonaisuutta ja sen toimintoja. ”Topologialla” tarkoitan tilallisuutta, jonka Euroopan biopolttoainekokoonpano ja sen osat muodostavat aktiivisessa vuorovaikutuksessa toisiinsa sen sijaan, että tilaa käsiteltäisiin pelkkänä sijaintina. Käytän ”nomosfäärin” käsitettä luonnehtiakseni sitä viitekehystä, jonka EU on rakentanut ja jota se soveltaa yrittäessään ohjata biopolttoainekehitystä. Vaikka sekä materiaalit että metodit vaihtelevat väitöskirjan artikkeleissa, nämä kolme edellä esitettyä analyyttistä työkalua leimaavat tutkimusstrategiaani, jossa tarkastelen tilaa, politiikka ja lakia toisiinsa kytkeytyneinä.

Tarkasteluni tulokset korostavat kuinka suuressa merkityksessä EU:n biopolttoainekehityksen hallinnan instrumentit ovat olleet tiettyjen tilallisten järjestysten muotoutumisessa ja kuinka topologiset murtumiset ovat voimistaneet tarvetta poliittisille reformeille. Analyysi kartoittaa sekä laajan joukon toimijoita, jotka ovat tulleet EU:n ohjauspolitiikan vaikuttamaksi, että tapoja, joilla toimijat ovat osallistuneet institutionaalisen politiikan ja biopolttoaineiden tilallisuuksien rakentumiseen. Vakiintuneiden biopolttoaineiden kuluttamisen, kaupan ja tuotannon tilojen ulkopuolelle leviää vaikutuksia, joita tarkastelen spatiaalisesti sijoiltaan olevina ilmiöinä, joista keskeisimpänä esimerkkinä ovat epäsuorat maankäytön muutokset. Näiden tilallisuuksien tarkastelu paljastaa niitä rajoja, minne EU ohjauspolitiikka yltää ja mitä jää sen ulkopuolelle.

Vaikka Euroopan komission uudet ilmastopolitiikkaan perustuvat instrumentit ovat tehokkaita pysäyttämään näitä sijoiltaan pakenevia ilmiöitä, ne ovat myös luoneet omaleimaisen ontologisen rakennelman biopolttoaineiden ohjaamiseksi. Tämän ohjaustavan mukaisesti biopolttoaineiden tilallisuus näyttäytyy etukäteen määräytyneeltä. Sen vuoksi toimijuutta, jolla voisi hillitä maankäytön muutosten haitallisia vaikutuksia, käsitellään poliittisesti lähes tarpeettomana.

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I accept as truth that dissertations are born out of multiple ambitions and motivations – and their rhizome-like associations. Following the trail of factors that have influenced the emergence of the situation in which you are reading my work and acknowledging of those is, subsequently, a challenge not easily overcome. Well, what does a scientist do in these types of situations? S/he creates a methodology for examination, naturally. My approach is that, instead of simply mapping these factors, I characterize the key events and actors related to those along this non-linear path of successes and, importantly, also failures. I draw a processual picture, not accurate or sharp, but meaningful to myself.

It is reasonable to mention purely from the perspective of academic objectivity that, by hearth, I am an environmental and social activist deeply concerned about the degrading ecologic conditions in the versatile ecosystems around the globe – if you allow me to be a bit dramatic here! Nonetheless, this concern is also my key motivation of doing academic research with an interest how do we as individuals, communities or societies encounter and form relations to our environments. First things to acknowledge, therefore, are the key moments leading to this path of being concerned. I wish to credit my parents who took me often enough to nature parks and summer cottages to just to be in and to get acquainted with nature and also to see changes in environment, such as forest loggings, drained swamps and the eutrophication of lakes. Following this trail forward, I have to credit Finnish public broadcasting company (YLE) for their nature documentary series *Avara luonto* since 1984. As a child eager to acquire information about our planet, those were truly events in Saturday evenings; to be able follow how unfamiliar and intriguing animals, indigenous forest communities, marshlands, fungi, coral reefs and other biotypes are presented to you. These stories, however, did not often have happy endings the final words being: 'these ecosystems are under human pressure and risk becoming extinct if no action is taken…' I honestly wonder: how many people have become activists through following these programs?

While my studies at the Geography department of the University of Turku, I encountered three mediums for conveying my awareness into action. Thank you *Friends of the Earth* for making me understand what global grass-root activism and encountering the Global South in equal terms is about. Thank you *Greenpeace* for exemplifying what it truly means to be politically incorrect. Thank you *New Wind* association and people around *s/v Estelle*. Here I learned to believe in the possibilities of accomplishing impossible things and the capacities of people to express solidarity even in the most dreadful times.

It was around 2006 when it began to unfold how the ambitious political push of the European Union towards biofuels could lead to the increasing utilization of tropical feedstocks such as palm oil. Therefore, environmental non-governmental organizations began to re-think their position on these green-labelled fuels. I remember an email from one Friends of the Earth activist questioning 'how it came to this, wasn't biofuels a *good* thing'. Truly, I have to thank the European Union for making things interesting, challenging and complex. Indeed, *how* it came to this? I have an impression that, in Finland, this growing tension between aims and outcomes of EU biofuel development was first recognized and fully understood by *Otto Miettinen* who heavily influenced that I received a position in *Finnwatch* to prepare a report on the use of palm oil as biodiesel. The report was clearly a stepping stone because, while writing it, I encountered such challenging questions that this dissertation is about providing answers to those.

For me, being accustomed to work in technically not-so-functional environments and eating re-heated, bucket-carried leftover elementary school food in my earlier profession, the conditions of work are mostly related to people and the ways I am inspired by them. First and foremost I would like to contribute *Risto Kalliolla*, the head of our department, for being encouraging and respective from the beginning of my studies to the finalizing of this work and, if the pattern continues, likely in my future work in our department. *Annukka Malmsten*, I honestly admire your navigation skills in the wild jungles of university bureaucracy. Concerning my supervisors *Jussi Jauhiainen* and *Timo Vuorisalo*, they have – probably unknowingly from the roles of each other – made a balanced team for pushing this work forwards the former making the necessary critical remarks and questioning my intentions such as: 'Isn't Deleuze passé' and the latter telling how wonderfully things are moving forward and how brilliant my research is, against my own impression of it! *Leena Laurila*, regardless of the fact that I probably managed to traumatize your children with our tunnel of horrors in Vappusumppu, you have always been sunny and helpful, keeping things operational. The final touch of my academic writings has not usually been my own but *Suzanne Collins*' who I had privilege to meet via the Language Centre of the University of Turku. I thank you for knowing it better how to express my thoughts (in English) than myself. Finally, I had the privilege – unlike many other doctoral students – of enjoying the 100% success with my funding applications. The constant support for this work from the Graduate School of Integration and Interaction in the Baltic Sea Region and the Finnish Cultural Foundation *Juhani Korpivaara*'s Toyota-rahasto has enabled me to focus solely on this work.

Then my co-workers. Without the sometimes kind and encouraging, sometimes brutally honest critique of *Mikko Joronen*, this dissertation would not have seen the light of day. *Rebecca Frilund*, because of you, I haven't considered the worst hippie of our department and, further, I am probably not the only one who is inspired by your personal commitment to your research topic. *Katri Gadd*, the same goes to you – except the hippie part. *Hanna Luhtala*, with your sarcastic remarks you have kept me self-critical and well-prepared for the comments of peer-reviews. *Lauri Hooli*, your relax presence and moustaches have been the light in the short days of winter. *Pauliina Nordström*, I admire your courage to enforce your creative freedom also in the not-so-flexible realm of academic writing and capacities to look beyond. I thank you *Riina Lundman*, not for your academic expertise, but mostly, for being here co-working and co-experiencing the ups and downs of the process of becoming a doctor. *Maija Suomela*, long you were my only contact with the world out there external to academia concerning this topic and without your robust interpretations, encrypting the directives would have been much more challenging. For my children, my ex- and current significant other and her children, I thank you for not being too interested in the content of my research thus making it possible to disengage from my work while being at home(s).

Writing these acknowledgements actually made me very joyous. With my syndrome of going forward with high intensity, it is desirable that at some points I am forced to look also backwards. One might learn something, like that making dissertation can be the time of your life when you have the most degrees of freedom, when there is space to venture in new directions and to encounter failures with the confidence that you are supported and accepted. Time of creativity and the following examination is my creation; which, in fact, is also yours.

1 INTRODUCTION

1.1 Focus on EU biofuel development

The importance of transport for the functioning of the European Union (EU) is emphasized by the European Commission while stating that: '[T]transport is fundamental to our economy and society. Mobility is vital for the internal market and for the quality of life of citizens as they enjoy their freedom to travel' (CEC, 2011b: 3). However, new solutions are desperately needed in transport as it has been the EU's only economically significant sector to increase its emissions after signing the Kyoto protocol in 1997, and moreover, the EU's imports of oil and gas amounted to more than 400 billion euro in 2012 (CEC, 2013b; 2014). The business-as-usual scenario of the energy consumption of the EU does not look promising for the development of energy security as International Energy Agency (IEA, 2013) estimates that the Union's reliance on imported oil could grow to more than 90% by 2035 while the centre of gravity concerning energy demand moves increasingly towards emerging economies in Asia, Africa and South America. The EU, subsequently, aims to curb 60% of its GHG emissions by 2050 and simultaneously seeks to mitigate its oil dependence. Biofuels, as a potentially domestic, renewable source of energy that can reduce GHG emissions in comparison to fossil fuels, have a significant role in achieving the environmental, economic and climatic targets set for transport according to the European Commission.

Although some of the Member States of the EU have almost a century-long tradition of developing biofuels for transport (Lampinen, 2008a), the continuous biofuel policy development in the EU dates to the early 1990s when the Commission made proposals for easing the market penetration of biofuels. Biofuels are a versatile source of renewable energy because they are refined from a wide range of organic feedstock, such as the crop-based alternatives of rape, corn and palm oil, the wastes and residues of forest industries, food and agricultural industries, and genetically modified algae and microbes that are designed in laboratories. Moreover, these feedstock can be refined into renewable butane, methanol, ethanol, hydrotreated vegetable oils, esterified biodiesels, synthetic biogases and many others (see IPCC, 2011, Chapter 2; Speigh, 2011). Originally in its transport and energy strategies, the Commission argued that through promoting biofuels it would not only be possible to curb the GHG emissions of transport but also to improve urban air quality, make better use of organic wastes, solve the problems of stagnating agricultural development in the EU, improve the European energy security by lowering the need for energy imports and diversifying the EU energy palette, and to support regional development (e.g. CEC, 1995; 1997).

In spatial terms, the growing consumption of biofuels in the Union throughout the 2000s has not only influenced the EU Member States. When one begins to follow the actors who are producing, researching, financing and trading biofuels consumed in the EU, associations quickly take the observer from the industrial oil palm plantations of Indonesia to Finnish food industry waste, from technological research institutes to oil industry lobby groups operating in Brussels, from the financing decisions of the international investment banks to the land right claims of displaced communities in Uganda. Certainly, biofuel development has created a complex constellation of associations between human actors and elements located around the globe. This is so because, since the 1990s, the EU has not only become the third largest producer of biofuels after the United States and Brazil, but also the largest biofuel importer of the world (see Systèmes Solaires 2013, Lamers et al., 2011). The consumption of biofuels also associates spaces external to the Union via trading land (LandMatrix, 2014), financing biofuel investments (Sheppard & Mittal, 2010) and constructing the ubiquitously applicable calculative instruments of biofuel governance (Levidow, 2013).

Concurrent to the fast growth of biofuels consumption in the EU, which reached a 5% share of energy consumption in road transport, concerns have been raised over whether biofuels are, after all, climatically, socially or environmentally more feasible alternatives to fossil fuels. The critique is established on the negative sequel catalysed by direct and indirect land-use changes, especially in tropical forests, as they release carbon sequestered rom soils into the atmosphere (e.g. Hooijer et al., 2010; Laborde, 2011), disturb the circulation of water and diminish regional biodiversity (Fargione et al, 2010; Harvey & Pilgrim, 2011). Moreover, biofuel development has contributed to the expansion of the industrialized plantations that have catalysed detrimental consequences for the subsistence farmers of the Global South (Sassen, 2013; Lee et al., 2010), and further, by allocating food for fuel, increased the volatility of food prices and weakened the global food security (HLPE, 2011; OECD/FAO, 2012).

Therefore, tension has mounted between the political aims that the Union seeks to reach through increasing the share of biofuels consumed in transport and the actual consequences and benefits of fast biofuel development. Against this backdrop of complexity and rapid evolution, my general purpose in this dissertation is to examine the plethora of topological consequences that EU biofuel development has constituted around the globe. Moreover, I explicate how the political and legal instruments of the EU have not only influenced but also been influenced by these evolutions. In other words, this dissertation is about how the EU's legal and political instruments of steering biofuels have been co-constitutive in relation to the spaces of biofuel development. As a contribution to the existing literature about the biofuel policy formulation of the EU, and to fill the gap concerning the role of space and scale in studies concerning energy transitions (e.g. Coenen et al., 2012; Bridge et al., 2013), I do not merely examine the evolving modalities of governance and the institutions involved but I trace the implications of Union's political and legal instruments in the spatially multiform *entity* loosely assembled around the biofuel development of the EU.

1.2 The research design and its theoretic foundations

The research strategy of this dissertation is built on the works of Manuel DeLanda, a Mexican philosopher who has drawn some attention in geographic discussions with his writings on assemblages and topology. For instance, Escobar (2007; 2008) has introduced DeLanda to scalar debates and as a defender of scientific realism, Anderson et al. (2012) discusses how materiality and policies operate in assemblages, Dittmer (2013) founds the assemblage approach useful in discussing materiality in geopolitics, Anderson (2012) studies place and temporality through this approach, and Prince (2010) examines how policy transfer operates in the context of global assemblages. However, DeLanda has been treated as little more than a curiosity in the mainstream geography even though, as it will be demonstrated in this dissertation, his thoughts can be applied to thinking about human/nature interaction and the geometries of spatial explanation.

DeLanda's contributions are discussed in detail in the synopsis, because I have applied them in the four separate, nonetheless closely interconnected, researches in which I examine how policies operate in the loose entity that might be characterized as the European biofuel assemblage. As highlighted earlier, there is neither a scale as such nor a single spatial form, such as locally refined rape methyl ester, in which the dynamics of EU biofuel development occur. Therefore, I take multiple entries to examine how space, policies and law influence in the formation and development of this assemblage. The research questions are:

1) How has the EU's mode of governing biofuels evolved in relation to the changing topology of the European biofuel assemblage? (Article **I**)

2) Do the policies and legal instruments of the EU Member States have the capacities to tackle the increasingly globalized biofuel development? (Article **II**)

3) What is the constellation of political actors of the European biofuel assemblage and how do they influence the European Union's biofuel policy-making? (Article **III**)

4) How can the topology of indirect land-use changes be characterized and what are the challenges of the Commission's calculative, model-based instruments of governance? (Article **IV**)

Surely, several gaps are left without examination concerning the EU and its biofuel development. For instance, the policy-making processes within the EU institutions and the implications of biofuel development in the Global South are discussed only on the basis of other research and theoretic contributions. Regardless of the frequent notions about economic factors influencing biofuel development, they are not under direct focus. This demarcation is grounded on the fact that the demand, production and trade of EU biofuels are steered through complex networks of incentivizing, regulating and restricting political, legal and financial instruments implemented by the Union. Indeed, the development of biofuels around the globe has mainly been driven by policies instead of markets. Moreover, following the operations of policy insiders within the EU institutions while there are more than 6000 official lobbyers operating in Brussels (Transparency register, 2014) – and several more un-official – would require a larger team of researchers (see Maclin & Bello 2010 on 'event ethnography' and biofuel agenda setting). I also do not explicate the potential negative outcomes of biofuels in detail because the risks related to biofuels have been thoroughly investigated from various perspectives (e.g. Fargione et al., 2008; Harvey & Pilgrim, 2011; Smith, 2010; Thaler, 2013; Windengård, 2012), and what is more, might have been somewhat hyped, especially on the issue of large-scale land acquisitions, so called 'land grabs' (e.g. Hamelinck, 2013). Biofuels as renewable fuels that have the risk to cause negative impacts on climate, environment and subsistence farming are an easy target for critique. Nonetheless, being an easy target does not equate to also being a good target. Subsequently, I find much more purpose in examining the actual relations between the instruments governing biofuels and their implications for this complex development instead of mapping potential risks – especially without unfolding the opportunities.

Various research materials and methods are selected in all of the papers. However, the main sources consist of the EU's and Member States' biofuel legislation and policy initiatives that have been implemented to launch and govern biofuel development. I have additionally gathered comments, press conferences, and the minutes of the plenary meetings in the EU institutions that have taken part in the recent biofuel policy development. Furthermore, I conducted 15 interviews in order to scrutinize how policies and laws have influenced the national biofuel developments of Sweden and Finland (Article **II**, annex 1). For studying the constellation of actors associated with the European biofuel assemblage, I selected the public consultation on indirect land-use changes (iLUC) that was organized by the Directorate-General for Energy, because it gathered a wide sample of the key actors of biofuel development (see DG Energy, 2010). Moreover, as the iLUC policy development has been influenced by agro-economic equilibrium models quantifying the GHG emissions that biofuels can indirectly catalyse (see DiLucia et al., 2011; Gawel & Ludvig, 2011), these models have been examined to unfold the modellers' ontological characterizations of this elusive phenomenon. Additionally, all papers utilized the statistical information concerning EU biofuel development that is prepared by Systèmes Solaires (2004–2014).

What is common in these four independent articles is the use of three analytical concepts: *assemblage*, *topology* and *nomosphere* to unfold how policies and space are affecting and being affected by each other.[1] Next, I will shortly define these, but will elaborate on this topic in the following section of this dissertation that thoroughly grounds my approach by introducing DeLanda to the discussions about spatiality and human/nature relations.

With *topology*, I refer to the type of understanding of spatiality where space is, fundamentally, approached through the relations between versatile actors and elements. The findings presented on absolute, metric space, such as the surface area that has been cleared for biofuel plantations, which have their importance in characterizing EU biofuel development. However, unfolding the connections that make this type of spatiality possible, for example, land conversion technologies, financial institutions, policies governing the preparation of the plantation, are also characterizing the spatiality of the plantations but in *topological terms*. Accordingly, objects are not distributed in space *as such*, but they are the very constituents of space. Importantly, as the crucial differentiation to relational approaches to space, the topological approach here stresses how space cannot be considered solely as an achievement of human agency, because the non-human elements influence, and set boundaries to what space can become.

An assemblage is a term that originates from a book prepared by Gilles Deleuze and Felix Guattari (1988) – *A Thousand Plateaus*. Assemblage is the object of my analysis: an emergent and always unique entity that is constituted from the relations of its parts. Similar to Latour's (2005) conception of actors and networks, each assemblage is constituted of its parts, but nonetheless, individual assemblages are always parts of larger assemblages. Moreover, assemblages are not 'perpetual entities', because they are in the constant processes of assembling and re-assembling the relations between the parts that constitute individual entities. In principle, all entities can be treated as assemblages, for instance, from the ephemeral assemblage of a surfer and a wave (Anderson, 2012) to DeLanda's (1997) analysis of the

1 These concepts have not been explicitly used in all these articles and, further, their characterizations slightly differ from paper to paper. The reason for this is – first and foremost – pragmatic: a researcher has to embed concepts in a framework that is commonly used in the publishing journal. Moreover, reviewers express their views about why some concepts are not suitable at all. Nonetheless, these three concepts have guided the analytical strategies all of the independent articles.

European urban networks. In this dissertation, I have conceptualized a loose entity of the European biofuel assemblage through which I can study how the European Commission's policies and the EU's legal instruments are influencing the arrangements of the versatile parts associated with this entity. Spatiality is closely connected to the analysis of the assemblages, as the ways in which the relations between actors and elements are formed characterize the topological character of an assemblage.

A nomosphere, introduced by David Delaney (2004), conceptualizes the entity of laws, norms and practices that always precedes all human associated spatial differentiation. I use nomospheric thinking to conceptualize the necessary logic that guides EU biofuel development. Certainly, the European Commission does not discover biofuels each time it introduces new biofuel policies, and thus some continuity exists in the evolution of the governance of biofuels. Moreover, the nomospheric approach necessitates exploring the spatial implications of laws and policies: they are always implemented by some actors in some locations. Consequently, this temporal and spatial contextualization of law eliminates the conception of how law could operate without agency (see Olwig, 2005).

2 INTERTWINING SPACE, POLICY AND LAW; EXPLANATIONS THROUGH ASSEMBLAGES

In this section, I explicate more thoroughly how space, policy and law are influencing each other in the framework of topological understanding concerning spatiality. The conceptualizations of this dissertation rest on the shoulders of Manuel DeLanda and David Delaney (and concerning my methodology, also Bruno Latour) who certainly have differences in their understanding about spatial ontology. Nevertheless, they share similarities concerning the performative role of non-human elements in social interaction and the emergent formation of spatiality through the relatedness between elements and human actors. Moreover, they do not rely on the causal modes of explanation. All of these topics have crucial importance in examining the dynamics of the space, law and policy of the European biofuel assemblage.

2.1 Assemblages as a legitimate research object

Manuel DeLanda's writings introduce the key concept of this dissertation, *an assemblage*. DeLanda is a philosopher although his writings are not strictly derived from philosophy in itself, since he exemplifies and grounds his main arguments through the topological geometry of Henri Poincaré (DeLanda, 2010), the urban models of Walter Christaller (DeLanda, 1997) and the sources of authority described by Max Weber (DeLanda, 2006a) to name a few inspirations of his analysis. Escobar (2008) names DeLanda's research orientation as neo-realist, scientific realism without essences (compare, for instance, the realist position of Sayer, 2000: 82). In Castree et al. (2004), DeLanda is affiliated with the more-than-human 'ontological choreography' that approaches entities, including human bodies, always in the middle, influenced by and influencing the manifold processes and intensities of their surroundings instead of accepting any transcendental, essential forms as the basis of ontology.

The term 'assemblage' itself has lately received growing interest as an analytical tool not only in geographical but throughout social and cultural studies (see Collier & Ong, 2005; Marcus & Saka, 2006; Braun 2006; Li, 2007; Allen & Cochrane 2007, 2010; McFarlane, 2009; Allen, 2011; Anderson

& McFarlane, 2011; Anderson et al., 2012; Dewsbury, 2012; Legg 2012). Assemblage has been used as a descriptive term for the coming together of versatile entities (Sassen, 2006). In comparison, DeLanda (2006a) goes further by proposing assemblages as 'a new ontology' for social sciences – although DeLanda (2011c) pinpoints that he offers a model of assemblages to explain movements, organizations or phenomena, which, like all models, are simplifications of the complex world. Though the definition of assemblages outlined by DeLanda (2006a, 2011a) is short and efficient, 'a whole with properties that are irreducible and immanent', it is not as illustrative as one could hope for. Therefore, I examine more thoroughly what kind of entities assemblages are, how they are constituted and how the dynamics of assemblages can be examined. Indeed, the term assemblage has versatile meanings, and thus the importance of defining the concept and its analytical purpose thoroughly becomes paramount to the clarity of my analysis.

Firstly, I explicate the characterization by Deleuze & Guattari (1988) of how different actualized entities can be, in very general manner, layered as different *strata*, which offers a solid ground for how to understand the performative role of the material, also in social interaction. Certainly, developing biofuels requires complex arrangements with motor vehicle technologies, biomasses, refineries, distribution infrastructures, the instruments of agricultural production and many other factors. Approaching relationships between space, policy and law exclusively through semantics without any notions of the causal capacities of matter thus does not appear to be a fruitful approach. Deleuze & Guattari (1988) argue that from the primordial intensities of the early globe, all matter has been layered into three different main stratifications, *inorganic* (geological), *organic* (biological) and *alloplastic* (social) (see also Bonta & Protevi, 2005). These strata differentiate from each other by their sorting principles, for example the population dynamics of the biological strata differentiate it from the geological, and further, by their distinctive relations between *content* (fold and the stratified matter) and *expression* (functional form of the structures of the strata). DeLanda (2009) describes this transition from geological to biological in that animals can go beyond the content of their genes by expressing identity beyond the organic stratum – like bowerbird males do by building nests and decorating them using inorganic elements for females to express their capabilities of reproduction. The alloplastic stratum is different from the organic as the language has the capacity to express any other strata, thus distancing the expression further from the content (also Message, 2005: 267). Nonetheless, both the content and the expression have capacities to influence the dynamics of their surroundings (Deleuze & Guattari, 1988; Bonta & Protevi, 2005).

In Deleuze's thought, an assemblage is a coming together of things within strata, which is more heterogeneous and ephemeral than the strata itself. Assemblages can be constellations of parts belonging to different strata, and subsequently, there can be a diverse set of elements which constitutes the whole, understood as a singular assemblage (DeLanda 2006a: 12). DeLanda, however, differentiates himself from Deleuze by suggesting that there is no particular need for the strata as a separate entity in relation to the assemblages. The strata itself can be seen as a very stable and extensive assemblage that consists of numerous individual assemblages. For instance, the fitness of a population cannot be defined by a single parameter as the properties of fitness evolve in relation to changing environments. What is more, fitness is not defined through an individual, because fitness as a property belongs to populations where there are differences between individuals (Endler, 1986: 4). The orientation to individual assemblages thus becomes justifiable, because strata alone cannot explicate the properties of individual assemblages (DeLanda, 2011b). Therefore, reducing the explanation of EU biofuel development to a purely material or semantic basis would result in lopsided analysis.

Secondly, I introduce DeLanda's argument for how the relations of assemblages should be understood. According to DeLanda (2006a), the most persistent metaphor of society is the one of society as an organism. Different organs perform their roles and the society as a whole – which the parts constitute – benefits. This rather transcendental conception about society as an organic whole is established on the perceiving of institutions and actors within society through *the relations of interiority*. This refers to a particular understanding that certain, essential elements are necessary (for example the army, policy, banks) for the functioning of all states. Instead, DeLanda (1997) urges us not to approach nation states as entities *as such* but as a constellation of institutions, banks, citizens and other actors and elements that evolve over time. Therefore, DeLanda (2006b) argues that avoiding the organic conception of societies' relations should be treated through *exteriority* by which he refers to a conception that none of the parts that constitute the individual entity of an assemblage are irreplaceable. For instance, the dynamics or properties of the European biofuel assemblage do not change if the Finnish oil company Neste Oil buys its biofuel feedstock from Swedish or Polish rape farmers. Indeed, concerning the paradox of the ship of Theseus, DeLanda would argue that the identity of Theseus' ship would remain even if all of its parts would have been changed as long as its properties would remain the same.

Moreover, the parts of an assemblage can be plugged out and in to other assemblages like, for instance, the Brazilian sugar cane producers' change *vis-à-vis* the world market prices of oil and sugar if they sell their crops to the biofuel or agricultural industry. This conception, however, does lead to the conclusion that an assemblage would remain without changes if several of its parts were replaced. To continue with the same example, considerable changes would emerge in the operations of the European biofuel assemblage if all European rape oil that is used in manufacturing biodiesel would be replaced with palm oil. Harman (2008: 371) describes DeLanda's ontological status of the assemblages so that: '*if each assemblage is person then every assemblage is made from sub-personal components as well... there is no final layer where assemblage could be reduced*.' In some sense, this has strong similarity to Latour's (2005) conception of actor-networks that each actor is a network and each network is an actor. Similarly, any part of an assemblage constitutes an individual, singular assemblage. A vivid example against micro- or macro reductionism can be found in Wagner's (2009: 78–79) illustration about slime moulds: when there is abundant food in the environment, slime moulds exist in single-cell amoebae. When food supplies begin to be exhausted, amoebae release chemical signals into their environment that attract others, thus gathering a collective of slime moulds. This collective begins to operate as a slug that has new emergent capacity: to crawl from exhausted environments to elsewhere. In a new location, amoebae transform for the final time into spores that wind and water can transport into distant places where the whole cycle begins again. Certainly, here it is evident how individuals and wholes are operationally *co-dependent* even in far simpler assemblages than the one of the European biofuels.

From here, *thirdly*, I arrive at the crux of DeLanda's definition of an assemblage: it has to have some *emergent* feature in relation to the parts that constitute it, which is why it is irreducible to its parts. Emergence is defined as a new feature that is born from interaction between at least two assemblages that do not individually possess that particular feature, such as the capability of movement of the slug phase of slime moulds. These emerged properties are not transcendent but accountable, actual. Concerning social assemblages, for instance, a human individual does not have the capacity to express solidarity that is absent in the community surrounding this individual. So solidarity is not the property of an individual person but the community – although solidarity is performed by individuals gathered in communities. Similarly, the European biofuel assemblage has the capacity to increase the volatility of the global food prices, which an individual farmer does not have. To avoid the pitfall of strengthening the distinction between society as a whole and individuals, I need to clarify that, indeed, an assemblage has no independent existence without its parts because the parts always precede the entity they constitute. Nonetheless, entities such as the European biofuel assemblage cannot be explained merely by studying its parts but the focus has to be set also on examining the dynamics of this entity.

2.2 Topological and intensive thinking

A similar question that has been posed to actor-network theory can be made to DeLanda's ontology of assemblages: if the universe is populated by assemblages, what remains external to assemblages, how do they emerge and change? While Latour (2005: 244) has provided the rather vaguely characterized entity of *plasma*, that '[…] *which is not yet formatted, not yet measured, not yet socialized, not yet engaged in metrological chains and not yet covered, surveyed, mobilized or subjectified*', DeLanda (2002) has put serious effort into answering these question. Therefore, in this sub-section, I explicate DeLanda's metaphysics that is based on the difference between *virtual* and *actual* articulated by Deleuze (1994 [1968]) – although the roots of virtual thinking are in the vitalist philosophy of Henri Bergson.

Concerning the ontology of Gilles Deleuze, Žižek (2004) provides a rather paradoxical characterization: a transcendental realism – although there is nothing transcendental about virtual thinking (Deleuze, 1990 [1969]). As Hallward (2005) emphasizes, the etymology of this concept is rooted in virtue, something having potency and force. Through virtual, Deleuze describes the kind of a potentiality to become actual as a generative force that drives change in the world. Virtual constitutes unity (conceptualized as the plane of immanence or plane of consistency on which different strata are accumulated) that has a pantheist character as all actual reflects this immanent force of becoming. Deleuze's ontology is distinctive by highlighting how being is difference. Deleuze's thinking does not begin from characterizing the identity of objects, processes or other entities of the world but he understood that it is the process of differentiation between entities that is the precise source of identity. For him, the plane of immanence and its intensities are the driving force of differentiation, which explains his paradoxical notion of *pluralism = monism* (Deleuze & Guattari, 1988: 20). Nevertheless, there is no mysticism to Deleuze's concept of virtual because it is, as DeLanda (2012) pinpoints, an approach that is grounded not only through philosophy *as such* but also through the non-metric, topological geometry and intensive thinking in thermodynamics. Deleuze does not posit virtual against real but against the actual, both being real (see Escobar 2008, pp. 286). For Deleuze, topology is a way to think about possibilities (or better, the structures of the space of possibilities), capacities and tendencies that have not been actualized. Let me give a concrete example: while drinking water, it is in liquid form, but certainly, we know that the same water in a glass could turn into ice if taken to below zero Celsius temperatures; or how it would begin to take a gaseous form if heated to 100

Celsius. Yet it might be that this particular glass of water never turns into ice, and subsequently this capacity of qualitative transformation only exists as virtual, not actual.

In geographical literature, the relational and metric (often: *topological* and *topographical*) spatialities are commonly arranged as opposites. In mathematics, the metric spatial understanding began to erode when Riemann in 1851 published his dissertation, in which he examined the ways to describe the mutability and multiple folding of space in a topological, Riemannian surface (Woodward et al., 2010, p. 271), instead of studying objects always in three dimensions. In other words, Riemann introduced intensive geometry apart from the extensive, universally applicable metric geometries. Afterwards, especially Henry Poincaré's topology of studying *phase space* has, according to Jones (2009, pp. 498), two particularly relevant topics for geography. *First*, Poincaré eradicated the Kantian notion of how the formation of space could be known prior to the investigation of it. In differential calculus, the rate of change is the input to calculus and the result is a certain value at a particular point (also see DeLanda, 2009). Poincaré, however, took the insights of the differential calculus further by using each relevant finite curvature influencing the becoming of an object to characterize the possible states into which the object can transform. As a point in case, pressure and temperature are intensive flows that can be described as the dimensions of the *manifold* that affects whether a particular cup of water takes the form of gas, liquid or ice (Smith, 2003: 412). The actualization of the object is one point in this multidimensional, virtual manifold. In other words, the dimensions of a manifold constitute the topological phase space of an object (Lorenz, 1993: 41-42). Consequently, each assemblage has its manifold with N number of dimensions that influence its degrees of freedom.[2] This is in sharp contrast to the conceptions of metric space where space itself is always present.

Second, this change into using differential calculus makes it possible to study the fixity of the space-time of an object (Jones, 2009). In general, topological mathematics is concerned with how the properties of an object remain the same in the continuous foldings and unfoldings of the object. DeLanda (2002: 24-26) stresses that the topological geometry is the least differentiated, because the topology of an object remains the same as long as there are no new points or the fuse of the existing ones; the triangle, circle and square are *homeomorphic* (also Smith 2003, pp 417). Therefore, for instance, it becomes possible to discuss the spatial diversity of indirect land-use changes catalysed by EU biofuel development as an entity, because they all share the same form of being related to the intensity created by previously occurred direct land-use change elsewhere (see Article **IV**). Thus, the metric form characterized through extensive properties such as length or area can be differentiated while the topology remains the same.

All in all, manifold is the way to approach the topological diagram that structures the immanent patterns of the becoming of assemblages. However, a human body alone consists of thousands of dimensions which structure the degrees of freedom and the European biofuel assemblage surely much more. Consequently, the full description of the topological diagrams of complex organisms is a theoretical construction.[3] Nonetheless, it is an important one, because it offers *a realist position without*

2 Deleuze & Guattari (1988) discusses the same virtual organizing principle as a *diagram* (also see Lorenz, 1993)

3 Although in this dissertation this following notion is not put into use, it is important to understand. The insight of Poincare was that he found attractors, shortly describes as a point in phase space where the trajectories of systems are commonly attracted. Consequently, from the infinity of possibilities, there are points where systems have tendencies to actualize (Lorenz, 1993; DeLanda, 2011b).

essences, and consequently is compatible with the ontological status of assemblages (see DeLanda, 2010: 142-43). The topological diagram is non-essential in a sense that it would not exist without material catalysis, like in soap bubbles actualization to perfect spheres through the optimization of surface tension, where the incorporeal dimension of the manifold is the minimum for energy saving. Therefore, their effects are actual but the manifolds themselves always remain incorporeal (Deleuze, 1994: 169; DeLanda, 2002: 75).

After shortly explicating the mathematical roots of virtual thinking, I present the relevance of the virtual in characterizing assemblages. *At first*, the virtual offers a possibility to approach the pre-identity of an assemblage that influences the formation of assemblages. The commonly used example is Deleuze's description about embryogenesis (body without organs). DeLanda (2002) argues that in an embryo, there is always the topology of the organism present as intensive differences within the embryo through which Deleuze pinpoints how the process of individuation has structures that influence the degrees of freedom. Simply, due to the genetic constraints, a vertebrate cannot develop out of the embryo of an invertebrate – although morphological mutations can certainly occur. The contingent process that has resulted in the genetic setting of vertebrates, for instance, has taken millions of years of differentiation in isolated populations as a continuum of singular events. As the embryogenesis continues, the embryo itself begins to form actual metric qualities and qualitative differentiation between the cells begins to create organs. This body-without-organ-thinking of Deleuze has relevance in this dissertation. Accordingly, the formation of the European biofuel assemblage was catalysed by the tensions between the existing patterns of energy consumption and transport and growing problems related to energy security, climate change and environmental degradation (Article **I**; also Smith, 2010). Biofuels emerged as a solution for the mitigation of these tensions, but nonetheless, their becoming has been structured by the versatile dimensions of the manifold of this assemblage, such as weather patterns, the intensive properties of rape methyl ester, consumer attitudes and such other human and non-human factors. Moreover, the European biofuel assemblage has taken a corporeal form – instead of being merely a potential solution – by sedimenting its actors, technologies, distribution infrastructures and patterns of consumption, for instance.

The second relevance of the virtual becomes tangible when the capacities and tendencies of an assemblage are approached. In comparison to the relational principle, actors (or assemblages) can be approached only in relational terms by investigating how they disturb, transfer, mediate and disconnect other actors – especially concerning the metaphysics of Latour (2005). Therefore, both the properties and capacities of an actor are inaccessible as it can be approached only through others. According to my stance, studying biofuels or the policies governing them without any acknowledgement of the properties of various biofuels or their capacities as moving powers in combustion engines would not be especially fruitful. For instance, the qualities of the feedstock that has been used to refine biodiesel through esterification affect the qualities of this end product. Palm oil as a feedstock produces a high pour point (15°C) that begins to affect the properties of the biodiesel when temperatures begin to go below this point by making it semi-solid. Now, even though this palm oil biodiesel would never be tested in the conditions of a Finnish winter, I argue – without doubt – that this biodiesel would turn into a more solid form, because the dimension of temperature of the manifold would affect it similarly in Finland as in the laboratory where engineers have recognized this property associating with the fuel's capacity to function in engines.

2.3 Assemblages and debates about spatiality

After explicating the ontological status of assemblages, I continue to build my approach for *how* to study the dynamics of space, policy and law in EU biofuel development by embedding DeLanda's topological thinking in geographical debates concerning spatiality. Despite the fact that geography studies the spatial aspects of different objects of inquiry, Malpas (2012: 227–28) argues that space itself has not very often been the central topic of researches; rather, the focus has been on spatial rhetoric or imagining. However, after the linguistic turn and the long period of representation oriented approaches that followed, there has been a rise of new spatial orientations in post-structural geographies in which the space itself has been considered as an active constituent in social relations (see Massey 2005; Murdoch 2006; Hincliffe 2007), actor-network theory (Latour 1993; Law & Mol 2001), mobile sociology (Urry 2003, 2010), heterogeneous rhizomes, sites and assemblages (Deleuze & Guattari 1988; Doel, 2000; Braun, 2006; Woodward et al., 2010), and the topological geometries of the social (Mol & Law 1994; Serres & Latour 1995, Law & Singleton, 2005).

Traditionally, the modelling of spatial structures, processes and phenomena has been the core methodology of geography. The models of spatial explanation have commonly been examined through extensive properties such as length, volume or area that are projected on the surface of metric space (see Murdoch, 2006, pp. 12). Thought of metric space is familiar to Kantian transcendental idealism, where space exists autonomously of the objects populating it (Hinchliffe, 2007; Herod, 2010: 6; Popper, 1963: 179 cited in Jones, 2009: 489). It functions like a container for the objects of the world and the relations between objects do not influence space as such. Therefore, all (spatial) phenomena can be described as movement or folding in four dimensions (the axis of space plus time). The downside to this conception is that it creates agency-free landscapes, where actors cannot influence what the space that they populate becomes. Accordingly, this metric understanding about space has provided ontological fixity for scales and territories (Herod, 2010). In contrast, Allen (2011: 153) emphasizes that phenomena – such as globalization – have gone beyond the mappable coordinates of the metric when there is 'a mix of space/times embedded in the practices of the diverse actors' which shape assemblages. Consequently, new approaches have been needed in the spatial explanation of the increasingly complex contemporary world.

In opposition to absolute space, the relational conceptions of space reject the ontological position where space exists independent of the objects as a dead container – actually, space is the objects. Space folds and unfolds according to the evolving relations of the objects. Therefore, there is no stable and perpetual space. The relational principles dismantle the sharp distinction between objects and space, since objects can be understood only through their relationship to other objects, not through being in space as such (see Massey, 2006). Despite the spatial imaginary opened by the various relational approaches, they have, nonetheless, encountered problems. *Firstly*, the open-endedness of the space cannot properly tackle the problem of succumbing into 'spatial voluntarism'. There are always constraints and limitations on how the identities, regions, scales of territories are formed (see for example, Paasi, 2004: 541-42). Thrift (2006: 140) has notably claimed that 'there are no borders', however, Malpas (2012) effectively dismantles this argument by pointing out that if there is a relation, it means that connection is necessary between at least two entities, and if there are no borders to make a separation between entities, the relation thus becomes impossible. *Secondly*, relational tradition has partly embedded itself in the idealist ontology, in which the research has oriented towards language and signifiers, and the material has had no role in explaining the research objects (Delanda, 2009). Herzogenrath (2009: 1) summarizes that 'nature has had a hard time during the post-modernism', referring to the dominance of linguistic and representation over material. *Thirdly*, and perhaps most fundamentally, what the relations between objects are and what they relate to has not been properly scrutinized in the relational tradition. Accordingly, Jones (2009: 495) criticizes the relational approaches, because they have not been able to make a proper distinction between *relations* and *relational properties*. If all explanations reduce to everything being connected to everything, the explanation has no strength while examining differences in motion, acceleration or slowness becomes impossible, since all objects of the research are equally mobile.

Consequently, there has been an orientation towards the topological conceptions of space in order to alleviate some of the problems related to absolute and relational understanding. However, under the rubric of topological, numerous different approaches to spatiality are discussed: Malpas (2008), for instance, unfolds Heidegger's onto-topological thinking in which topological is the mode of spatiality to gather, fold and unfold in events; Latour's (2005, 2013) topological refers to certain types of actual, the mediation and modes of gathering of and between actors and networks; Jones (2009) draws directly from Poincaré's mathematics and philosophy, and Agamben (2005) on his writings on the non-territorial spatialities of the states of exceptions (see Belcher et al., 2008). To continue discussions about DeLanda's topology, I introduce some of his most relevant points originating from the concern of the causality in spatial relations and explanation, how causal relations influence the operation of scales in and between assemblages, and finally, how differentiating geometries should be treated as an epistemic question in regard to studying assemblages.

By recognizing the morphogenetic and expressive capacities of the material, DeLanda (2006a) pinpoints that the analysis of 'human' assemblages cannot be reduced to semantics and it has to be supplemented by causal analysis. However, this notion needs to be elaborated as causality can bring forth connotations to environmental determinism, which is among the reasons why human geography has been alienated from biology and other life sciences (e.g. Castree, 2009). Causality, determinism and contingency are particularly important topics because, for instance, Cartwright (2007) stresses how the conception of causality frames the way phenomena are studied, and further, brought into political decision-making. There are no golden rules in studying causality because there are multitudes of different relations that can be regarded as causes. DeLanda (2006a: 11) suggests that materiality should be treated as *contingently necessary* rather that *logically obligatory*. According to his ontological stance, causal explanations should be understood as *catalysis* where there is no causality that would axiomatically lead a → b but rather that from a → b or → c or → d, where → presents the same causal agent (Harman 2008: 370). The event of a cause is always more than just the cause, by which DeLanda refers to the idea that events are produced by a complex set of factors that influences the outcome of the cause. Hallward (2005) expresses the same point as 'a creation is an effect that becomes irreducible to its cause'. Importantly, catalysis operates in two ways: to have a (causal) capacity to affect, it also requires the capacity to be affected. A similar notion is presented by Stallins (2012: 432) related to the relationship between the environment and genes of an organism; genes do not simply determine the phenotype of an organism but their functioning is in contingent relationships to their environment, which subsequently localizes genes.

Let me give an example of this topic that is more closely associated with the topic of this dissertation: when a policy instrument has the capacity to increase biofuel production, there has to be some actor or element allowing changes in the versatile production patterns of biofuels to occur. Deriving from Gibson's (1979) examinations of actors' capacities to recognize 'action potentials' of their environment, DeLanda (2006a) discusses this type of relations through *affordance*, capacities to affect and to be affected. The notions about affordance illustrate Harman's (2008) point that when DeLanda characterizes the capacities of assemblages, they are treated as relational by definition. Causality is, in other words, dispersed (Stallins, 2012). This discussion about causal capacities roots the distinction between virtual and actual. As DeLanda (2011a: 3) exemplifies, a knife can have the actual property of being sharp. This is property is not relational. However, based on the property of sharpness, the knife has the capacity to cut. Whether this knife ever cuts anything or not, it is a question of possibilities, the virtual. Thus, the capacities of the knife to cut might never actualize, despite the actual property, if the knife has no relation to a thing that affords to be cut. I put these notions of causality in use later while illustrating the relation between policies and actual biofuel development in the European biofuel assemblage in the following section.

The understanding about causality also has its role in characterizing the scales and other spatial formations in and between assemblages. By definition, each assemblage has some property that is emergent in relation to its parts. There are actual transitions related to the properties and capacities to affect other assemblages when singular entities constitute a new, larger scaled entity. DeLanda (2006a), consequently, argues that scale has to be understood in terms of part-to-whole relations – not as a social and political construct alone. Indeed, scales occur intentionally and unintentionally, as Stallins (2012: 430) emphasizes. It is not a human quality to constitute hierarchies because they are very common in nature. As a point in case, the genes of individual ants are connected not only to its phenotype but to the more-than-individual operational patterns of the colony (Grene, 1987). To describe the relation with the whole and its parts, DeLanda (2006a) introduces the concept of *redundant causality* that can be elaborated into how spatial relations influence the dynamics of an assemblage. The parts of an assemblage are redundant to the dynamics of this entity in a sense that they can be replaced with others parts without changing the basic operations of this particular assemblage. Consequently, the explanation, according to DeLanda (2006b), has to be rooted in the scale in which assemblages operate. In a globally operating, multi-scaled settings such as the European biofuel assemblage one has to follow scalar formations affecting the process in question (for instance, see on policy transfer Prince, 2010). Scales, however, are not ontological but relational – but nonetheless actual. Thus, social assemblages operating on wider scales should be understood as having an objective existence due to their capacities to causally influence the operations of the parts of the entity they form.

In this way, DeLanda avoids the two types of reductionism, micro and macro. There are individuals, institutions, movements, communities and nation state assemblages that are actors who influence the dynamics of the entities they are related to. For instance, explaining the development of the European biofuel assemblage cannot be reduced to the ambitions of individual Commission's officials, because this entity has properties that have emerged from the interaction of its parts. Moreover, DeLanda's approach does not approve macro-reductionism, as each assemblage has its individual historic constitution from its parts. In other words, each assemblage constitutes an individual singularity

(DeLanda, 2011: 185), and consequently, the general models of explanation cannot fully unfold the identity of assemblages. The ontology of DeLanda's spatial understanding is thus flat (see also Escobar 2007, 2008).

DeLanda's approach denotes the importance of Deleuze & Guattari's (1988) argument that assemblages consist of enmeshes of connections that are both rhizomatous and arboreal in order to avoid spatial imaginary that *a priori* emphasizes the horizontal mode of connecting.[4] Indeed, Grene (1987) stresses that all systems that transport information (such as DNA) are necessarily hierarchical, because 'in that the arrangement of their elements constrain, and thus, controls the very elements as long as the system so constituted continues'. Concerning the geometries of spatial explanation, DeLanda (2010) consequently pinpoints that geometries should be considered as tools for describing assemblages, and importantly, that those different assemblages require different approaches. Therefore, the aim of DeLanda is not to explicate some fundamental approach to the spatial explanation of assemblages but to argue that different geometries are needed for different purposes. This is a strong *epistemic* point concerning the discussions about spatiality. Certainly and fundamentally, all of the capacities and tendencies of assemblages are influenced by their virtual manifolds which cannot be tackled by metric geometries. Even so, actual assemblages have extensive properties like distribution and area that are, as metric properties, not accurately characterized through topological geometry as it does not distinguish a cup from a donut.[5] Why should all research objects be described through their relations, albeit that the spatial ontology of objects is presumed relational? Assemblages that, of course, relate, also have metric qualities such as the size of European rape or soy plantations of South-America which have importance in characterizing the European biofuel assemblage or in the fold of the proteins that maintain the structure of cells (see Wagner, 2009). There is a continuum with qualitative leaps from topological, differential, projective, affine and metric geometry in their preciseness to metric characteristics of objects (Sklar, 1977: 49-54). Therefore, in an epistemic sense, what geometries should be utilized while designing the methodology of a research is a question of relevance. And the answer: naturally, the one that explains the object of the study best.

2.4 Intertwining policy, law and space through nomospheres

David Delaney's (2004, 2010) concept of *nomosphere* constitutes the third analytical tool of this research along with topology and assemblages. Through this concept, Delaney analyses the role of law in studying the formation of space and, vice versa, space in the formation of law. Benson (2012) argues that law has been given various roles in constituting spatiality, which are based on the differentiating ontological conceptions of the space itself. Hence, in this section, I examine how the nomospheric thinking of Delaney can be approached in the topological context outlined by DeLanda – as a virtual dimension of a manifold that structures the space of possibilities to what an assemblage can become. I additionally explicate how the relations between the nomosphere and space can be approached in terms of *affordance*; i.e. their properties and capacities to influence and be influenced by the dynamics of the assemblage.

4 The rhizomatous mode of connecting is derived from Deleuze & Guattari (1988) and has become synonymous with a type of spatial arrangement that is built of the maze of unpredictable, contingent connections between actors and elements, and moreover, that is non-hierarchical (see Vogl, 2013). The opposite is arboreal, through which Deleuze and Guattari (1988) examine spatial arrangements that are hierarchically structured and well-sedimented.

5 Indeed, these two are homeomorphic in topological terms although they have differentiating metric fold.

The nomospheric thinking of Delaney is rooted in the concept of nomos, introduced by Carl Schmitt (2006:[1950]: 67) who traces the concept to the Greek where it holds as the content of being the 'first measure of all subsequent measures, for the first land appropriation understood as the first partition of space, for the primeval division and distribution'. Nomos can, subsequently, be understood as the intensity of how space becomes divided and populated. Schmitt's conception does not contain merely the law but also the other social and political norms and practices that influence the spatial becoming. Space is therefore a condition of political and legal agency (see Meyer et al., 2012). For Delaney, the main reasons for introducing such an entity as a nomosphere are not only to conjoin law, space and policies. Delaney also seeks to dismantle the out of proportion, positivist status of the law.[6] As Latour (2013) holds, legal is not merely laws in themselves, some obscure 'law-stuff', but it has to be treated as a mode of existence that has versatile associations to the spheres of politics, power relations and so on (also Blandy & Sibley, 2010: 278).

For Schmitt, the Law – understood as absolute – functions analogously to positivist natural law that states only calculable function without substance. As Olwig (2005) argues, natural(ized) law is always at risk of losing the connection to the spatiality that it seeks to steer, because all laws have to be rooted to communities and to the actual relations of norms, customs, and traditions where laws could be implemented. This insight is tightly associated with the governance of biofuels as well through quantifying GHG emissions. The case is surely described *par excellence* by Lansing (2010) through illustrating how the local communities have difficulties in understanding the point of calculating carbon to offset emissions on the other side of the globe; the United Nation's law on offsetting emissions being disconnected from the space where it becomes implemented. Furthermore, the laws and policies regulating climate change, or biofuel development in particular, can be seen as deduced from the law-like models that assess the actual impacts that occur or might occur (see Palmer 2012 for instance).

Delaney raises this logic of spatial differentiation that precedes the actual constitution of space in a central role in his writings about the intertwining of space, law and policies. In short, Delanay (2004: 851) describes that: 'the nomosphere is a way of thinking about the complex, shifting, and always interpretable blendings of words and worlds, in which our lives are always embedded and unfolding'. Thus for Delaney, the nomosphere is not one but many, as nomospheres of different topics and scales necessary entangle and enmesh. For Delaney, space is not a passive category where human action occurs but it is among the main constituents of this very action. Delaney argues that space is a result of the interaction of heterogeneous actors and other elements; however, law has not been generally treated as a significant constituent as it perhaps should be. What I find lacking in Delaney's thought, however, is a more thorough description concerning the modal status of the nomosphere as an entity that always works as a pre-identity for spatial differentiation. As Vismann (1997: 46) argues, 'nomos opens with a drawing of a line in the soil', and therefore the law is already present in the site where it actualizes', and therefore it has to have some sort of an existence that is immanent to actual spatial formations.

6 I do not make sharp distinction in this analysis between policies and law. The reason for this is that the governance of biofuels in the EU is constituted of directives, strategies, white and green papers, reports, regulations and communications, and what is more, there are differences in directives whether they are more like policy or law by their properties. Consequently, the separation of where policies transform into laws is not clear cut. Moreover, I argue that policies are constituents of the nomosphere, as Delaney also emphasizes how these entities do not reduce to law alone.

I argue that nomos can be interpreted as a pre-individual element of an assemblage that structures the spaces of possibilities of an assemblage's spatial becoming. Brown (2010) and Karaman (2010) argue that DeLanda has given limited attention to human dimensions of manifolds in his theory of assemblages – his example concerning the forms of authority (charisma, religion, bureaucracy) in hierarchical assemblages which he treats as singularities in the manifold that, nonetheless, can be enforced via actual practices such as punishment (also see DeLanda, 2006a; 2011: 166). Accordingly, nomospheres can be treated as a virtual element behind the actualized legal or political instruments that operate, for instance, between singularities of regulative/strategic and incentive/sanctioning.[7] As Schmitt (2003: 77) argues, nomos is the first act of spatial ordering, and therefore the nomosphere has to precede the emergence of any human related spatial order – in other words, it has to be virtual. It cannot be put into actual form, not least because of 'the unwritten rules' that influence social interaction. However, it is important to stress that nomos does not have any transcendent qualities as both Schmitt and Delaney argue that nomos is constituted not only by law but also by material practices and customs. Nomospheres, nonetheless, are not unchangeable entities as discourses, technologies, materialities and people move, dislocate and transfer – likewise with DeLanda's virtual (compare to Delaney 2010, 26). Moreover, one important implication is that laws and policies cannot be revealed simply by following the evolution of actual evolutions of assemblages, namely, the capacities of laws and policies to freeze spatial relations. For instance, the absence of biofuel development in Finland was strongly due to legislation and a political atmosphere that sanctioned the use of biofuels (Lampinen, 2008b; also Article **I**). Therefore, the nomospheric dimension of the manifold of an assemblage can precisely be the factor that supresses the becoming of the assemblage.

There is still one aspect that supports the reading of the nomosphere as virtual. Scmitt (2006: 77) continues that the 'nomos is precisely the full immediacy of a legal power not mediated by laws: it is a constitutive historical event – an act of legitimacy, whereby the legality of a mere law first is made meaningful'. In other words, he argues that laws that mediate relations between other actors draw their capacities to influence from the nomos itself. This insight can be embedded deeper in the framework of DeLanda. DeLanda (2011a: 3–4) makes a distinction between the properties and capacities of actors and assemblages. His previously mentioned example introduced a knife that can have the property of being sharp or blunt. Based on this property, the knife has the capacity to cut – however, these capacities might not ever actualize because this knife might not be used for cutting (also Dittmer, 2013: 8). Thus, the actualization of a capacity is always relational, as for the knife to cut there has be to something that affords to be cut. When this important distinction is taken to exploring nomospheres, it becomes evident that even though the properties of the nomosphere or the legal and political instruments mediating it can be incentivizing, for instance towards building biorefineries, by their properties, it does not lead to the conclusion that even a single biorefinery would be built. The incentivizing capacities of legal instruments are in relation to a complex network of financing decisions, power relations between actors, consumer attitudes and other factors that can afford a biorefinery to be built. This conception also leads to the rejection of linear causality that a legislative instrument Y would always X in the targeted assemblage as the capacity to affect actualizes in spatial and temporal settings populated by different actors constituting the assemblage.

7 Escobar & Osterweil (2010) have also associated virtual thinking and political agency. In their approach, making virtual politics refer to changing the conditions of the Real politics, which, in other words, refers to unfolding the political horizon beyond the pragmatic, rational solutions. Thus, I do not find these approaches to exclude each other; nomosphere simply denotes the entity that is approached through virtual policy-making.

3 METHODOLOGY OF EXAMINING ASSEMBLAGES

In this section, I examine the conditions of answering the key research question of this dissertation: how the European Commission-introduced policies and the EU's legislation concerning biofuels have influenced, and further been influenced by, the fast biofuel development of the Union. As I pinpointed earlier, answering this research challenge is based on the use of three analytical concepts: assemblage, topology and nomosphere. DeLanda, despite his conclusive analysis concerning assemblages, offers quite limited *methodological* insights into how complex assemblages should be researched. The main problem is that DeLanda discusses with a very narrow scope of social research, namely Goffman, Weber and 'network theorists' (Brown, 2010: 113–114), and consequently he treats the findings of social sciences as a minor part of his ontological project. For example, the discussions related to the micro and macro formations influencing spatial formations have been more thoroughly discussed in the tradition of ANT (Latour, 1993; Law & Mol, 1994) and Deleuze's thinking has been put into spatial terms, for instance by Doel (2000). However, I demonstrate in the following chapters how DeLanda's rich theoretic thinking can be put into use while designing a research strategy for examining dynamics between space, policy and law.

Methodological considerations in this paper are oriented to crafting an approach through which I am able to examine the evolution of the EU influenced nomosphere of governing biofuels *vis-à-vis* the actual development of the European biofuel assemblage. Certainly, following the insights of Collier & Ong (2005), the European biofuel development constitutes a globally operating assemblage that, nonetheless, operates on the connections established on the more localized assemblages of producing, trading and consuming biofuels. There are municipalities in the EU that have launched biogas production. There are national companies such as the Finnish state-owned Neste Oil that operates around the globe producing, researching, trading and certifying biofuels. However, there are also the EU negotiated free trade regimes with some of the countries and regions of the Global South that are affecting the operations of the European biofuel assemblage (see Lamers et al., 2011). What follows is that there is a diversity of actors and elements that operate in versatile spatial, scalar and sectorial settings. Consequently, to be able to explicate the intertwining of space, policy and law, recognizing the key actors and the groups of these actors becomes a necessary condition. Latour (2005) pinpoints that, generally, studies where there are a small number of actors included tend to be of poor quality, because studying agency as it occurs is replaced with the general modes of explanation.

Accordingly, this notion constitutes a challenge not easy overcome; how to narrow the scope of actors and other elements of the assemblage for analytical purposes? Following DeLanda's notion about the operations of an assemblage, my concession here has been that all elements cannot be identified – and nor is it useful to do so – because many of them are redundant to the entity that they form. In other words, it is not necessary to identify all of the particular forest industry operators in the European biofuel assemblage to understand the role of the forest industry; however, the removal of all the forest industry actors would change the identity and the operations of the assemblage. This particular problem also concerns the policies and directives of the EU, because biofuels are part of rural, security, development co-operation, land-use, climate, fiscal, energy, transport, waste, municipal, regional, innovation and environment policies. Consequently, all individual proposals from all these sectors cannot be taken into close examination.

Thus, I have taken shortcuts, mainly by using content analysis to recognize key actors, elements, policies and laws, and further, how these have been associated in the European biofuel assemblage during the last two decades of promoting biofuels. While analysing the policy documents, I have gathered the actual entities that the policies are seeking to steer. Concerning the political actors of the assemblage, I took my entry through the public consultation, organized by the DG Energy (2010) concerning indirect land-use change policy development, which gathered a total of 144 answers around the globe from actors and groups of actors having a wide range of professional fields. In Article **III**, where these materials are investigated to explore the constellations of actors influencing the policy formulation in the EU institutions involved in preparing directives, I apply a quantitative method of cluster analysis that differs from the qualitative approaches of other examinations in this dissertation. The reason for this is practical; surely, following the actual connections between the versatile actors involved in EU policy formulation would be fruitful for understanding their interaction, but the sheer scope of actors and networks involved exceeds the capacities of an individual researcher to fully investigate those *in a certain limited period time*, as the relations are evolving. Nonetheless, using cluster analysis that begins with building clusters/groups around the sameness of the (discursive and non-discursive) parameters characterizing the individuals of the analysis can be regarded as compatible with the topological analysis established on studying the relations of actors, because it also studies how individuals *relate*. Concerning the national biofuel developments of Finland and Sweden, I further gathered 15 interviews from the key actors of the national biofuel assemblages who I selected through snowball sampling. Recognizing the elements and actors of the European biofuel assemblage makes it possible to follow what kind of topological connections they constitute and how their dynamics are influenced by the nomosphere of EU biofuel governance and the actual political and legal instruments implemented.

As DeLanda (2002) pinpoints, the spatiality of an assemblage cannot be fully comprehended by studying its metric qualities of the assemblage, such as size and distance. A topological analysis needs to examine the relations between the actors and elements that constitute the individual entities, and moreover, to acknowledge the ways human and non-human factors structure the spaces of possibilities for assemblages to actualize. Following Delaney's insights – in relation to actual connections – an analysis concerning the interrelatedness of space, policy and law requires the examination mode or logic, discussed under the rubric of nomosphere. Surely, biofuels did not emerge in materially, socially or politically empty coordinates in the EU but instead there were several prevailing conditions (the dimensions of the manifold) that influenced their rapid growth throughout the 2000s. Moreover, the actual practices of biofuel production, trade and consumption create new spatial arrangements, like the displacements of local communities in front of industrial monoculture plantations, which are legitimized through the nomospheric settings. However, this EU influenced nomosphere does not determine the topological evolutions of the European biofuel assemblage but it outlines the logic of how the relations between the actors and elements of the assemblage can be arranged. For instance, promoting biofuels that are catalysing direct land-use changes in tropical peat-swamp forests is not eligible due to the nomospheric setting that favours the climate change mitigation and the protection of biodiversity. Making this practice eligible according to the sustainability criteria would require nothing less than the disconnection of the nomosphere of biofuel governance from the climate change mitigation that is a crucial element in the foreign politics of the EU (e.g. CEC, 2012a). That is to say, the horizons of the Realpolitik in the European biofuel assemblage are narrowed by the nomospheric setting.

Transition from the nomosphere to the actual spatial formation of EU biofuel development can be approached in the terms of Bruno Latour who has also derived much influence from Deleuze.[8] The nomosphere is a whole that consists of variable individual pieces of legislation, local norms, and forms of social interaction. These all can be treated as actors (or better, as parts of the assemblage) that mediate the capacities and tendencies of the nomospheric setting to influence the relations between the other elements and actors of an assemblage. By applying the catalytic principle causality outlined by DeLanda, the consequences that new political and legal instruments create in the EU cannot be fully anticipated because they do not determine the relations of assemblages. Implementation of these instruments always becomes entangled in the context in which they are applied. For instance, the biofuel target of 5.75% consumption by 2010 set for all Member States in the Biofuel Directive (EC, 2003) had encouraged Sweden to reach 7% consumption while Estonia stayed at zero. Therefore, the nomosphere that is affecting the development the European biofuel assemblage leads to variable actualizations in the EU Member States as they have distinctive, always unique topologies concerning biofuels (Article **II**).

This differentiation leads to a question: should the nomosphere steering the European biofuel assemblage be treated as a whole or as multiple? Well, yes and no. As Delaney (2010) pinpoints, nomospheres are many – as I would argue that the nomospheres affecting sugar beet production in the Member States of the EU differentiate from a sugar cane plantation in Brazil, because the latter is more strongly influenced by Brazilian policies and law. Nonetheless, Brazilian sugar cane production is influenced by (and has been influencing) the nomosphere of the European biofuel assemblage. Analysing this nomosphere as a whole makes it possible to scrutinize the role of EU biofuel policies, for instance in relation to certain scalar structures that influence the multiple ways policies are transferred (Article **III**)

These relations between nomospheres and the individual assemblages they influence, however, cannot be considered perpetual as new technologies, social relations and materialities emerge to influence biofuel development. The nomosphere of biofuel development evolves when unexpected ruptures in developing biofuels arise and the Commission needs to introduce new instruments and practices in order to adapt to changing conditions. Indeed, tax exemptions allocated to biofuels cannot operate as instruments for how to govern the ecological impacts of land-use changes. Thus, it becomes necessary not only to characterize the nomosphere(s) of biofuel development but also to analyse how it evolves according to the changing material, technological, economic and political conditions of European biofuel assemblage (Articles **I; III**). The nomosphere is as processual as the spatial differentiation that it influences. The European biofuel assemblage is definitely affected by the evolving connections between the legal and political instruments designed to govern EU biofuel development, which finally draws the attention towards explicating what kind of spatialities these topological relations between the actors and elements of the European biofuel assemblage constitute.

Certainly, it cannot be enough to recognize which are the actors and elements that relate in the European biofuel assemblage to reveal the spatiality of this entity; a more thorough explication on how they relate is also needed. For Latour, spatial thinking begins from networks, in that 'in its simplest but

8 For example, by stating that his approach of the Actor-Network theory is better characterized as the Actant-rhizome ontology (Latour, 2005)

also in its deepest sense, the notion of network is of use *whenever action is to be redistributed*' (Latour, 2011: 797). As all actors are relational, so is the understanding about spatiality.[9] Thus, studying even the most stable and globalized assemblages has to start somewhere because the global form is not given, it is construed on the connections of more localized assemblages. Everything ranging from scientific models to language is produced somewhere. Thus, a relevant concept in Latour's spatial thinking needs to be introduced: *a mediator*. Latour's social theory has been described as the sociology of translation since it places such emphasis on forming and upholding relations between actors (see Latour, 1987; also Harman, 2009). Translation refers to a process where two actors, for instance the EU providing tax exemptions for biofuels and public transport agencies, seek to influence each other through a mediator, a fuel distributing company. Latour (2005: 39) characterizes that 'mediators transform, translate, distort and modify the meaning or the elements they carry.' When this notion is put in spatial terms, it explicates a process of how spatiality evolves through the (evolving) repetition of relations. The fuel distributor in my example may take political action towards the Commission to push the institution to allocate further subsidies, for instance, for developing the distribution infrastructure of biofuels. Or it can refuse to distribute any biofuels and disobey the Commission. Latour, therefore, holds that all action is always distributed through mediators: all action creates impacts that exceed a particular actor or an assemblage.

This insight of Latour can be discussed under the heading of dislocation that bears similarity to DeLanda's characterization of causality, where an event is always more than its cause. Latour's actors are never alone in the stage although it has been the axiom of 'traditional' sociology that objects (actors) have been treated as non-comparative. All human action is connected with the materiality of assemblages, and consequently action becomes entangled in the surrounding. Nevertheless, the spatiality is not in a state of constant change as there are also more territorialized structures. For instance, in relation to producing biofuels in the EU, the harbour of Rotterdam has specialized technologies, infrastructure, knowledge capital and other such elements that maintain it as a hub for palm oil transports into the EU. Consequently, this *mobility* and *immobility*, and *mutability* and *immutability* have been put as opposites on the axis that characterizes the spatiality built on these relations of actors (e.g. Mol & Law, 1994; Law & Mol 2001; Mol & Singleton 2005; similar arguments are also made by Urry, 2010). It is important to stress that these are just two variables that are set to describe the actors and their relations which do not drain the multiplicity of different relations between actors, but which, however, serve as an illustration of how actors affect the spatiality. As Gasché (1999) argues, spatial relations should be considered as multiplicity, and thus different topologies to characterize assemblages can be applied. Without doubt, new modes of mediation will occur as assemblages evolve, as I have argued in Article **IV** with Joronen.

9 Indeed, Deleuze's space is also constituted of associations: '[Y]ou never walk alone. Even the devil is the lord of flies'.

4. TOPOLOGICAL READING OF THE FORMATION OF THE EUROPEAN BIOFUEL ASSEMBLAGE

In this section, I draw conclusions from the four articles that more thoroughly analysed particular aspects concerning the relations of policies, law and space in the evolutions of the European biofuel assemblage. As I have stressed earlier, this assemblage constitutes a loose entity that operates on multiple spatialities, sectors and scales – which is to say: differentiating topologies. I have deduced four types of spatialities associated with EU biofuel development, studied their singular histories of development, and examined the instruments of the laws of the European Union and the policies of the Commission that have structured the spaces of possibilities concerning these spatialities. I examine the nomosphere that is governing EU biofuel development through assessing the mode of designing associations between the actors and elements of this entity.[10] As pinpointed earlier, it does not reveal much about a particular topology of an assemblage to state that these elements are associated, but a researcher has to dig deeper and incorporate some qualitative features concerning how these associations actually

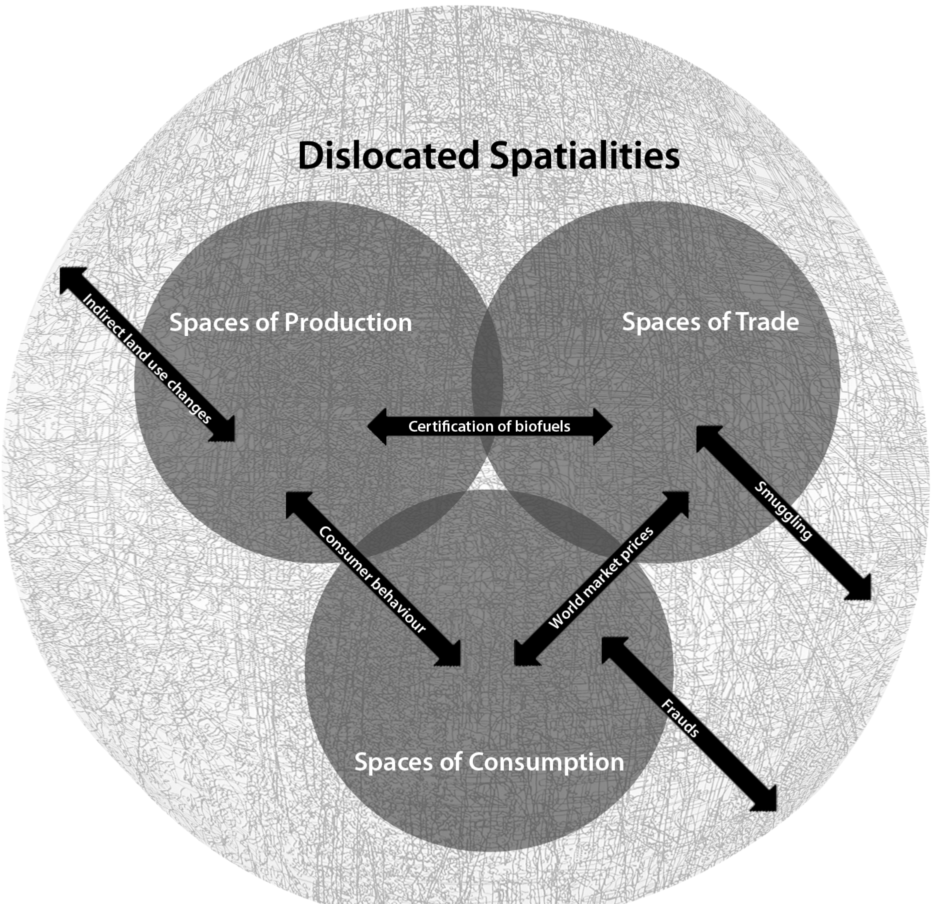

Figure 1. *Topology of the European biofuel assemblage.*

10 Admittedly, this topological reading does not give full attention to the political agency and power relations between the biofuel associated actors and the EU institutions of decision-making. This is due to the need to focus this analysis on the actualized instruments and the multiplicity of ways they influence the relations between the actors and elements of the biofuel assemblage. This topic, however, has been elaborated in Article **III;** Pilgrim & Harvey (2010); Palmer (2010).

operate, and moreover, how they are designed to operate. In order to avoid misapprehensions, I do not here claim that these four spatialities that I introduce (see Fig 1.) would be separate from each other; on the contrary, they are in many ways constituted in relation, one influencing and being influenced by the other in the dynamics of the European biofuel assemblage. Spheres describing the distinctive topologies are related to each other with a multiplicity of mediators. Therefore, mediators of this figure are merely examples of the types of versatile associations. Dislocated spatialities describe the open-ended associations that penetrate the spatialities of established governance.

4.1 Spaces of production

4.1.1 Agriculture

As the clear majority of biofuels consumed around the globe are crop-based, *first-generation* traditional biodiesel and ethanol, the sites of agricultural production still remain as the key spatialities related to biofuel development. Biofuels are still a rather insignificant form of land use concerning all the fields and pastures of the globe, but nevertheless, as it has been indicated by OECD/FAO (2012), the increased consumption of biofuels has caused rises in food prices and increased the turbulence in the agricultural commodity market (also de Gorter et al., 2013). Brazilian sugarcane, corn from the United States, European rape oil, sugar beet and wheat, soy from Argentina and palm oil from South-East Asia are among the most used crops as the feedstock of the biofuels consumed in the EU. The main products refined from these feedstock are ethanol and biodiesel. Their production has a long history; original T-Fords were designed to run on ethanol (see Lampinen 2008a) and, for instance, the ethanol development of Brazil was launched in the 1970s (Hollander, 2010). Even though these agricultural feedstock could be used in producing biogas that tends to have better energy and climate performance than liquid fuels (IPCC, 2011, chapter 2) its consumption has remained low, constituting less than 1% of the EU's biofuel consumption (Systèmes Solaires, 2013). The rate of imports has grown since the emergence of the assemblage, and therefore the impact of the European biofuel assemblage on the agriculture of the Global South has increased (Article **IV**).

The topological form of the production is most often an industrial plantation monoculture where production is highly intensive, well governed and measurable by its climatic and environmental impacts – also in the Global South. These monocultures are deeply connected with the trade of agricultural commodities and internationally operating financing systems (see Smith, 2010). Several researchers have pinpointed that biofuel development has strengthened the industrial plantation model of production (e.g. Altieri, 2009; Lee et al., 2010; Harvey & Pilgrim 2011; Cotula, 2011). The Commission has itself stated that 'biofuel production also contributes to increased intensification of agricultural production in the EU, which can increase pressure on the use of land with high biodiversity value and soil carbon stock and use of fertiliser' (CEC, 2009). On the other hand, the Commission's nomosphere concerning the agricultural spaces of production has not been the straightforward promotion of intensified agriculture. The Commission stated (CEC, 2000) that 'biofuels will also help to create jobs in rural areas and thus preserve the rural fabric by providing agriculture with new outlets. In this respect, care needs to be taken to ensure that bio-fuels do not lead to a continuation of highly intensified forms of agricultural production'. However, safeguarding agriculture from intensification has not received the ambitious instruments of political or legal steering and the actual biofuel development of the EU has been strongly associated with the existing agro-industrial complexes. For instance, Cargill, Archer Daniels Midland, and Diester Industrie, which are big players in agribusiness, are also among the biggest biofuel producers operating in the European Union (Systèmes Solaires, 2013). These large scale, globally operating companies connect the localized assemblages of agriculture with the European biofuel assemblage. The Finnish state-owned oil company Neste Oil provides a good example of building associations. It has two refineries in Finland, one in the Netherlands and one in Singapore. They use versatile feedstock that range from animal fats from the slaughterhouses of New Zealand and palm oil originating from Malaysia to technical corn oil that is a residue of corn ethanol production in the US. Not only is this individual company acquiring feedstock but it also affects the development of biofuel certification systems and has approximately 60 different research projects running around the globe.[11] Not only are these actors important in material terms but also political terms. Especially the agricultural lobby groups have impacted the biofuel policy-making in the Commission – some actors even refer to these agricultural actors as the farmers mob in Brussels (Article **II**).

Consequently, the actualization of EU biofuel development has not generally supported de-centralized production models of energy or agriculture – although Swedish municipally driven biogas development, in particular, illustrates how it is economically, environmentally and politically possible (Article **II**). Support for the subsistence farmers of the Global South through biofuels, which was outlined in the EU biofuel strategy (CEC, 2006b) has not played out either. Instead, there has been an increasing amount of land acquisitions discussed under the term 'land grabs' made by companies and investors operating on a global scale and it remains unclear whether these types of investments benefit more than the local elites (Matondi et. al., 2011; Anseeuw et al, 2012; Sassen, 2013; Cheru & Modi, 2013). Initiatives such as out-grower schemes that can improve the security and environmental performance of agricultural production, and group certification promoted by certifying bodies has not gained much popularity concerning the agricultural spaces of production of biofuels (see Lee et al. 2010). The impacts of this development are discussed more thoroughly below, concerning the spatialities of dislocation.

The role of the European Commission in supporting the emergence of the agricultural spaces of biofuel production has been significant. The Commission began its biofuel policies by proposing a directive that would make it obligatory to lower or remove excise tax on agricultural sourced biofuels (CEC, 1992a). Even though the directive was not implemented, the Directive concerning the harmonization of excise duties (EC, 1992) made it possible for the Member States to propose tax exemptions for biofuels (legislation was strengthened and amended in EC, 2003c; 2009b). The role of EU domestic agriculture has also been further encouraged by Common Agricultural Policy reform in 2003, making it possible to allocate subsidies for energy crops. However, in addition to these actual legal and political instruments that lowered the market access of biofuels, it was the Commission's strategies and action plans that grounded the importance of agricultural biofuels. These political instruments promoted biofuels not only for environmental, air quality and climatic benefits but further due to biofuels' capacity to solve the problems of agricultural overproduction, support sustainable regional development, and in particular, enhance the energy security of the EU (Article **I**).

11 Personal communication with a Neste Oil representative in 2012 and 2014.

4.1.2 Wastes and residues

Concurrent with the plummeting popularity of crop-based biofuels in the nomospheric setting of the European biofuel assemblage, the Commission has given special focus to developing the spaces of production associated with wastes and residues. Even though Finland and Sweden, for example, have been producing various biofuels from their forest residues (Örnsköldsvik's pulp mill ethanol production began as early as 1909), these advanced, *second-generation production pathways* have not contributed a significant proportion of the world biofuel production – although they might be nationally or municipally important (Article **II**). In fact, it is the opposite: their commercialization has been slower than expected (e.g. Beurskens et al., 2011; EC, 2012a; also Rothenberg et al., 2013). Even biogas, refined from wastes and residues has received limited attention from the Member States of the European Union. These spaces of production are associated mainly with food industry side products, municipal wastes, and forest and pulp industry residues. There is great potential in using these material flows as they are not competing with food production, and subsequently have better energy and greenhouse gas performance than agricultural crops (IPCC, 2011, chapter 2).

These spaces of production are constituted of actors that operate with elements, such as municipal waste flows like sewage sludge, pulp mills with side-products of black liqueur and pine oil and retail networks that accumulate sugar-rich wasted. These actors have construed both centralized and decentralized solutions. Swedish biogas municipalities are illustrating the dispersed model of producing advanced biofuels while the forest biomass-to-liquid projects generally operate in larger scales in close co-operation with the pulp industry, producing tens of thousands of tons of fuels annually (see UPM's 100 000 tn fast pyrolysis project in UPM, n.d.). These actors are also influencing biofuel policy-making, for instance the 'Green' transport development of Stockholm has been promoted – and taken as an example of sustainable urban transport development – by the Commission (Article **II**).

Here, it is also important to stress that these spaces of production are foremost located in the industrialized North, and for instance Eisentraut (2010: 89) argues that many of the advanced refining technologies are complex and costly, and thus advanced biofuel development does not provide solutions that would be applicable in the Global South. Nonetheless, concerning the material elements within the EU, wastes and residues provide only a partial solution as pine oil, for instance, is used in the chemical industry (see Arizona Chemical's concerns over pine oil in Raunio, 2013), and importantly, the sustainable waste policies orient to *reduce* the amount of waste instead of *increasing* it. Kampman et al., (2012), for instance, assesses that there are truly sustainable wastes and residues (that do not, for instance, compete with other uses of the same resources) to reach the 10% renewable target set for road transport in the renewable energy directive (RED) but not much more (EC, 2009a).

The European Union has been keen to promote the development of these technologies, and has been implementing them in practice since the 1990s. For instance, Stockholm in coalition with other European cities has received a series of biofuel and other 'Green' transport project funding from framework programs (Article **II**). Moreover, the Commission has funded the research, development and deployment of new technologies, particularly concerning the utilization of forest biomasses in transport. For instance, the low carbon demonstration programme NER300 promoted two large scale Swedish forest biomass-to-gas projects and one biomass-to-liquid project in Finland (CEC, 2012b). However, the actors operating in the advanced biofuel sectors argue that even though the Commission has favoured advanced biofuels, the political and legal instruments have not been strong enough (Article **III**). Advanced biofuels, nonetheless, were allocated a double counting in the RED, which introduced a 10% renewable fuel target for 2020.[12] Moreover, environmental and development non-governmental organizations claim that subsidies for crop-based biofuels are one of the factors hampering the market penetration of advanced biofuels (e.g. T&E, 2012). The nomosphere governing biofuels has thus legitimized the transition towards advanced biofuels, but the tools to actualize this transfer have been inadequate. Advanced refining technologies have not commercialized to challenge the dependency on crop-based biofuels and, further, the infrastructural changes that are be needed for certain technical solutions have not yet actualized (Article **II**).

4.1.3 Microbes and algae (and the spaces of research)

Though there are no biofuel refiners that currently produce advanced, so-called third generation, biofuels from laboratory engineered algae or microbes on a commercial scale, I find it important to characterize these spaces further as their future actualization is backed up by the nomosphere of the European biofuel assemblage. As a point in case, Spanish water company FCC Aqualia received €7.1 million from the EU to initiate algae based methane refining in 2013 (EurActiv, 2013). Moreover, the competition to find commercially viable production pathways for third generation fuels is real. The actors of these spaces are not only the leading biofuel companies financing research units around the globe but also chemical industry giants such as DuPont and Syngenta. The latter-mentioned companies have long experience in genetic manipulation and other techniques that can solve the existing limitations, for instance, in converting lignocellulose into sugars efficiently.

I demonstrated in Article **III** that advanced biofuel producers have divergent opinions concerning the legislative development in the EU in comparison to traditional, crop-based biofuel producers. Although it is very likely that the Commission's emphasis on developing non-land-using biofuels is environmentally and climatically sound policy-making, I find some truth in Smith's (2010) argument about how policy-makers tend to think that the following generation of technologies will be able to solve the complex consequences of prior technological solutions. Levidow and Papaioannou (2014) argue that the imaginaries unfolded by the advanced biofuel have been a necessary element in moving forward from the controversies surrounding crop-based biofuels. Nonetheless, more than 200 American scientists have warned Obama's government about the hazards of increasing the cultivation of the fast growing lignocellulosic feedstock such as elephant grass (see Foster, 2012). The mode of connecting the European biofuel assemblage to feedstock alternatives generating smaller land-use impacts can present a new set of risks (Levidow, 2013), and consequently some safeguards should be designed in advance to make the possibly emerging detrimental consequences less likely.

12 This double counting means in practice that 5% of biogas consumption is enough to meet the 10% target. Under the quadruple counting introduced in the iLUC directive proposal, only 2.5% consumption would be satisfactory. The problem, naturally, is that the actual amount of fossils consumed in transport would remain at 97.5%.

4.2 Spaces of trade

By their properties, biofuels differentiate from other forms of renewable energy since they can be traded globally through the pre-existing transport infrastructure. However, it is not just the biofuels that are traded but the feedstock of biofuels like sugars, cereals, animal fats and vegetable oils, land and refining technologies. Prior to the emergence of these global biofuel and mass trading networks in the mid-2000s (Mol, 2007; Hollander, 2010; Smith, 2010), the internal energy markets of the European Union constituted a significant target for the Commission's legislation. The functionality of the internal energy markets of the Union was considered a key element in determining the success of the penetration of renewable energies. According to the Commission, the liberalization of the internal energy markets had been disturbed by national initiatives. 'Companies [...] must operate in an efficient legal and fiscal framework which encourage investment and innovation and that are protected against undue public and regulatory intervention' (CEC, 1995, p. 8). Thus, the Commission has been implementing policies that remove market and trade barriers making the market penetration of biofuels more difficult. Here, with a key element of guaranteeing the functionality of internal markets, the Commission has pushed towards the increasing harmonization of taxation on biofuels and, moreover, to guarantee the global marketability of biofuels, a standardization of biofuels has had to be developed (Article **I**).

The oil distributors of the European biofuel assemblage have become more dependent on imported biofuel and -masses since the origin of the EU biofuel development (Article IV). As Lamers et al. (2011) stress, finding accurate information concerning the quantities and origins of the consumed biofuels in the Union are difficult to trace as only rare Member States require the trade information to be public and several companies consider their trade relations as business secrets. Nevertheless, the most recent estimates concerning the imports are 15% for ethanol and 30% for biodiesel (Systemes Solaires, 2013). However, these figures do not reveal the large share of imported biomasses that are refined into biofuels in the EU. The spaces of trade subsequently constitute an important form of spatiality that characterizes the assemblage. Certainly, tropical alternatives are more lucrative because labour is cheaper, land is cheaper, the yields are considerably higher and there is still much potential in developing even more intensive forms of agriculture and more yielding strains. Nevertheless, the increased mobility and flows of biofuels require more or less stable spatial formations and institutions to regulate and govern these flows (Urry, 2003). Hence, for instance, the harbour of Rotterdam specialized in the logistics palm oil transport, has increased its significance in the European biofuel assemblage. The topology of trading biofuels is mainly developed on the existing patterns and the companies who have been deeply involved in the trade of agricultural products prior biofuels. Biofuel giants Cargill and Archer Daniels Midlands are also part of the agro-industrial complex with Bunge and Luis Dreyfus that control 75–90% of the global trade of grains (Murphy et al., 2012).

The European Union policies have strengthened the global trading networks by taking biofuel into EU free trade negotiations that have increased the mobility of biofuels and, further, designed global standards concerning the properties of biofuel (CEC, 2007c). What is more, the Commission has pinpointed in its strategies concerning biofuel development that it can be beneficial for developing countries to produce feedstock for the growing markets of biofuels. The CAP reform in 2011 further opened the trade of agricultural products, originally to strengthen European meat production (TNI, 2012: 4). As a result, the farmers of the South, especially in the African continent, have reported experiencing a rush of European companies closing long term land deals in the Global South to produce feedstock suitable for biofuels (e.g Cotula, 2011; LandMatrix, 2014; Neville & Dauvergne, 2013).[13] It is important to note, however, that it is not only the Industrialized North that is making acquisitions as Brazil, China and India, for instance, have closed considerable amounts of land deals as well. These investments have been discussed under the somewhat misguiding rubric of 'land grabs' – although investing companies are invited by national political elites (Cheru & Modi, 2013). At worst, these investments can lead to the displacement of subsistence farmers and pastoral communities, and destroy pristine ecosystems. Despite the negative media attention, the role of foreign direct investment is not determined to have negative outcomes alone as, for example, African agriculture lacks the capital, skilled people and technologies to expand the production sustainably (e.g. Msangia & Evans, 2013). Sassen (2013) illustrates the topological complexity around this topic: closing a land deal and launching the production requires several multi-scaled actors and elements that range from national and regional authorities, investment banks, environmental impact assessments and development co-operation agencies. Subsequently, the outcomes of land deals are, as DeLanda (2006a) would say, contingently necessary in a sense that they will catalyse impacts, but it is not determined that they will be negative.

Generally, the European Union's nomosphere concerning the trade of biofuels has been internally conflicted as the legislation and policies governing it have supported 'free trade', but simultaneously the imports to the EU have been regulated by trade barriers and other instruments. Notwithstanding clearing obstacles to making investments in the Global South and making the trade of biofuels easier for European companies, the Commission has implemented policies and laws that have supported the domesticity of production and consumption due to agricultural and biodiesel lobby groups against the interests of the producers of the Global South and biofuel importers in the EU. Prime instruments have different trade barriers, namely keeping up high customs fees for imported biofuels (Systems Solaires, 2012). For instance, based on a complaint prepared by the European Biodiesel Board in 2007, the EU was protected against the US subsidized soy oil by imposing a provisional anti-dumping duty on the imports of biodiesel originating in the US. (EC, 2009d) This regulation, for instance, has proved to be an efficient border, as biodiesel feedstocks were imported mainly from two countries: Malaysia and Argentina constituted 90% of all imports in 2012. Nonetheless, the Commission implemented a strong antidumping regulation also concerning biodiesel imports from Indonesia and Argentina (EC, 2013). Moreover, the domesticity has been protected through standardization that favours biofuels produced from the European feedstock (Article **I**). The nomosphere thus connects EU biofuel development to the trade policies of the EU, which not only promote the establishment of free trade regions and networks of trade but also maintain and enforce the trade barriers of the Union. Indeed, trade in biofuel is far from the freedom of markets due to a complex network of subsidies, tax exemptions, customs fees and other instruments regulating the economic setting of biofuel trade.

13 One additional remark must to be made, however: the scope of the land deals is highly contested. For instance, Hamelinck's (2013) analysis indicates that the Land Matrix Database contained only 10% verifiable land deals, rarely associated with EU biofuel development.

4.3 Spaces of consumption

Continuing from the regulated markets of biofuels, the Commission has not ensured that biofuels would commercialize just by enhancing their economic feasibility in relation to fossil fuels and removing the (internal) trade barriers – albeit that the importance of the principle of free market economy is pinpointed in several policies and laws (Article **I;** also see CEC, 2007a). Among the most influential mechanisms of governance are quotas that dictate the minimum amount of biofuels that need to be consumed in the Member States of the EU (Article **III**). Indeed, since the origins of biofuel policies in the Union, the Commission has strengthened the biofuel development by harmonizing the spaces of biofuel consumption. When the early strategies concerning biofuels promoted setting all-European targets, they were not considered mandatory. The Altener programme (CEC, 1992b) had already proposed a 5% biofuels target for 2005. In 2000, the Commission proposed to set an aim of 20% usage of alternative fuels by 2020 to give more stable ground for companies to invest in the biofuel sector (CEC, 2000). Nonetheless, the biofuel targets set by the Union have concerned road transport alone even though aviation, marine transport and railways need to find more suitable alternatives.

However, the rapid growth of biofuel production and consumption in the EU was launched by the Biofuel directive (EC, 2003) that set indicative targets for the share of biofuels in transport: 2% by 2005 and 5.75% by 2010. This directive connected EU Member States more tightly to biofuel development as they had to establish national biofuel action plans to introduce the mechanisms of biofuel promotion. What is more, as I pinpoint in Article **I**, the Commission has been keen to use its juridical powers to ensure that even the indicative targets set in the Biofuel directive concerning biofuel consumption have been introduced into national energy strategies (CEC, 2006a). The Commission, however, saw that the indicative target was not a strong enough mechanism to guarantee the market penetration of biofuels, as only Sweden and Germany were able to reach the 2% target of 2005, and thus when it introduced the 10% target for the share of renewable energy in transport and the 6% GHG emissions reduction target concerning the transport fuels in 2020, they were mandatory (EC, 2009a; 2009b). Partially due to the incentivizing nomosphere for domestic agricultural feedstock, the biofuel consumption of the EU has actualized around biodiesel, rape methyl esters in particular, and ethanol (see Systèmes Solaires, 2013). The consumption patterns within the EU Member States are presented in Fig 2.

Although the biofuel targets of the Union concern the Member States, their biofuel related topologies are unique (Article **II**), and thus the constellation of actors who are actually involved in reaching national targets is diverse. In other words, Member States *as such* do not launch the consumption of biofuels, but national legislation can create a nomosphere that supports the common aims of the EU, which may or may not catalyse the emergence of biofuel development (Hillman et al., 2009; Ulmanen et al., 2010). It is fuel distribution companies that hold a key position, for instance, in implementing the blending mandates concerning E5 or E10 but the distribution of pure blend biofuels like B100, E85 and biogas requires a wider set of actors to co-operate, subsequently increasing the topological complexity. As I stress in Article **II**, the launch of pure biofuel consumption requires the simultaneous take-off of biofuel production, consumption and distribution – in Sweden for instance, building associations between oil companies, car manufacturers and municipalities (Birath & Pädam, 2010). Municipally originated policies and laws have included instruments such as the governmental procurement policy

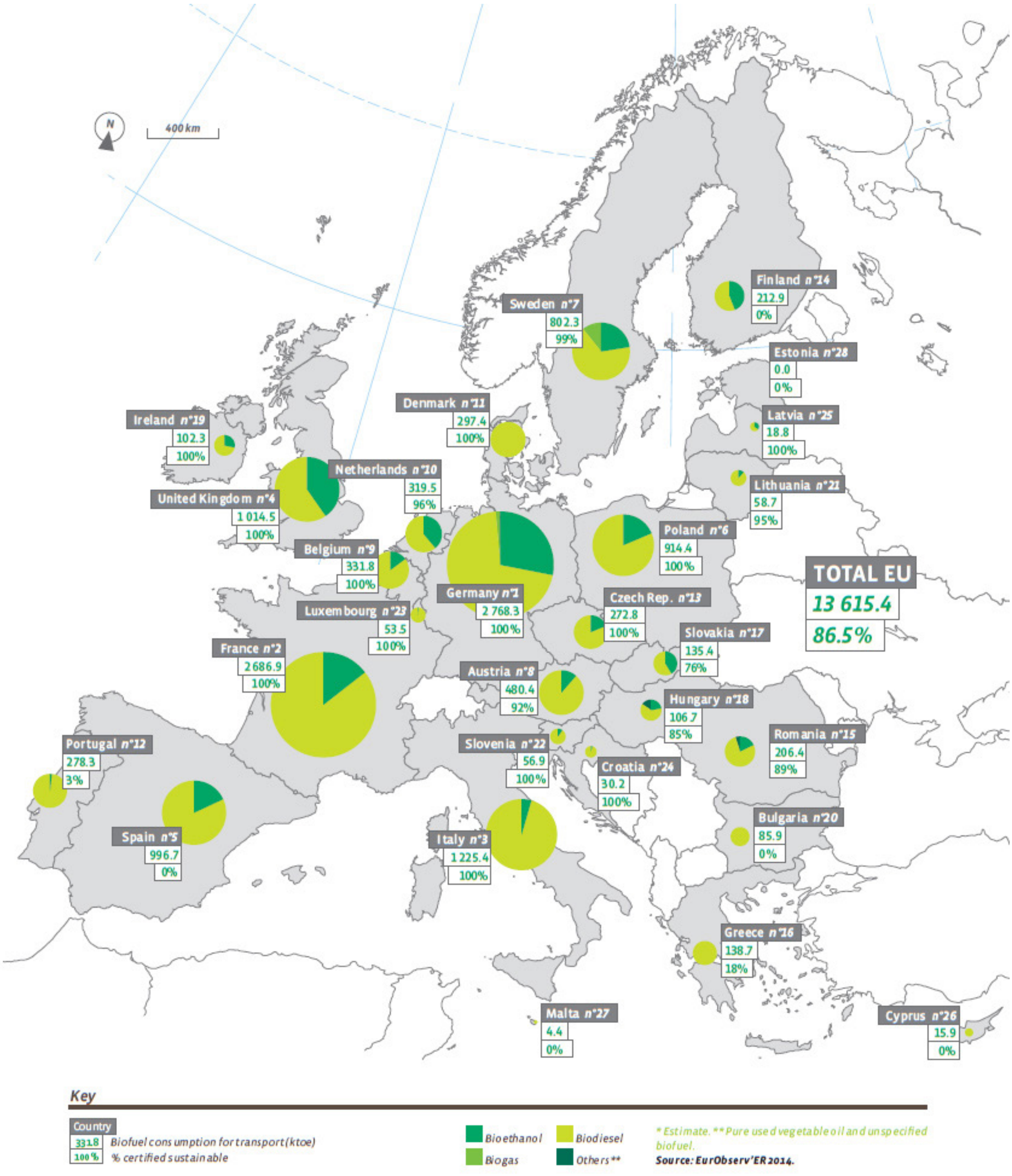

Figure 2. *Consumption of biofuels in the EU Member States in 2013 (ktoe).*
Source: Systèmes Solaires 2014: 10, modified by the Author

of the ‘Green’ cars that use pure blends of biofuel, the funding of biogas production facilities, the raising of public awareness, allocating privileges like opportunities to park freely or use bus lanes for ‘Green’ cars and supporting oil companies in making changes in their fuel distribution infrastructure (Article **II**). Indeed, the implementation of the Commission biofuel targets diverges in the Member States as EU instrument policies are meshed into the national and sub-national constellation of actors and the nomospheres of biofuel governance.

Consumer attitudes towards biofuels are also variable in the Member States of the Union. Environmental and development NGO have especially brought to the attention of general public and politicians the negative outcomes that biofuels can catalyse, such as tropical deforestation and growing food insecurity (Pilgrim & Harvey, 2010). Moreover, the German car industry took action to highlight the risks that low blend ethanol E10 can have for vehicles (Moore, 2011). These campaigns related to biofuels have utilized the results of scientific publication (see T&E n.d) and publications prepared by the NGOs themselves (e.g. Schlesinger, 2010). Therefore, an important battlefield concerning the governance of biofuels has been *semantic*; whether biofuels are a solution to mitigating climate change, pro-poor (CEC, 2006) or simply a ‘crime against humanity’ (Ziegler, 2013). For instance, Finnish oil company Neste Oil has labelled its hydrotreated vegetable oil as green diesel (see Neste Oil 2012) whereas Greenpeace Nordic has consistently referred to it as palm oil diesel, thus unfolding the main feedstock of this fuel, which is perhaps the most contested biofuel feedstock (Greenpeace Nordic n.d.; also IPCC, 2011).

The Commission has supported a multi-approach to commercializing biofuels by, for instance, making it possible to support the national vehicle procurement policies to favour biofuels (e.g. CEC, 2007b; EC, 2009c; CEC, 2013b). The direction of having more alternatives in transport fuels is further strengthened by proposing a directive that would make it mandatory for Member States to provide gas to secure the commercialization of gas vehicles especially in road transport (CEC, 2013a). Although biofuels are mainly used in road transport, the Commission’s strategy concerning alternative fuels (CEC, 2013b) and the Energy Roadmap to 2050 (CEC, 2011a) argues that the future of biofuels is in aviation, marine transport, rail and long-distance road transport that cannot be electrified. Thus, the nomosphere concerning the spaces of consumption might be elaborated from passenger cars on roads to air, water and rail transport. How this expansion of biofuels – which in 2012 constituted 3% of the world’s liquid fuel makers (IPCC, 2014, chapter 8: 45) – can be achieved without compromising the welfare of ecosystems, atmosphere or food security seems an almost insurmountable challenge to overcome, which will be discussed in the next subsection.

4.4 Dislocated spatialities

Latour (2005) stresses how all action is generated by – and influences – the environment in which the events of the action occur. Similarly, DeLanda (2006a) holds that every event is always more than its cause – in other words, an event produces another event that is irreducible to the prior event. According to these insights about the (spatial) entanglement of action, the effects of biofuel development surely exceed the above-examined, well-governed spatialities, which I will discuss under a general term of *dislocated spatialities*. With this concept, I refer to the economic, material, social and political consequences of biofuel development that leak from the well-regulated process of the

European biofuel assemblage. Admittedly, there is nothing particularly new in this concept as such, since Law and Mol (2001) have discussed *the topologies of fluid and fire* that illustrate mutable, moving and possibly non-present, yet affective mediators of spatial relations, Urry (2003) has characterized the *unpredictable and turbulent spaces of flows* that exceed regulated networks, Serres (2007) has introduced *parasitic mediation* where (spatial) relations between two things are always affected by a third (Article **IV**), and Albertsen and Diken (2006: 239 – 41) who draw from Deleuze's notion that flows between two actors can be *quantum*, prone to disconnections, disruptions and transformations. Moreover, this is not a purely theoretical discussion without the contacting surface of politics: in the UN framework of governing climate change, the spatial displacement of emissions has been recognized and discussed as *carbon leakages* (Ostwald & Henders, 2014).

The reason why I do not wish to apply any of these ready-made conceptual frameworks is that the mediation of the consequences (also indirect) of biofuel development takes new topological forms as new technologies, local weather patterns, food price disturbances and other new factors affective to the European biofuel assemblage emerge in time. Therefore, as Joronen and I emphasize in Article **IV**, the spatial relations of biofuel development should be treated as a multiplicity, and thus explicating all topologies of biofuel development under specific spatial categories appears to be a futile project. That is to say, under the rubric of fluid spatialities, I discuss all kinds of non-governed forms for how impacts are mediated from their original assemblages associated with EU biofuel development. Biofuels emerged in the middle of forestry, agriculture, waste management and transport, which necessarily catalyses changes in the dynamics of these already stabilized entities. To argue this point more forcefully: there was no 'empty space' waiting for biofuels to emerge into, and subsequently the growth of the European biofuel assemblage has dislocated and distorted previously existing processes. Moreover, among the purposes behind the Commission beginning to craft the incentivizing nomosphere of biofuel governance was the specific need to re-structure agricultural production; to solve its problems related to declining profits and overproduction. In other words, the indirect consequences of the biofuel development were, in some sense, among the reasons why biofuels became promoted in the first place.

Currently, the attention of EU biofuel policy-making concerning the dislocated spatialities of biofuels is focused on indirect land-use changes – in particular, the greenhouse gases that they catalyse (CEC, 2010a). In addition to this phenomenon, the fast growth of biofuel consumption in the EU may have catalysed various harmful indirect impacts, such as displacing subsistence agriculture by supporting industrial monocultures and encouraging land grabs (Anseeuw et al 2012; Sassen 2013), accelerating tropical forest loss due to the increasing demand for vegetable oils, sugars and cereals cultivated in the Global South (Fargione et al., 2010; Laborde, 2011; IPCC, 2014, chapter 11), and increasing the volatility of food prices by allocating food to fuel (HLPE, 2011; OECD/FAO, 2012). It is important to note that these displaced spatialities do not only concern the spaces of biofuel production: in 2010, Italian customs officers discovered an illegal cargo of 10,000 tonnes of subsidized US soy oil, bearing a Canadian seal, docked in Venice. Thaler (2013: 151) argues that Brazilian interest in developing the ethanol sector of Mozambique is rooted in the desire to trade ethanol for European markets without high customs fees. Moreover, fuels have been imported to the EU through third countries to avoid custom fees; economic operators have discovered loopholes to import ethanol without custom fees as non-classified products under combined nomenclature (Systèmes Solaires, 2011-2013); and frauds that concealed the true origins of feedstock have been exposed (Forde, 2013).

These dislocated spatialities of biofuel production, trade and consumption have fuelled debates about the purpose of crop-based biofuel development and created a substantial challenge for the EU concerning how to navigate dislocated human and non-human actors that are catalysing these negative consequences. Indeed, these dislocated spatialities are the most notable shortcoming of the biofuel sustainability criteria introduced in the Renewable Energy and Amended Fuel Quality directives (EC, 2009a; 2009b). Therefore, the Commission began in 2009 to assess whether iLUC is significant enough that it should be tackled with legal instruments as it was required by the European Council. The scientific knowledge about indirect land-use changes was at that time largely absent (through original implications about the scope were prepared by Fargione et al. (2008) and Searchinger et al. (2008), and consequently the Commission was also obliged by the European Parliament to introduce a methodology of assessing the scope of iLUC. The iLUC consultation in 2010 was established on the knowledge construed by agro-economic models that assessed the iLUC impact of biofuels concerning the type of feedstock used (Al-Riffai et al., 2010; Blanco-Fonseca et al., 2010; Edwards et al., 2010, also Marelli et al., 2011; Laborde, 2011). The models are consistent in their results that iLUC indeed exists, and therefore indirect GHG emissions catalysed by biofuels are more than zero – although the results vary depending on the model, databases and numerous variables that are fed into the models (Havlik et al., 2011; Wicke et al., 2012; Prins et al., 2010; Overmars et al., 2011).

As an outcome of the consultation, the Commission proposed a directive with the prime orientation being to disengage the European biofuel assemblage from the agricultural spaces of production by setting a 5% limit for crop based biofuels in reaching the 10% renewable energy target for transport. The Commission further introduced crop-based iLUC factors – a negative GHG co-efficient for particular crop-based biofuels – for reporting purposes, took the opportunity to gain GHG savings from the utilization of degraded lands, and increased the multiplying factor for non-LUC biofuels from two to four on some feedstock. In conclusion, the Commission declared that crop-based biofuels will not be eligible for subsidies after 2020. Although the proposal has undergone changes in other EU institutions, its main purpose, not to incentivize the use of crop-based biofuels, has remained. This purpose has been enforced in the framework for energy and climate for 2020–2030 by omitting to construe renewable fuel targets for transport (CEC, 2014a) and in Guidelines on State aid for environmental protection and energy 2014–2020 (CEC, 2014b; (112-114)) that regulates food-based biofuel refineries not eligible for support.

The EU institutions have been under considerable pressure from different political actor groups of the European biofuel assemblage (Article **III**). Certainly, these agro-economic equilibrium models that have quantified the GHG emissions from indirect land-use changes under selected scenarios have made this phenomenon tangible enough to be taken into the spheres of EU policy-making. In some sense, the economic equilibrium could be treated as one of the dimensions of the manifold of the European biofuels assemblage that structures the space of possibilities concerning trade (see DeLanda, 2011a). Nonetheless, what these models have *not* been able to accomplish is tackling the topological complexity of iLUC and agency related to 'making space' (Article **IV**). Gillon (2014) also argues that iLUC models have simplified the complex associations between local environments, human agency and localities. Furthermore, the models have not explicated the factors that could dampen the likelihood that indirect impacts will occur – although exceptions can be found (e.g. Lapola et al., 2010). Consequently, I find this passage from Latour (2010: 475) contains an important point concerning how the models construe the relationships between the indirect consequences of biofuel development and EU political and legal instruments designed to mitigate it:

'*It is really a mundane question of having the right tools for the right job. With a hammer (or a sledge hammer) in hand you can do a lot of things: break down walls, destroy idols, ridicule prejudices, but you cannot repair, take care, assemble, reassemble, stitch together. Its limitations are greater still, for the hammer of critique can only prevail if, behind the slowly dismantled wall of appearances, is finally revealed the netherworld of reality. But when there is nothing real to be seen behind this destroyed wall, critique suddenly looks like another call to nihilism.*'

In other words, the iLUC models have been transferred into a language of critique that offers a hammer to tear down almost the whole framework of instruments designed to encourage the transition from fossils to renewables in the EU's transport. What is revealed, however, is a calculative nomosphere crafted by the Commission, according to which actors are not considered capable of counteracting the potential negative consequences of biofuels. Indeed, this solution of the EU is somewhat contradictory to the results and policy suggestions emerging from the multi-disciplinary sciences of iLUC (compare with Laborde, (2011: 85–88) for instance). The 'real' that these model-based policies of the Commission have unfolded, is not populated by actual actors and elements that are affecting the European biofuel assemblage. iLUC factors – which are the negative greenhouse gas coefficients that were proposed in order to report how the climatic performance of biofuels compares with fossil fuels – treat all the spaces of oil crop production, that range from oil palms to coconuts for instance, as the same by their capacities to catalyse iLUC that is 55 gCO2eq/MJ (see CEC, 2012, annex V, part A). Multiform critiques and worst-case scenarios have certainly been presented about biofuel development, but the mechanisms for how to transfer the moving powers of road, air, rail and marine transport in into sustainable, renewable path remains an open question. Or, how could the expansion of agriculture, which surely needs energy, be achieved sustainably?

This need becomes even more evident in the context of the Global South in general and the questions about land-use changes and food security in particular. These issues have been discussed by Msangi and Evans (2013) and Gorter et al. (2013). Lund (2010) pinpoints with clarity how land-use rights and the ownership of land, authorities legitimizing these rights and the formation of authority are all deeply interconnected. As territory, space is governed, but not owned by its governing agency. As property, on the other hand, space is owned, but not governed by its owners (Lund, 2013: 14). Therefore, bought access to land, for instance by foreign companies in African states to produce feedstock for biofuels, is prone to contestations by local communities and their – often informal – traditional land-use rights, state authorities and private investors. Concerning these types of relations, the challenges of EU biofuel development to navigate its social and environmental consequences become rather obvious, especially in terms of steering dislocated spatialities with ubiquitously applicable calculative schemas. In these localized, heterogeneous assemblages where direct and land-use changes and their indirect consequences occur, the legislative and political instruments of the Union cannot alone solve the emerging concerns. Even so, it is certainly important to take into account how these EU instruments of biofuel governance operate in these contexts. Where and who will be affected by the indirect consequences of biofuel development, as demonstrated by Leal et al. (2012) and Villoria and Hertel (2011), are highly important factors concerning the climatic, environmental and social sustainability of biofuels. This is so because, in terms of metric space, the land area required by EU biofuel development can be sustainably utilized. However, if these impacts hit the most vulnerable groups of subsistence farmers and pastorals, the consequences of biofuels can transform into something highly negative to their welfare.

Indeed, the Commission has been accused of having a biofuel policy that has not tackled the problems emerging from land grabs as, for instance, the sustainability criteria for biofuels introduced in the RED only measures variables related to biodiversity and GHG emissions (e.g. Levidow, 2013). Also, the certification programs approved by the Commission have varying capacities to guarantee the social sustainability of biofuel production (see Schlamann et al., 2013). However, the EU has shown interest in solving some of these problems (see EP, 2012: 18): 'in general, additional demand for wood and other natural resources automatically leads to additional pressure on ecosystems and habitats, which increases the risk for environmental degradation, further conflicts between different land-uses and respective actors who depend on the benefits from the land.' Forest related degradation can be approached, for example, through the United Nation's Reduced Emission through the Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) and the EU Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan. In principle, the EU has agreed upon its land-use policies (2004) that could, if enforced, enhance the sustainability of large-scale land acquisitions. One tool that the EU could also enforce and redesign are the bilateral investment treaties as part of the Union's investment policy between EU Member States and third countries (TNI, 2012: 3–7; see also Graham et al., 2011). Nonetheless, when the focus of dislocated spatialities is (almost) solely on GHG emissions, these initiatives have been side lined in the Commission's recent initiatives concerning the governance of biofuels. I will elaborate these challenges in the final section of this dissertation.

5. CONCLUSIONS AND DISCUSSIONS

5.1 Assemblages as tools in analysing relationships between policy, law and space

The diverse topologies of EU biofuel development and their rapid evolutions have constituted a daunting challenge for the European Union to design ubiquitously applicable legal and political instruments for using organic feedstock as transport fuels. Indeed, biofuels have unfolded an interesting, yet challenging, setting for studying the relations between space, policy and law. Biofuels as a form of alternative energy generate and disrupt the flows of energy via ecosystems and the systems of economy, thus bridging the topics of human and physical geography, as suggested by Hoare (1979). The growing production, trading and consumption of biofuels have created new types of spatial and scalar arrangements between municipalities, states, regions and trading areas around the globe (e.g. Hollander, 2010; Mol, 2010; Sassen, 2013). Biofuels have not only been influential in dissolving existing borders but also in construing new ones (Article **I**). Moreover, the EU simply cannot be reduced to its decision-making bodies or to its Member States; the groups of actors formally and informally affecting the EU's biofuel policy formulation – and being affected by it – are numerous (Articles **II**; **III**). For coping with the spatial polymorphism and the widely dispersed agency in relation to policy and law, my examination concerning the evolving EU governance of biofuels needed a robust ontological scaffolding that would be capable of holding up non-human agency, evolving relations between actors and both the fixity and open-endedness of spatial arrangements. Even though I agree with the conclusion of Bouzarovski (2009: 461) that 'geography is in an optimal methodological and conceptual position to unravel the spatial contingencies of the energy restructuring process', there is a more specific need to have discussions *within* geography for how to approach and examine the spatial constitutions of transitions in energy production, trading and consumption (see also Bridge et al., 2013). My offerings to the discussions about the intertwining of space, policy and law in the context of biofuels were established on elaborating the core insights of Manuel DeLanda's ontology of assemblages.

I find that assemblages offer a legitimate, analytically sharp object for researching multi-scaled, evolving and heterogeneous entities. DeLanda provides a thorough description of how human actors and other elements have both expressive and material capacities to influence the dynamics of assemblages. Therefore, no factor should be treated as irrelevant prior to investigation, as it is assumed in environmental determinism or the idealist metaphysics of language and representations. Indeed, to launch the municipal production and consumption of biogas requires considerable efforts in assembling the material, technological, political and economic elements into an operational entity, as demonstrated in Article **II**. Moreover, his approach explicates strength common to assemblage approaches; namely, how the gatherings of multiple actors and elements can be treated as singular entities without having to disregard their heterogeneity. Each assemblage is constituted of its parts and each part is an individual assemblage itself. This is possible because DeLanda treats relations between parts and the whole through exteriority; the whole can be redundant to a singular part constituting it, and moreover, the parts of one assemblage can be further connected to other. Because of the constant connecting, disconnecting and reconnecting of the parts of an assemblage, these entities never reach a final, perpetual state – although an assemblage can have steady, stabilized borders, hierarchies or scales. This insight makes it possible to discuss the entity of the European biofuel assemblage, despite the fact that the actors and elements have changed radically in the last two decades.

DeLanda also provides a firm ground for approaching Deleuze's conceptions of virtual and actual by explicating the roots of virtual thinking in topological geometries (also Jones, 2009; Smith, 2003) through which factors narrowing spatial open-endedness can be approached. Indeed, organizing factors, such as the energy saving minimum that folds soap bubbles into a sphere and salt particles as a crystal, are mechanism independent of the folds they create. Since the same manifold of the energy minimum takes different actual metric forms in crystals and soap bubbles, it can only be understood through topological terms, as a virtual manifold structuring the degrees of freedom of becoming. It is through these structuring factors that oil palms cannot actually be grown in Antarctica or engines used without knocking unless the gasoline used can sustain a certain level of pressure before detonating. Similarly, it is possible to think that human agency constitutes dimensions to manifolds, such as DeLanda's use of Weber's tricotomic conception about the sources of authority in hierarchically folded assemblages. However, recognizing the structuring principles of spatial forms does not lead to the understanding of stable or determined assemblages – quite the contrary. The intensive flows in the dimensions of manifolds such as temperature and pressure keep the actualized assemblages evolving and differentiating although they can be temporarily stabilized.

As a (neo)realist, DeLanda emphasizes the importance of the causal capacities of material in a way that avoids the critique of how causality leads to reductionism by his notion of catalysis. Instead of acknowledging a determined relation from an event to an outcome, events are always particular and can lead to multiform outcomes because causes are dispersed and entangled with their surroundings. An event can thus catalyse impacts but not determine outcomes. DeLanda understands this relation between an event and impacts through affordance. To have the capacity to affect, there needs to be an entity that affords to be affected. For instance, increasing the demand for crop-based biofuels certainly has the capacity to catalyse land-use changes by allocating food to fuel, but it does not causally lead to these land-use changes; moreover, these land-use changes can take multiple forms from an increase in yields to forest clearings in front of new plantations. In other words, causal relations between an event and an outcome are contingently necessary instead of logically obligatory. Causal capacities are further associated with the discussions about spatial scales and hierarchies. Although DeLanda's spatial ontology is flat (Escobar, 2007), through the emergence of new properties and capacities an assemblage has causal capacities to affect the parts that constitute it. For instance, the European biofuel assemblage as a whole has capacities to restructure the waste flows of the European Union by regulating their fiscal environment, by financing the construction of new types of distribution infrastructures and motor vehicle fleets that can operate with waste refined biofuels and other such mechanisms that mobilize versatile actors and elements to support this transition. This scale of change cannot be done by a singular waste company, or a municipality interested in biogas, even though they are the actors of these evolutions (see Article **I**). Scale, whether consciously construed or emerging out of non-human events, has to be understood in a part-to-whole relation.

Moreover, as Deleuze and Guattari (1988) explicate, purely rhizomatous (horizontal) or arboreal (vertical) forms of connecting are abstractions and assemblages are always something in between. As the types of connections in and between assemblages influence the spatiality that these entities constitute, subsequently there is a multiplicity of different types of spatial arrangements. The modes of connecting, for instance, direct and indirect land-use change cannot be treated as the same (Article **IV**), and therefore there is no 'golden rule of geometry' that would *a priori* determine the most accurate or purposeful ways to characterize the spatiality of an assemblage. In an epistemic sense, I find reason in characterizing the spatial distribution of the biogas stations of a particular EU Member State in metric terms if a research concerns the use radius of vehicles and the coverage of the renewable fuel distribution network. However, the whole network could not be characterized through metric space as its operations are connected to fluctuating oil prices, investors, the maintenance of this network, population centres, and other such factors that are approachable only in relational terms.

Despite the extensive discussions about the ontology of DeLanda's assemblages, the main new theoretic contribution of my dissertations concerns David Delaney's nomospheric interpretations and how they can be made into more systematic form through the approach of assemblages. Indeed, space and law have been treated co-constitutive in my analysis. The legal and political instruments of governance influence how the heterogeneous elements and actor of the assemblages are associated with each other, and further how these evolving relations influence the processes of formulating laws and policies. Assemblages can be treated as the entities through which various nomospheres operate, consequently filling the gap in Delaney's thought of how nomospheres are overlapping and entangled. Assemblages thus contextualize nomospheres in certain topologically mappable arrangements. The other contribution of DeLanda (2011a) is the distinction between properties and capacities. It is clear that a legal instrument has properties, being regulative or incentivizing, for instance. But whether a particular political instrument has the capacity to affect the dynamics of an assemblage becomes a question of affordance. This makes the capacities of a particular law or policy virtual. To be precise, this dimension of the manifold that influences the capacities of legal or political instruments to assign relations within an assemblage can be treated as the nomospheric setting of an assemblage. Thus, nomospheres are pre-individual entities, immanent and irreducible to the actual relations of assemblages, but nonetheless affective to their topological formations. The governance of biofuels, certainly, did not simply emerge out of nothing but from a pre-existing mixture of specific needs to reconstruct the energy and agricultural production and consumption patterns of the EU, tackle the phenomenon of climate change and to improve urban air quality (Article **I**).

5.2 Approaching the evolution of EU biofuel policy in spatial terms

In this dissertation, I examined how the European Commission's policies and the legal instruments implemented by the EU have affected European biofuel development during the last two decades (1992–2013). This analysis was conjoined with a topological investigation into how the spatialities of the European biofuel assemblage have evolved and, further, influenced the biofuel policy-making of the Union. Despite some examinations concerning the spatial evolutions catalysed by the fast growing biofuel development of the EU (e.g. Smith 2010; Mol, 2007), as a contribution to the existing literature concerning the EU governance of biofuels I did not only explicate how political and legal instruments connect, mutate and dissolve associations between the different elements and actors of the assemblage. I also studied how the mode of connecting has evolved by examining nomospheric transitions affective to the governance of biofuels. The main results are summarized in Table 1, which illustrates the spatialities of the European biofuel assemblage, the actual political and legal instruments implemented in the EU and the nomospheric intentions that affect the mode of governing the associations of this loose entity. However, some caution is required – this type of table creates an illusion that these spatialities would not be interacting with each other, which would be contrary to the key points of this dissertation: there are multiform, dynamic associations between the actors and elements of the spatialities.

I recognized three distinctive phases that do not only unfold the topological ruptures of the European biofuel assemblage but also interpret the changing modes of governing biofuels to explicate how space, policies and law have intertwined in the European biofuel assemblage (Article **I**). The development of the assemblage began when the Commission through its strategies portrayed the potential connections between biofuels and the multitude of actors that could benefit from the increasing production of biofuels in the EU. During this period, from 1992–2003, the character of the nomosphere can be described as strategic and enabling. Nonetheless, the Commission introduced legal and political instruments such as tax exceptions for agriculturally sourced biofuels which favoured EU biofuel development to cluster around the agricultural actors and elements in the Member States. The major producers were, and partially still are, agro-industry giants although oil companies have increased their biofuels production. Subsequently, the emphasis was set to launch biofuel production – although the first initiatives concerning unified targets of renewable fuel consumption were also presented in the Commission's biofuel policies.

Table 1. Spatialities, political and legal instruments and the nomospheric contexts of the European biofuel assemblage

Spatialities of the development	Implemented policies and laws	Aims of governance
Production		
• Large scale industrial plantations of the South • Regulated sites of EU agriculture and energy crops • Municipal and food industry wastes and agricultural and forest sourced residues • Laboratories designing microbes and algae	• Tax exemptions for various biofuels to encourage investments in the sector • Research, development and deployment for the commercialization of versatile biofuel technologies • Common Agricultural Policy allocating subsidies for energy crops • Standardization of biofuels in order to ordain their functional relationships with the distribution infrastructure and motor vehicle fleets	• Increase the market penetration of biofuels • Enhance the energy security of the EU and mitigate climate change • Find advanced biofuel solutions • Support regional development and rural job creation • Ordain functional relationships between vehicles and fuels
Trade		
• Existing trading patterns of agricultural products and biofuels • Trade of technologies • Trade of land • Trade of carbon through Clean Development Mechanism	• Free trade agreements between the EU and other biofuel producing regions • Customs fees for imported biofuels and masses • Land-use policies • Transnational investments policies • Development co-operation • Standardization	• Dismantle trade barriers of the South • Protect domestic production • Make biofuel associated land investments more sustainable • Integrate developing countries to world trade • Make the trading of biofuels global
Consumption		
• Existing oil-based transport fuel networks for low blend biofuels • Emerging transport system of alternative moving powers (harbours and roads) • Differentiating consumer attitudes towards biofuels	• Tax harmonization (tax exemptions for biofuels made possible) • Biofuel and renewable targets for MS • Instruments for biofuel consumption increase (e.g. support for alternative fuel captive fleets) • Mandatory alternative fuel network construction	• Remove national barriers of biofuel market penetration • Guarantee safe investment environments for companies • Make infrastructural changes to fuel distribution and motor vehicle technology, thus enhancing the energy security of the EU
Dislocation		
• Multiform, often detrimental impacts dispersing from the governed spaces of the production, trade and consumption of biofuels	• Sustainability criteria • Instruments favouring non-crop-based biofuels and the utilization of marginal and degraded land • Land-use policy • Approved certification schemes for biofuels *Suggested instruments:* • iLUC factors (for reporting) • Cap for crop-based biofuels	• Target biofuel feedstock for non-land-using alternatives • Improve the utilization of marginal and degraded lands • Guarantee the climatic sustainability of biofuels • Safeguard forest biodiversity • Limit the interaction with biofuels and agriculture

In the mid-2000s, the topology of the European biofuel assemblage transformed to be networked through increasing trade with the agricultural producers of the Global South and North America. Concurrently, the nomosphere governing biofuels began to evolve to incentivizing and globalizing. This globalizing tendency of the European biofuel assemblage was ignited and strengthened by a particular focus on the spaces of consumption, namely by harmonizing EU Member States' targets concerning biofuels. However, the transferring of the EU's biofuel targets to the Member States has not been a success story. Still in 2012, the reported consumption of biofuels in Malta and Estonia remained zero (Systemes Solaires, 2013), which, in general, emphasizes the distinction between the properties and capacities of legal and political instruments (see Anderson et al., 2012). Moreover, biofuels were integrated in various EU led free-trade negotiations and the standardization of biofuels enhanced in order to transfer them to be suitable for global trade. Thus the Commission also gave special attention to the spaces of trading biofuels within the EU and between the Union and other biofuel or mass-producing regions of the world. The Commission, nonetheless, also continued protecting domestic biofuel feedstock with its trade policy instruments; even though, for instance, European companies and financiers are simultaneously associated with long-term land acquisitions in the Global South (Havnevik & Haaland, 2011; van Gelder & German, 2011; Mol, 2010; Sassen, 2013), which pinpoints that it is not only biofuels that are traded in the assemblage but also land and cultivation practices.

These globalizing connections of the assemblage not only increased the share of imported biofuels but also the complexity of navigating the negative consequences of biofuel development, which are discussed in this dissertation under the rubric of dislocated spatialities. Certainly, the impacts of the EU's rapid biofuel development have been dislocating since the origins of this assemblage, because it emerged in the middle of agriculture, waste management, transport and other such sectors. After 2009, the focus of EU policy-making has accentuated the designing governance of these dislocated spatialities. These versatile topologies of dislocation are mainly related to the crop-based biofuels that still constitute the majority of consumed biofuels in the EU because they catalyse the strongest land-use impacts, and further, allocate food to fuel. Thus, the Commission has begun to reorient the European biofuel assemblage from fields to wastes, residues, and laboratory-designed microbes and algae, which has introduced a new constellation of actors to the assemblage (Articles **I; III**). Even though the recent directive proposal on iLUC that proposes a 5% cap for the share of crop-based biofuel eligible for subsidies in 2020 has been characterized as a u-turn in the Commission's biofuel policy, the transition towards biofuels that do not cause land-use changes has already been politically encouraged (and financially supported) by the Commission's previous instruments of governing biofuels, namely through the biofuel sustainability criteria. These instruments of governing biofuels that have broken the path-dependency of biofuel policies supporting agricultural producers also indicate a rupture in the nomosphere since the mode of connecting is increasingly based on regulation and calculation.

All in all, the development of the European biofuel assemblage stresses how policy, law and space are deeply interconnected. Explaining the emergence of increasing EU regulation based on the quantified GHG emissions without acknowledging the actual clearings of peat-swamp forests in South East Asia or, on the other hand, without paying attention on the dominance of climate change mitigation in the political agenda of the EU, would result in a lopsided analysis. Indeed, transitions in the nomosphere of the European biofuel assemblage have influenced the topological ruptures of the assemblage, and further, been influenced by these. Although EU biofuel development constitutes a globally operating, loosely gathered assemblage, the parts that constitute this entity should also be understood as singular entities. As I demonstrated in Article **II**, the Member States of the EU can be treated as assemblages that are, certainly, influenced by EU level instruments, but nonetheless, have their own nomospheres in which the EU instruments are transferred and implemented. Moreover, the evolutions of the multiform assemblages associated with EU biofuel development are not likely to stop. Subsequently, the Union cannot expect its instruments to be implemented in municipalities, nation states or sugar cane plantations without changes, translations made by the mediators of political and legal instruments – or without consequences that could be tackled with the same instruments that are catalysing them. Indeed, the governance of biofuels is an evolving process of designing, implementing, actualizing and re-designing, which influences the emergence of new spatial arrangements.

5.3 Unfolding the challenges of the EU's strategy to develop biofuels

As it has been highlighted throughout this dissertation, the formation and development of assemblages is contingent instead of determined; actual formations associated with their virtual potentialities. Subsequently, I elaborate the examination of the challenges of the Commission's way of governing biofuels with increasingly topologically indifferent calculative instruments for horizons beyond the 'Realpolitiks' of the Union, as Escobar and Osterweil (2010) encourage. I do not wish to create an impression here that this dissertation would promote 'the right mechanisms of promoting biofuels'. Instead, my purpose is to pinpoint the challenges that are the results of approaching complex issues such as land-use changes associated with the European biofuel assemblage that are already determined, without acknowledging the potentialities of space to become different though agency. Certainly, these topics have been discussed previously, for example by Palmer (2014) and Levidow (2013), but without fully tackling the diverse set of actors and their relations that are being influenced by the evolving modalities of governance.

As a backdrop to this discussion, there is a scientific consensus that robust GHG emission reductions in transport are needed quickly in order to avoid the catastrophic consequences of climate change, because GHG emissions are far from the track of staying below 2 Celsius of warming (see IEA, 2013). In terms of environmental protection and energy security, the Union itself recognizes the need to counteract the increasing dependence of oil imports from environmentally hazardous fossil fuels from the Arctic, tar sands of Canada, Russia or Kazakhstan and deep sea oil drilling (e.g. CEC, 2014). Although electric vehicles can commercialize in some urban parts of the world, they are not feasible solutions in marine transport or aviation. The global transporting of goods, energy and people, which is necessary for the operation of a globalized economy, has not shown signs of diminishing – indeed, quite the contrary. Globally, the sector of transport was responsible for 23% of total energy-related CO_2 emissions in 2010. Additionally, the IPCC (2014, chapter 8: 4) states that: 'without aggressive and sustained mitigation policies being implemented, transport emissions could increase at a faster rate than emissions from the other energy end-use sector'. The environmental and climatic performance of agriculture – which needs to expand to meet the growing world population and the Westernizing consumption habits in the Global South – is not going to enhance without significant effort, which, in particular, necessitates finding solutions to the energy problems of agriculture (e.g. Laborde, 2011; Sanchez et al., 2012).

Manifestly, encouraging cycling, walking and the use of car pools, improving fuel efficiency, lowering speed limits, increasing the use of rails and public transport and designing intelligent transport systems all are efficient ways to reduce the GHG emissions from transport. Moreover, I fully agree that the EU and its Member States, regions and municipalities should try to use multiple legal and political instruments to mitigate the detrimental consequences of transport. These above-mentioned instruments, however, lack a genuine solution for one of the most pressing problems: how could the seemingly ever-growing transport sector around the globe become renewable? Focusing on the increasing use of wastes and residues is certainly a sound, feasible alternative for biofuels, but as demonstrated by Hamelinck (2013), the EU has enough truly sustainable waste resources to reach the 10% renewable target. By 2030, advanced biofuels could constitute 16% of transport fuel consumption (Barret, 2014). Nonetheless, over 80% of the consumption of transport fuels would still be based on fossils, on the roads of the EU alone, after reaching this potential.

Of course, this notion should not lead to the conclusion that biofuels should be promoted without tackling their negative consequences. Indeed, the current challenges of the EU's biofuel policy development are related to food and environmental security, and the accelerating of the global climate change, which were not considered even as potential problems when the Commission began to promote biofuels. The proposed instruments for tackling these outcomes include assigning a cap concerning the share of crop-based biofuels, the feedstock specific GHG co-efficients and omitting to propose a renewable fuel targets for transport in the 2020–2030 policy framework (CEC, 2012; 2014). If implemented, these instruments can halt crop-based biofuel development, and gradually sideline them. Although these can be robust mechanisms in mitigating LUC associated problems, those instruments do not encourage improving the environmental or social performance of the existing spaces of biofuel production already influenced by EU biofuel development (Article **IV**). Furthermore, they do not create a stable environment for making investments even in advanced biofuels – out of which some are tightly associated with agriculture, such as using straw as feedstock. These instruments narrow the horizon of approaching LUC by focusing on the calculative nexuses of carbon alone instead of recognizing the multi-form spatial outcomes of this dislocation of land-use practices (also Palmer 2014). Especially the passive GHG co-efficients denote that the nomosphere of the European biofuel assemblage treats the multiplicity of sites producing soy, palm, rape or sunflower oil around the world as the same concerning their capacities to catalyse iLUC. Subsequently, the legislation built on the agro-economic models of iLUC risk of becoming naturalized, positivist law that is losing its connection to the space that it seeks to steer, as discussed by Olwig (2005).

Even though the Commission was mandated to design instruments to assess and govern iLUC after the approval of the RED by the Council as early as in 2009 (EC, 2009a), the iLUC directive proposal of the Commission is still being debated in the EU institutions of decision-making (see Article **III**). This hold-up has left this negative consequence of biofuel development being non-governed and entrenches the Member States deeper in the use of crop-based biofuels without any improvements to farming or other land-use practices. Moreover, the share of renewable energy in the consumption of EU road transport showed a decline for the first time in 2013 after implementing the biofuel directive in 2003 (Systemes Solaires, 2014). Günther Oettinger, the Commissioner of Energy, stated after the European Council of Ministers voted against the iLUC proposal on 12.12.2013 that the only beneficiaries of this non-action are OPEC and Russia. Although his statement was probably born more out of frustration than a carefully executed analysis of the situation, this dissertation, nonetheless, ends by pointing out that in order to carefully explicate the effects of biofuel related land-use changes in particular, and other dislocated spatialities in general, the focus should also be on the evolving, actual topological relations of the European biofuel assemblage. In comparison to the approach of the European Commission, when IPCC (2014, chapter 11: 100–101) characterizes bioenergy and its versatile economic, environmental, social, institutional and technological outcomes, they can be positive or negative. In other words, the impacts of bioenergy are contingent.

Subsequently, what follows is the most crucial point of this dissertation: the EU's ontological conception of biofuels which treats the assemblages of producing biofuels rather as homogenized by their capacities to catalyse dislocated impacts is hardly compatible with the pursuits of the EU to strengthen land-use planning, protect vulnerable ecosystems or to support the rights of subsistence farmers to access land (e.g. EU, 2004; CEC, 2006b; 2010b). In the pursuance of sidelining crop-based biofuels through the modality of calculating carbon emissions, the Commission enforces disharmony within the EU's policy framework concerning land use which might benefit from the more holistic, geographical imaginaries of policy formulation.

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