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## Contextualizing the Bioeconomy in an Unequal World: Biomass Sourcing and Global Socio-Ecological Inequalities

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The term ‘bioeconomy’ is commonly met with a sense of uncertainty regarding its meaning and purpose. In general, there are three different fields of public and scientific debate about the bioeconomy. Nicholas Georgescu-Roegen (1971) referred to the bioeconomy as a transformational pathway towards a degrowth society. In contrast, the debate about ‘biocapitalism’ focuses on the commodification of bodies, biological matters and micro-organisms in the context of biotechnological innovation (Cooper 2014; Sunder Rajan 2007). Lastly, bioeconomy policies are also viewed as presenting themselves as a means of replacing the fossil base of modern societies through the intensified use of biomass sources.

In this volume, we primarily refer to this third strand of the debate. Against the background of climate change, bioeconomy was introduced as a transitional strategy by the OECD in 2009 and was subsequently

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revisited by Germany (BMBF and BMEL<sup>1</sup> 2020; BMBF 2010), the US (The White House 2012) and the EU (European Commission 2012, 2018). In these policy processes, the biotechnology sector has played (to varying degrees in different countries) an influential role in determining the content and direction of specific measures to facilitate the emergence and institutionalization of the bioeconomy (Meyer 2017). Many corresponding policy documents address primarily the agricultural and forest sectors while highlighting the significance of research and innovation (R&I) programmes as the pillars of a knowledge-based transition towards a sustainable bioeconomy. By 2018, 14 countries as well as the EU had adopted national bioeconomy strategies; another 34 countries refer to the bioeconomy in their agricultural or research strategies (German Bioeconomy Council 2018, p. 13).

Considering this landscape, the concept of the bioeconomy is far from being static or monolithic. There is no common definition of the bioeconomy, since the objectives of national or supranational policy strategies vary depending on the technical background and specializations of the actors involved, as well as on sector views and interests related to existing biomass and biotech industries (Kleinschmit et al. 2014; Backhouse et al. 2017; Vivien et al. 2019). In some cases, the prefix ‘bio’ stands for the promotion of biotechnologies (OECD 2009). In the case of the EU, it highlights the use of biomass as the resource base of a ‘knowledge-based bioeconomy’ (European Commission 2012), or a ‘circular bioeconomy’<sup>2</sup> (id. 2018; BMBF and BMEL 2020). The strategies and policies of semi-peripheral countries such as Argentina or Malaysia can be placed between the biomass-focus of the EU and the biotech-focus of the OECD.

Despite their specificities, there is a common assumption and narrative enshrined in all of these strategies: the idea that technological innovations are a necessary means of decoupling<sup>3</sup> economic growth from the

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<sup>1</sup>BMBF is the German abbreviation for Bundesministerium für Bildung und Forschung and means Federal Ministry of Education and Research. BMEL stands for Bundesministerium für Ernährung und Landwirtschaft or Federal Ministry of Food and Agriculture.

<sup>2</sup>According to the European Commission (2015), a circular economy refers to the use of and reuse of products, materials and resources for as long as possible as part of the economic circuit.

<sup>3</sup>On the impossibilities of a circular bioeconomy from a metabolic standpoint, see Giampietro (2019).

overexploitation of resources and the harmful levels of CO<sub>2</sub>-emissions generated through capitalist modes of production, consumption and energy combustion.

Although bioeconomy policies address global problems, the political discussions and research on the emerging bioeconomy are mainly focused on Europe and North America (see Backhouse in this volume). This is particularly striking since the bioeconomy relies on growing levels of biomass production for food, fodder, fibres and bioenergy, as well as for chemical components for biotechnologies, which are produced worldwide. Yet, a global perspective that considers the production of globally traded biomass and its effects on the agricultural and forestry sectors of different countries as well as knowledge production in several contexts beyond Europe and North America is still a lacuna in the political and research fields on the bioeconomy.

With this edited volume, we seek to address this research gap insofar as we scrutinize bioeconomy policies in several countries in (and across) both the semi-peripheries and the centres. We consider interconnections between different world regions and assume that bioeconomy policies as well as their main fields of action (research and development, agriculture and forest sectors) are not developed and implemented within ahistorical vacuums. Instead, they are intertwined with global socio-ecological inequalities between centres and semi-/peripheral countries as well as within countries since colonial times. Hence, this volume seeks to contribute towards answering the following guiding questions: How is the bioeconomy dealt with in different countries? To what extent does the bioeconomy perpetuate or change existing global socio-ecological inequalities between biomass producing semi-peripheries and centres with regard to where processing takes place and value is produced?

We use the term *socio-ecological* to underline the assumption of political-economic approaches within the research field of political ecology that view nature and society as dialectically interrelated (Görg 2004). Nature cannot be thought of without society and vice versa. From this perspective, today's global socio-ecological inequalities are shaped by the capitalist mode of production: capitalism, with its need to accumulate and grow, has led to a level of resource depletion that is unparalleled

in human history (O'Connor 1986), and it affects people and nature in unequal ways.

Drawing on theoretical and empirical research in political ecology, we identify four dimensions of global *socio-ecological inequalities*. (1) Resource access and use: people are not only unequally integrated as paid or non-paid labour into the production and reproduction processes of global capitalism, but they are also asymmetrically involved in the (over)use of natural resources. As research on unequal ecological exchange and unequal ecological footprints show, this socio-ecological inequality has a global dimension, since resource use and consumption by individuals is influenced by their place of residence as well as whether they live in semi-peripheries or capitalist centres (Bunker 1985; Martinez-Alier et al. 2016). (2) Environmental degradation: as environmental and climate justice movements as well as ecofeminists demonstrate at the local to the global level, people are also unequally exposed to the negative consequences of the degradation of nature, such as damage to health by pesticides. Further, these inequalities are re/produced along different structural categories such as class, gender, ethnicity and/or citizenship that influence and reinforce each other (Agarwal 1998; Bullard 2000; Acselrad 2010; Sundberg 2008). (3) Unequal production of knowledge: studies on green growth policies such as the promotion of renewables, or on conservation projects show that people are unequally involved in the political processes of problem definition and developing technical solutions (e.g. Escobar 1998; Lehmann 2019). As a result, (4) the changes that this leads to, such as the expansion of palm oil plantations for biodiesel, often have negative impacts on marginalized classes and groups such as small farmers or indigenous peoples as they usually lack the means to defend their land and customary rights (e.g. Backhouse 2016; Fairhead et al. 2012; Tittor 2020).

The *global perspective* is of utmost importance, since the globalized agricultural and forest sectors are inserted directly and indirectly into the unequal global relations that have evolved since colonial times (Bunker 1985; Moore 2000). We draw on the insights of world systems theory that social inequalities cannot solely be explained on a national level since they are shaped also by inequalities between countries (Korzeniewicz and

Moran 2012). In this perspective, global inequalities need to be analysed on a global scale that includes a historical perspective of 500 years of capitalism, and an understanding that colonialism enabled capitalism and structured global uneven developments (Wallerstein 2007). In this light, we address the pitfalls of methodological nationalism. While the nation state remains important in the introduction, construction, socialization, implementation, maintenance, legitimation and even defence of many bioeconomy agendas, the study of how biomass, and particularly bioenergy, is to offset societal change in times of global ecological crises requires an analytical move that goes beyond the study of national 'containers'.

Against this background, we have divided the two guiding questions into four blocks. Each chapter in this volume addresses at least one of the following questions:

- How can we think and/or rethink the concepts of bioeconomy and energy? How can a global perspective on socio-ecological inequalities contribute to a complex and critical understanding of bioeconomy?
- How is the bioeconomy discussed and implemented in different countries? Who participates in the negotiation of specific bioeconomy policies and who does not? Who determines the agenda?
- To what extent does the bioeconomy and biomass sourcing change or reproduce existing socio-ecological inequalities in rural areas?
- What are the implications of bioeconomy policies and transitions for existing relations of extraction and inequalities across regions?

The empirical focus of the volume mainly addresses the use of biomass and bioenergy by drawing on different analytical perspectives about the agricultural and forestry sectors. We refer to bioenergy as the use of biomass for producing fuels, i.e. first- and second-generation agrofuels, power and heat. Biomass-driven energy development in the transport, electricity and heating/cooling sector provides a large and longstanding depository of experiences that can be used to mobilize knowledge for the analysis of the bioeconomy. Energy is one of the pillars of many bioeconomy strategies. At the same time, bioenergy has been one of the focal points for social struggles surrounding the transition away

from fossil-based resources. Thus, experiences in this field shed light on the transformation towards a post-fossil society, its actor constellations, challenges and contradictions.

The regional focus of this volume brings together multi-disciplinary contributions from social scientists working on bioeconomy-related issues in South and North America, East and Southeast Asia, and Europe. The volume has been organized by the German research group *Bioeconomy and Inequalities. Transnational Entanglements and Interdependencies in the Bioenergy Sector (BioInequalities)*, which is funded by the BMBF. Therefore, it is worth noting that half of the authors are located in Germany. We acknowledge our positionalities within the academic structures of the Global North, an area of the world that is highly involved in the promotion of the international bioeconomy debate and its agenda. This volume is further enriched by a series of contributions from authors from and/or based in a variety of other countries and regions. The aim was to broaden the largely Eurocentric research landscape and political debate on bioeconomy, while moving discussions beyond the study of Europe and North America. We have included regions and countries that qualify as initiators of the bioeconomy debate and that have bioeconomy policies which are being put into practice. Due to the focus on bioenergy and biomass, longstanding important players in the transnational bioenergy sector have also been selected. We consider this volume a first impulse to expand the debate on bioeconomy, especially in terms of the impacts and forms of biomass and bioenergy production, and to encourage a regionally more varied research agenda that will hopefully include countries and regions that we could not consider here.

In this volume, we study global socio-ecological inequalities on various scales and consider different analytical categories. This multidimensionality of inequalities requires different methodological approaches. Thus, the contributions in this volume embrace a variety of methods: most chapters are based on qualitative research, including fieldwork, expert interviews and participatory observation. Many contributions complement their analyses with existing quantitative data sets. Some of the chapters analyse policy papers, expert and media debates on bioeconomy and bioenergy, while others refer more to socio-ecological change and

the way it affects different social groups. Others put more emphasis on the historical emergence of inequalities and/or engage with ongoing debates about sustainability, energy, neoliberal natures, intersectionality and extractivism.

In the following, we outline the chapters' responses to the four blocks of questions of this volume. First, we approach central issues of the bioeconomy from different directions, such as unequal knowledge production, its neoliberal orientation, the production of value and unquestioned assumptions about (bio-)energies. In Sect. 1.2, we sketch out the main findings on bioeconomy policies in different countries. In Sect. 1.3, we summarize the reconfigurations and continuities of the socio-ecological inequalities that are present on the ground. In Sect. 1.4, we look at the extractive side of global biomass sourcing. Finally, we discuss the need for further research and the political implications of this volume.

## 1.1 Rethinking the Bioeconomy, Energy, and Value Production

The national and supranational strategies that target bioeconomy are mainly research funding strategies. The explicit aim of most national strategies is to compete for technological leadership in the emerging global knowledge-based bioeconomy. While many researchers criticize the technocratic and ecological modernization approach of bioeconomy policies, the global dimension of competing and unequal knowledge production beyond Europe and North America is still a research gap. As Maria Backhouse argues, the strategy-papers of the EU, Germany and the OECD reproduce global unequal knowledge production and simultaneously strengthen 'extractive knowledge' in the globalized agribusiness sector. Therefore, the bioeconomy concept is more connectable to the Brazilian agribusiness sector and less to agroecological movements and, thus, threatens to reproduce regional and global socio-ecological inequalities and aggravate climate change.

Kean Birch focuses on the market-based approach to the bioeconomy. He differs with critical perspectives that speak much too precipitately

of a 'neoliberalization of nature', leaving little room to develop alternative bioeconomy approaches. Instead, he proposes to examine in detail how markets and nature are co-constructed, in other words, how the biophysical materialities of biomass intertwine with socio-economic configurations to produce different kinds of bioeconomies.

Another key question in the critical debate on the bioeconomy is about the extent to which the bioeconomy opens new ways of value creation and the role that patents play in this (Birch and Tyfield 2013): Are patents tools of extraction or speculation? Referring to the European vegetable market, Veit Braun's answer is that neither description applies completely to these patents. Braun argues that native trait patents are a legacy of biotech plant patents from the 1980s and 1990s, but that they follow different material, legal and economic logics. Thus, unlike GMO patents, native trait patents cannot be understood as tools for extracting surplus value from farmers. Instead, they are simply a means to capture investment on the stock markets. Braun concludes that there is no single business model that would explain the rush of companies to patent in conventional plant breeding. Therefore, patents must be understood as complex value objects that fulfil different functions for different actors, and that often defy their original purpose of stimulating and protecting innovation.

Larry Lohmann takes a step back from the guiding questions of this volume and radically criticizes the concept of energy that has become generally accepted in everyday vocabulary—even by critical scientists and social movements. He argues that any serious study of bioenergy and global inequalities must take account of the oppression inherent in thermodynamic energy itself. Thus, he first underlines that the abstract nature that we now call energy was organized during the nineteenth century in conjunction with new waves of capitalist mechanization centred on labour control and productivity. He then sketches some of the ways in which the social or ecological contradictions of thermodynamic energy are intensified in the twenty-first-century bioeconomy, suggesting that this is a useful framework for understanding many of the conflicts explored elsewhere in this book. Finally, the chapter draws out some of the implications for social movements and how they might place themselves more strategically in struggles over today's bioeconomy.



## 1.2 Bioeconomy Policies and Agendas in Different Countries

In our own studies of the bioeconomy in Germany, Malaysia, Brazil and Argentina, we noticed that few people outside of state expert circles can make sense of the term bioeconomy. Accordingly, we asked ourselves whether the bioeconomy is fact or fiction. We learned that bioeconomy agendas have been materializing in research funding policies and state incentives for bioenergy policies in all of the countries under study in the last ten years. However, these policies have been developed in expert fora and are mainly defined by dominant agribusiness, biotechnology and conventional forest sectors. The dominance of these sectors stands out in all the cases we present in this volume, from Finland, Brazil, Argentina, Malaysia and Indonesia to Germany and the European Union. Most contributions observe more or less cooperative relationships between state institutions and business associations, and a deliberate interest in expanding the production and commercialization of biomass products, biotechnologies and bioenergy sources. In Brazil, Indonesia and Malaysia, the bioeconomy has been appropriated by agribusiness sectors. This is exemplified by Anne Tittor in her analysis concerning Argentina. Tittor argues that the bioeconomy narrative has been appropriated by the agribusiness and biotechnology sectors, and that they use it to reframe their activities as sustainable. These actors are responsible for focusing the country's entire economy on soybean exports, while ignoring the negative social and environmental impacts.

Non-industrial actors focusing on small-scale agriculture, forestry management, or cooperative bioenergy production are absent in most policy processes (see Lehmann in this volume). Moreover, little to no concern is expressed about the integration or even protection of localized livelihoods (see Toledo López in this volume), where work and land issues (see Lorenzen, and Puder in this volume) as well as gender relations (see Sinaga in this volume) are directly—and negatively—affected by biomass sourcing. Thus, these contributions suggest that current bioeconomy policies do not provide sufficient entry points to enable alternative designs to become part of the process. This is partly due to the fact that the policy development process is not the subject of social

debates about the form and objectives of this global socio-ecological transition project. This confirms on a global level what other authors have already discussed in the European context (TNI and Hands on the Land 2015): the bioeconomy is an exclusive project that lacks a democratic mechanism to ensure an open-ended negotiation process and the participation of all stakeholders.

For the German context, Rosa Lehmann emphasizes that the national bioeconomy agenda has thus far failed to integrate and reinvigorate the pre-existing knowledge and practices of civil-society actors engaged in cooperative schemes promoting citizen-based bioenergy production. Addressing issues of knowledge production from an energy justice perspective, Lehmann argues that the inclusion of these experiences would be a fundamental step towards the construction of a bioeconomy agenda that not only aims to induce technological change, but also to stimulate societal change.

Nevertheless, bioeconomy policy processes are contested and dynamic—and therefore changeable (Böcher et al. 2020). In this sense, the enduring intervention of civil society and critical academics have, for instance, led to some shifts in the revised version of the German bioeconomy strategy paper (BMBF and BMEL 2020). The paper acknowledges the fact that the additional need for biomass could aggravate the global socio-ecological crisis. Further, it opens its research funding explicitly to research and development in agroecology (*ibid.*). Whereas in the past, many official bioeconomy publications were full of euphonic promises of bioeconomy bringing sustainability and jobs, and mitigating climate change, a recent monitoring report questions Germany's growing ecological footprint, particularly if the country is to implement its new bioeconomy policy (Bringezu et al. 2020).<sup>4</sup>

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<sup>4</sup>The monitoring report shows that the German economy is systematically based on the import of biomass and thus on the import of agricultural land and water: 16.7 million hectares (ha) are used within Germany, whereas abroad, Germany uses about 43 million ha of land. A substantial amount of the biomass produced for Germany comes from Asia, Africa and South and Central America—together, this is more than the amount produced by Germany and Europe itself (Bringezu et al. 2020, p. 87). The climate footprint of the agricultural goods consumed in Germany also exceeds total territorial emissions, which means that the emissions occur in the countries where the goods are produced. According to the monitoring projections, this climate footprint will hardly change until 2030.

In his study of Finland, Tero Toivanen shows that the bioeconomy can also become the subject of public controversy. In Finland, the bioeconomy has been adopted by the forestry sector. The dominant narrative paints the Finish forestry sector as sustainable, and as offering the country an important role within a European bioeconomy future. However, scientists and climate activists have challenged this view by arguing that increased forest harvesting will undermine Finland's climate objectives. In doing so, they have triggered a contentious public debate about the pros and cons of the bioeconomy.

In their sectoral analysis on sugarcane electricity in Brazil, Selena Herrera and John Wilkinson show that the promises made about the merits of second-generation biofuels and electricity produced from residues are far from materializing. Although sugarcane bioelectricity is framed as contributing to the diversification and distribution of power generation in Brazil, its development depends on specific public policies, and it faces hard competition from both the powerful fossil oil and gas sectors, and the renewable energy sector, which includes both solar and wind sources.

### **1.3 Reconfigurations and Continuities of Socio-Ecological Inequalities in Rural Areas**

As various chapters in this volume outline, bioeconomy policies reproduce or reconfigure socio-ecological inequalities in the agricultural sector. The dominance of agribusiness in the development and implementation of most policy strategies and the absence of other stakeholders with alternative visions risks perpetuating existing socio-ecological inequalities in the agricultural sector in different countries as various qualitative studies in this volume demonstrate.

Kristina Lorenzen studies the changes to rural land and labour relations associated with sugarcane industry expansion in the Brazilian state of Mato Grosso do Sul. The expansion was encouraged by national policies that reflected global green development narratives. In this

context, Brazilian sugarcane-based bioethanol was framed and reoriented as a climate-friendly alternative to fossil fuels. Nevertheless, this 'green industry' resulted in the reconfiguration of rural social inequalities. Sugarcane expansion contributed to the deceleration of agrarian reform, increased the integration of (non-indigenous) peasants as temporary wage workers, and led to a double exclusion of indigenous people from land and wage labour.

Similar dynamics that reinforce existing positions of social disadvantage in the production of biomass can be witnessed in the case of the steadily growing palm oil sector in Southeast Asia. Indonesia and Malaysia are by far the largest palm oil producers worldwide. Despite claims by both countries that palm oil production can be environmentally sustainable and, therefore, contribute significantly to climate protection and stop ecological degradation, and improve people's working and living conditions in the region, the evidence suggests otherwise. In her chapter, Janina Puder argues that migrant workers deployed to perform the physically most demanding and worst paid jobs in the industry are systematically overexploited to keep palm oil highly profitable for Malaysian producers. Puder's main argument is that the specific intersection of class and citizenship enables the overexploitation of migrant workers, and that this shows that bioeconomy developments do not necessarily break with key features of capitalism. A related argument is made by Hariati Sinaga. In her historically informed study of gendered labour in the Indonesian palm oil industry, Sinaga demonstrates that the customary forms of female labour on the plantations today evolved from the colonial period and continue to shape a cheap and disciplined female labour subject.

By examining the biodiesel sector in Argentina, Virginia Toledo López addresses the territorial impacts of biomass production in the Argentinian north. Toledo López' contribution puts the contradictions of Argentinian agrofuel production at centre stage. On the one hand, she identifies a strong developmentalist narrative related to bioenergy production; on the other, she argues that the production regions are confronted with the negative impacts of biomass production, whereas the products are sold on the world market. This connects the northern Argentinian peripheries to the centres. Thereby Toledo López shows that

territorial inequalities are part and parcel of a bioeconomy situated in unequal structures.

## 1.4 The Extractive Side of Global Biomass Sourcing

It is still too early to say how the bioeconomy will affect the unequal global relations between the centres and semi-/peripheries in the long term. However, most policy papers are not aimed at changing the inequalities in global knowledge production or the global division of labour, and, instead, merely reproduce the status quo (see Backhouse in this volume). Further, Bringezu et al. (2020), who modelled the impact of the bioeconomy on biomass sourcing, suggest that the additional demand for biomass will amplify asymmetries between producing and processing countries. Therefore, the question is how these global socio-ecological inequalities will be changed by the rise of the BRICS-states.<sup>5</sup> For several decades now, the emergence of new global players including the BRICS, has been challenging the long-lasting dominance of countries that have represented the centre, both in political and economic terms. China and Brazil are significant examples of this shift. As Fabricio Rodríguez discusses in his chapter, the rise of these new heavyweights has had a significant impact on the direction of the global bioeconomy and, therefore, on the emergence of new global South-South inequalities. As Brazil intends to become an important supplier of bio-based resources and technologies, China's current role as a major consumer of non-renewable energies has created important constraints on the development of a global bioeconomy, while paving the way for new socio-ecological inequalities surrounding resource extraction.

However, the shifts in the global power structure do not mean that the global inequalities between the old centres and semi-/peripheries have become obsolete. For example, if we take a closer look at the quantity of resources that the EU will need in transitioning towards a bioeconomy, it is obvious that existing asymmetries in political and economic

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<sup>5</sup>Brazil, Russia, India, China and South Africa.

power within the world system are not being called into question. Malte Lühmann contends that the often-criticized focus on resource extraction as a development strategy is likely to be reinforced by the material base of the EU bioeconomy scenarios. Furthermore, Lühmann argues that the EU's move towards a bioeconomy represents a continuation of the extractive relations that already shape the global market and the structural asymmetries between semi-/peripheral regions and industrial centres. Whereas European countries concentrate on the development of bio-based technologies and innovation, countries in economically weaker positions are tempted to compete to become important resource suppliers.

Such a dynamic can be witnessed, for example, in the case of Argentina, which is one of the world's largest producers and exporters of soy. The Argentinian government aims to place the country in an economically more favourable position on the global market and hopes to become a regional forerunner in terms of promoting biotechnologies. Furthermore, in addition to their exclusive character, bioeconomy policies also reproduce the existing agricultural model. In this sense, Anne Tittor refers to the Argentinian approach to bioeconomy as an 'extractivist bioeconomy'. In doing so, Tittor shows how concerns of ecological sustainability are sacrificed in the global race for profit and pioneer status in the global bioeconomy.

## 1.5 Outlook

In the light of current dynamics in different arenas of socio-ecological inequalities, the insights gained from European, South American and Southeast Asian cases underline that the bioeconomy, in its current form, is likely to reinforce or even produce new socio-ecological inequalities. Our findings have led us to identify four areas of further research.

**First**, more countries should be part of research agendas on the bioeconomy and bioeconomy-related issues. We believe that research should not only focus on countries that embrace some sort of explicit bioeconomy policy (programmes, laws, agendas), but also on evaluating the possibility of renewing biomass-centred policies in countries with

a history in the relevant sectors. Examples include forest and agricultural resources in Russia and the former Soviet bloc, and countries in Sub-Saharan Africa.

**Second**, in our view, research should go beyond the analysis of strategy papers, narratives and the euphonic promises of the bioeconomy as sustainable, creating jobs and mitigating climate change and towards the analysis of different spheres of socio-ecological inequalities. For instance, these could include unequal access to and control over land or participation in policy development processes. As the chapters by Toledo López and Sinaga show, contextualizing the concrete socio-environmental impact of biomass sourcing both within specific local circumstances and historical structures reveal how this contributes to issues such as the devaluation and destruction of peasant livelihoods and makes female labour invisible. With contributions in this volume engaging with world systems theory, extractivism and research on transnational labour migration, we suggest how research could conceptualize the global perspective on socio-ecological inequalities from the local to the global level. However, more conceptual and empirical research is needed on the global dimension of socio-ecological inequalities in order to gain a deeper understanding of the interdependencies and interconnections between different societies, classes and groups that goes beyond the nation state. Insights from post- and decolonial research and border thinking provide starting points for further studies about a transnational bioeconomy, highlighting the coloniality/modernity of such an approach and the different axes of social inequalities.

**Third**, the real existing bioeconomy is currently strengthening powerful actors and mainstream practices in the forest and agricultural sector and, therefore, can contribute to deepening relations of exploitation, marginalization and dispossession as well as extractive and unequal trade relations. Against this background, we see a strong need to develop a transformative vision of the bioeconomy. One starting point could be the discussion about the meaning of bioeconomy as coined by Georgescu-Roegen as a radical degrowth perspective. Furthermore, we suggest conducting more research into existing alternative knowledge and practices. If Birch in this volume claims that another bioeconomy is possible, then the practices on which such a bioeconomy could rely

on need to be examined in more detail—and this should include actors working on alternative innovations and through cooperative practices under a market-logic as much as actors who consider themselves to be working in line with and those who go beyond a growth imperative. If Lohmann challenges the common understanding of energy and the role of energy science in capitalism with little-e-energies, then a closer look should examine these little-e-energies—the actors and practices—in order to understand potential starting points for a societal transformation towards a more just and low-carbon bioeconomy.

**Fourth**, we need a broader public debate and negotiation about the objectives of the bioeconomy. Different authors in this volume call for the conceptual and political integration of civil-society based experiences and knowledges. This means including various actors in bioeconomy policy making as well as research funding, regardless of whether they are working explicitly towards an alternative bioeconomy. The environmental, climate and energy justice movements, peasant organizations like La Via Campesina at the global level, prosumer cooperatives, environmental, feminist and antiracist activists, workers in environmentally harmful as well as biomass-based industries, unions as well as 4future-groups on the regional and local level are just some examples. It is both scientifically and politically important to consider these actors as key players of the politics of the bioeconomy.

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