Chapter 1
Introduction: Political Dimensions of the Bioeconomy

Abstract A seemingly inevitable transition to a bioeconomy is underway, raising expectations as well as important social and environmental questions. Climate change, ocean plastic pollution and other ecological issues have made the phase-out of fossil resources an imperative. Still, greater global reliance on biomass alternatives poses as many opportunities as risks. Ensuring that such a transition delivers sustainable development—with the inclusion of marginalized groups, addressing inequalities, and eradicating poverty in line with the Sustainable Development Goals rather than aggravating these problems—is a daunting task, yet a fundamental one. For that, more attention is needed on governance, on the political dynamics that have steered bioeconomy promotion, and on the often-overlooked social dimensions of sustainability. This introductory chapter discusses the concept of bioeconomy, its tenets, goals, potentials, and key risks. It presents an initial critical inquiry into the political ecology of bioeconomy promotion and then outlines this book's in-depth assessment focused particularly on emerging economies. As these actors increasingly come to shape the fate of global sustainability in the twenty-first century, the bioeconomy reveals to be an essential domain in which to analyze sustainable development politics in large democracies of the Global South.

Keywords Environmental governance · Biofuels · Social equity · Political ecology · Sustainable development · Ecological modernization

1.1 Rescuing the Social Pillar of Sustainable Development

Something goes missing when anyone describes sustainability as a win-win strategy. If the concept is three-dimensional, at least a third win should be there, including the ecological, economic, and social aspects.

People are strongly impacted by environmental degradation and the different strategies adopted to avoid or cope with it. Yet the social dimensions of sustainable development remain understudied, obfuscated, and at times ignored. The United Nations' (UN) 2030 Agenda and its Sustainable Development Goals (SDGs) have duly recognized social aspects of inclusiveness, justice, and poverty alleviation. However, these issues arguably remain marginal in most sustainability assessments,

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generally focused on reconciling the ecological and economic pillars (Barnett 2001; Lehtonen 2004; Robinson 2004; Cook and Smith 2012). Sometimes such social equity dimensions are treated as supplementary (see UNDP 2011). But such social objectives are inherent to the sustainability concept (WCED 1987; UNCED 1992; UNCSD 2012) as much as they are fundamental to understanding and addressing environmental issues (Berkes and Folke 1998; Ostrom 2005; UNRISD 2012).

Social dimensions are critical to sustainable development, as the 2030 Agenda highlights (UN General Assembly 2015). Improvements to basic living standards, inclusiveness promotion, and poverty eradication have long been significant tenets of "development" (Sachs 1979; UNCED 1992). Yet, already before the shock of the COVID-19 pandemic, about 821 million people worldwide were undernourished (FAO 2019), 2.1 billion lacked access to clean and safe drinking water (WHO/UNICEF 2019), and 860 million lived without electricity (IEA 2019).

At least three rationales would underscore more substantive actions to change such a reality. First, we may regard poverty eradication and social equity promotion as an ethical or moral imperative. Principles of justice, solidarity, and empathy for others are present in most philosophical or religious traditions—as in the so-called "golden rule" to seek for others the same as for oneself (Blackburn 2001; Singer 2002). Second, these goals also have a legal nature, as they are enshrined in democratic values and international law. Such laws include the Universal Declaration of Human Rights, the Rio Declaration on Environment and Development, as well as non-binding legal instruments such as the SDGs (UN General Assembly 1948; UNCED 1992; Bastos Lima 2009; Gupta et al. 2010; Gupta and Lebel 2010; UN General Assembly 2015). Those international commitments request universal access to essential resources and the opportunity for political participation, as well as the right to equitable development that prioritizes the needs of the least advantaged (UNCED 1992; Rawls 2001, p. 149). The 2030 Agenda makes this principle explicit aiming to "reach the furthest behind first" (UN General Assembly 2015, p. 3). Finally, equity is crucial to social welfare, as poverty and inequality compromise a wide array of other human development and social quality indicators. Poverty curtails both individual and collective potentials for intellectual and cultural expression (UNRISD 2010). Inequality, in turn, is often linked to low levels of social trust, high rates of violent crime, lower educational performance, and higher incidence of physical and mental health issues (WHO 2008; Wilkinson and Pickett 2009). Notably, these are issues that affect unequal societies as a whole—not just the poor.

Social aspects are also crucial in dealing with environmental issues. Values, principles, norms, and other institutions are fundamental to understanding how—and why—human activities impact nature and society itself (Finnemore and Sikkink 2001; Conca 2006; Biermann et al. 2009, p. 72). A Foresight Report of the United Nations Environment Programme (UNEP) has identified "Aligning Governance to the Challenges of Global Sustainability" as the most pressing environmental issue for the twenty-first century (UNEP 2012). It suggests that there needs to be considerably more attention to the role of institutions and governance mechanisms built to orientate human activity, hence on the social and political dynamics that shape them. Likewise, the social impacts of environmental degradation and responses created to

address it need to be well understood. Lack of attention to these dimensions can easily lead to strategies that overlook or even aggravate social problems, such as inequitable approaches to biodiversity conservation or climate change adaptation that end up excluding weaker stakeholders, deepening poverty, and creating further injustice (Fairhead et al. 2012).[1]

Social equity is an imperative not only within societies but also on the global level. In recent decades, half of all income systematically went to the wealthiest 10% of the world population, leaving the poorest 10% to live on 0.7% of it (Milanovic 2006). By the start of the 2020s, the richest 1% together possessed twice as much combined wealth as 6.9 billion people (Coffey et al. 2020). Notably, the World Bank observes that as much as 70% of income disparity can be attributed to international (inter-country) inequalities, rather than variation within each country (Milanovic 2006). Domestic imbalances have been pressing in some countries. Still, no single country is more unequal than the world (Milanovic 2016), which is recognizable given that nearly all those who still lack access to food, water, or electricity live in Africa, Asia, or Latin America. Therefore, bridging the North-South divide that separates developed and developing countries is a significant step not to be overlooked in addressing poverty and inequality on a global scale. That thus remains an essential dimension of sustainable development.

This book examines such social dimensions of sustainability from a political perspective. It focuses on bioeconomy governance, a novel, promising, and arguably necessary emerging sector where attention to equity is vital, for bioeconomy development may either become a way to redress injustices and eradicate poverty or perpetuate—possibly aggravate—existing problems. An assessment of what has been done with biofuels before and now under the bioeconomy umbrella is timely. It can unravel the sort of strategies and pathways being promoted, and which may either be adjusted or gain even more traction in the future. The next section describes the rise of the bioeconomy and some critical questions of environmental politics it poses. This introductory chapter then turns to the approach, boundaries, and scope of the research behind this book, before presenting its structure.

1.2 Environmental Crises and the Rise of the Bioeconomy

The United Nations has regarded climate change as the defining challenge of the twenty-first century (Ki-Moon 2007). The Intergovernmental Panel on Climate Change (IPCC) reports have consistently suggested that it has been human-induced and has already affected temperatures, rain patterns, and marine and terrestrial ecosystems worldwide. Climate change impacts human societies both directly (e.g., heat waves) and indirectly, due to damage to natural systems. That includes water

[1] See the special issue of *Global Environmental Change* on "Adding Insult to Injury: Climate Change, Social Stratification, and the Inequities of Intervention", edited by Marino and Ribot (2012).

scarcity, a higher prevalence of tropical diseases, and significant losses in rain-fed agriculture—all of which disproportionally affect the poor (Roy et al. 2018, p. 451).

There is a growing sense the world must urgently move away from CO_2-intensive fossil fuels such as oil, coal, and natural gas toward renewable energy sources. However, most renewables replace only power and not the liquid fuels still largely used in transportation, a sector that accounts for 14% of all anthropogenic greenhouse gas (GHG) emissions (IPCC 2014). Electric automobiles have been on the rise and rapidly conquered increasing market shares in Europe, with some European countries already setting deadlines to ban diesel cars. Yet, as of 2020, combustion-engine vehicles remained vastly dominant globally, while the shipping industry and aircrafts remained reliant on liquid fuel. Liquid biofuels (i.e., renewable fuels produced from biomass resources) have worked as an effective alternative to fossil energy. Biofuels manufacturing technology is well-established, easily replicable, and can be scaled up using many different feedstocks (raw materials). Their adoption requires only relatively minor to no changes in vehicle engine technology and existing transportation infrastructure. As a result, for the first decades of the twenty-first century, they have been regarded as more cost-competitive vis-à-vis fossil fuels than other technologies, and this may remain the case for some time in most of the world (Pacala and Socolow 2004; Mathews 2007; Bastos Lima 2018).

Despite the outcry and political opposition to biofuels, their global production has mainly remained unabated. An initial international enthusiasm raised annual biofuel production from 4.4 billion liters (bl) in 1980 to 18bl in 2000 before it increased eightfold to 153bl in 2018 (Koh and Ghazoul 2008; UNEP 2009; REN21 2019). In 2020, the International Energy Agency forecast continuous growth in the sector and a 25% increase in output by 2024 (IEA 2020). This production consists primarily of ethanol, an alcohol that can either replace gasoline or be blended with it, and biodiesel, which can be used in blended or pure form to substitute fossil diesel. In 2018, ethanol and biodiesel production respectively stood at 111.9bl and 41.3bl (REN21 2019). By 2028, the Organisation for Economic Co-operation and Development (OECD) and the UN Food and Agriculture Organization (FAO) project that those annual outputs will continue increasing to reach respectively 143bl and 44bl and coming mostly from production based on conventional feedstocks (OECD/FAO 2019). That is perhaps a glimpse of what the world may look like in terms of liquid bioenergy when the 2030 Agenda meets its deadline.

More recently, in light of political setbacks against biofuels in some places (particularly in Europe), they have been increasingly framed within a broader *bioeconomy* umbrella. Although the bioeconomy does not have a single, unambiguous definition, it generally refers to biomass-based economic sectors and value chains (Bugge et al. 2016; Bastos Lima 2018). Many aim to replace fossil fuels and other fossil-based products (e.g., plastics, chemical oils). However, the bioeconomy has sometimes been promoted simply as an avenue to spur sustainable development based on biological resources (Scordato et al. 2017). There is much enthusiasm that biofuels may be only the tip of the iceberg. Numerous bioproducts can emerge, aided by biotechnology development, to sustain greener societies (see European Commission 2018). That could help address global climate change and other environmental issues such as

biodiversity loss (which in part owes to its currently unrecognized economic value) and growing plastic pollution, most notably of the oceans (Scordato et al. 2017).

As some authors have long recognized, biofuels may not be the ultimate renewable energy technology but rather a stepping-stone towards more advanced and efficient ones in the future (Pacala and Socolow 2004). In the long run, biomass sources may no longer be significant fuel providers, but they will undoubtedly supply chemical components for many industries. This aim is best captured in the concept of *biorefineries*. It suggests industrially processing (i.e., refining) biomass to extract and separate its various (bio)chemical compounds that can substitute what today is made primarily from oil, such as plastics, solvents, and lubricants (Lynd et al. 1999; Kamm and Kamm 2004; Langeveld et al. 2010). Energy does not have to be the primary output but just one possible application, among many others. These other applications include bulk or commodity products of high volume and comparatively low value (e.g., industrial oils, adhesives, surfactants, solvents, and biopolymers for biodegradable fibers and plastics) as well as low-volume high-value chemicals for the food and pharmaceutical industries (Sandun et al. 2006; Langeveld et al. 2010; Aiking 2011). Economically, although only a small share of petroleum is used for non-energy purposes, its market value is approximately equal to what is used as fuel (Langeveld et al. 2010). Biorefineries thus present an enormous potential to provide renewable industrial feedstocks and create development opportunities. They have also led some to prefer to speak of *value webs* instead of (single) chains, as the same biomass feedstock can enter several downstream paths (Scheiterle et al. 2018).

However, it should not go unnoticed that if the broader bioeconomy follows biofuels' footsteps—as the forecasts expect it to do (OECD/FAO 2019)—the bulk of this new production will derive from agriculture, with significant ecological, socio-economic, and political implications. In the case of biofuels, despite more than a decade of eager (and over-optimistic) projections about "next-generation" feedstocks, virtually all commercial production remains consistently based on conventional sources. Ethanol is mainly from crops rich in either starch (e.g., corn, cassava) or sugar (e.g., sugarcane, sugar-beet). At the same time, biodiesel is produced chiefly from vegetable oils (e.g., soybean, rapeseed, palm oil). On a global scale, about 12% of all vegetable oil supplies are used for making biodiesel, and 18% of all sugar crops go to ethanol manufacturing. By 2028, industries may use 14% of the global corn and 24% of worldwide sugarcane production for biofuels (OECD/FAO 2019).

It is crucial to notice how a small set of crops has increasingly dominated production—even before any nominal bioeconomy pretensions. These crops (notably corn, soy, sugarcane, and oil palm) have sometimes been called "flex crops" and championed for their versatility, allowing for possibly meeting the demands of various downstream markets (Alonso-Fradejas et al. 2016; McKay et al. 2016; Oliveira and Schneider 2016; Bastos Lima 2018). They have two complementary features that seemingly make them unique: *multipleness* and *flexibleness* (Borras et al. 2016). Multipleness refers to the different uses these crops can have, including a large variety of co-products and by-products. In turn, flexibleness relates to producers' ability to easily switch from one utilization to another (e.g., sugarcane for sugar or ethanol making) based on economic and policy assessments. In other words, producers can

choose—and regularly adjust their choices—of which commodities to produce from those crops, selecting among different downstream markets depending on which one is most attractive at a given moment. These potentials can be a boon for flex-crop producers, but the bioeconomy's foundation on agriculture has broader implications.

Ever-larger reliance on agriculture means, first, that increased demand for liquid biofuels and other bioproducts provides a growing market and thus an incentive to cultivate those particular feedstock crops. As such, the bioeconomy becomes connected to the whole range of ecological and socio-economic issues related to agriculture: impacts on soil and water quality, deforestation, but also the creation of employment and income in rural areas. Globally, liquid biofuels already sustain more than two million jobs, more than any other renewable energy sector besides solar photovoltaic (REN21 2019). Second, the utilization of crops—or resources such as arable land and freshwater—for biofuel manufacturing or other novel uses means that these uses compete directly or indirectly with food production, thus impacting food supplies, food market prices, and possibly food security. Rather than deny or polemicize such a competition, the key might be to understanding how different objectives can be sustainably balanced—as required, not the least, by the SDGs. Third, expanded dependence on agriculture means that social groups, regions, countries, and even continents with this sector as a significant economic activity can become new energy and bioproduct providers, potentially altering political power structures from local through to the global level. As such, the bioeconomy has dimensions that go beyond conventional debates around renewable energy.

The fact that biofuels over the past decades and bioeconomy as of today have become so appealing to public and private interests does not, however, mean that these necessarily are sustainable endeavors. What it demonstrates is, instead, that such innovations have successfully captivated the actors whose interests and decisions shape the development agenda at domestic and international levels. This agenda is far from being uncontroversial or free of risks, as seen widely in the biofuels' case when some asked whether the cure was not worse than the disease (Doornbosch and Steenblik 2007; FAO et al. 2011; see also Chapter 2). There remain fears that, in trying to address the climate crisis, production on a larger scale could trigger other environmental problems related to deforestation or excessive freshwater consumption. Much evidently depends on *how* the bioeconomy is pursued (Bastos Lima 2018). Therefore, assessing the political and institutional factors that have shaped biofuel policy agendas and directed bioeconomy governance to date is timely.

1.3 The Political Ecology of the Bioeconomy

1.3.1 Ecological Modernization and Its Limits

Today's dominant strand of environmentalism and sustainability approach arguably is the ecological modernization paradigm (Adams and Jeanrenaud 2008; Foster 2012).

The early environmental critique in the 1960s and 1970s pointed to the damages caused by new technologies and the Earth's limited carrying capacity in the face of post-war aspirations for unlimited "progress" (Meadows et al. 1972; Dunlap and Van Liere 1978). In turn, ecological modernization contends that economic growth and technological development can advance hand-in-hand with conservation (Hajer 1995; Buttel 2000; Janicke 2008). Indeed, it argues that *further* economic growth is needed to address environmental issues through the development of cleaner and more resource-efficient technologies, industrial transformation, and new market mechanisms (e.g., ecological impact accounting, payment for ecosystem services, carbon markets) (Buttel 2000; Olsthoorn and Wieczorek 2006; Baker 2007; Pataki 2009). As an "ecological rationality" emerges in society, those issues become drivers of innovation, market opportunities, and potential sources of competitiveness and profit (Giddens 1998; Mol 2002; Beck 2010). Ecological modernization can thus be understood as a pro-industry, technology-based, and market-oriented approach to environmental policy (Weale 1992; Janicke 2008).

That makes ecological modernization different from "end-of-pipe" environmental management, as it promotes "preventive innovation" (Milanez and Buhrs 2007) instead of remedial solutions (see also Mol 2000; Cohen 2006). It also contrasts with more radical approaches to sustainability that aim at more profound—and more difficult—changes in human behavior or the industrial capitalist system. Instead, ecological modernization adopts a reformist approach, proceeding through incremental changes from within (Mol 2000, 2002; Pataki 2009). In practice, this means fostering an enabling institutional environment and gradually shifting production and consumption patterns towards sustainability. It proposes "reflexive modernity," one that continuously assesses the (ecological) risks it creates and evolves by responding to them (Mol and Spaargaren 1993, 2000; see also Beck 1992).

The relatively conservative stance of ecological modernization on social issues has been a significant source of criticism. Critics have perceived it as an approach that pays little attention to structural inequalities and tacitly maintains the socio-economic and political status quo (York and Rosa 2003; Foster 2012). First, on a conceptual level, ecological modernization tends to detach the social dimensions of environmental issues. It sidelines reflections on equity and ethics to promote eco-efficiency as a solution instead, taming—or, in reality, co-opting—the initial environmental critique on modern industrial societies (Levy 1997; Langhelle 2000; Martinez-Alier 2002; York and Rosa 2003; Baker 2007; Foster 2012). Environmental issues are thus regarded as technocratic problems to be addressed through the market and technological fixes. Meanwhile, the notion of sufficiency is replaced by renewed support to modernity premises such as unlimited economic growth and a consumerist view on human welfare (Christoff 1996; Baker 2007; Blühdorn 2011; Foster 2012).

Second, ecological modernization routinely overlooks social inequalities, politics, and power relations (York and Rosa 2003; Foster 2012). It assumes a conflict-free, harmonious society without political interests or domination structures. All actors supposedly are equally affected by environmental problems, and "there is no ecological proletariat" (Beck 1995, p. 3; Pataki 2009; Foster 2012). Therefore, it can be said there is only limited reflexivity (Eckersley 2004; Warner 2010; Foster

2012). Ecological modernization may revise particular policies or technologies, yet it offers a "discourse of reassurance" to the underlying political and socio-economic institutions in place, and thus to the inequalities they create (Dryzek 2005; Baker 2007).

Third, ecological modernization primarily promotes capital-intensive solutions, making business entrepreneurs, industry, and technology developers the primary agents of change (Christoff 1996; Baker 2007; Warner 2010; Blühdorn 2011). This bias is particularly attractive to wealthier, highly industrialized countries, which have a greater capacity to invest in such "solutions," thus minimizing the need for socio-cultural changes, such as their disproportional consumption patterns (Baker 2007; Blühdorn 2011). And fourth, ecological modernization uncritically advances (Western) scientific rationality as the one dominant knowledge system, with all its assumptions, prevailing norms, and related power structures (Cohen 1997; Pataki 2009). Governance guided by the ecological modernization paradigm usually offers little space for alternative, contrasting views. Such a lack of diversity, in turn, has shown to hinder reflexivity further and often give rise to purported sci-tech solutions full of unappraised impacts (Santos 2020).

These shortcomings have been observed, not the least, in the dominant approach to agri-food sustainability. There has been a clear focus on technical and biotechnological improvements such as crop hybridization and genetic modification instead of more systemic approaches based on agroecology. It builds on large-scale farming and appears to hold an unquestioned, nearly exclusive focus on improving yields and increasing production (IAASTD 2009; Horlings and Marsden 2011; Hardeman and Jochemsen 2012). This mainstream agenda has recently fallen under the aegis of "sustainable intensification," yet without challenging the problematic "hegemony of monoculture agriculture" and its persistent impacts, such as tropical deforestation (Sunderland et al. 2019). Moreover, more broadly, little attention is paid to access dimensions of food security, the impacts of dietary change, inequality in food distribution, or a broader set of environmental issues such as agrobiodiversity loss or pesticide use (Bastos Lima 2008; Horlings and Marsden 2011). Ecological modernization in agriculture has also overlooked the increasing dominance of corporate power in agri-food governance (Fuchs and Clapp 2009) and widespread cultural losses (Kneen 1995; Altieri et al. 2012).

Such a narrow focus and its disregard for equity dimensions was a key reason behind civil society organizations' skepticism—when not outright rejection—of the "green economy" banner, which draws heavily from ecological modernization (see ETC Group 2011; Wapner 2011; Jacobi and Sinisgalli 2012; Onestini 2012; Cook et al. 2012). The green economy has emphasized the need for an *economic* transition from a "brown economy" that depletes the environment into one that sustains it (Pearce et al. 1989; Barbier 2009; UNEP 2011; Brockington 2012). The concept jumped to the fore in the wake of the 2008 financial crisis initially as a strategy for global economic recovery (Barbier 2009; Brockington 2012), before becoming a core theme of the 2012 UN Conference on Sustainable Development (UNCSD, the "Rio+20"). To be sure, UNEP (2010, p. 5) defines it broadly, presenting the green economy as one means to sustainability, as an economy "that results in improved

human well-being and social equity, while significantly reducing environmental risks and ecological scarcities."[2] This broad scope, encompassing all three pillars of sustainability, is reaffirmed in the final UNCSD declaration, "The Future We Want," which sets several green economy principles that include, for instance: closing technology gaps between developed and developing countries, promoting social inclusion and equitable development to overcome poverty and inequality, and enhancing the welfare and empowerment of smallholders, indigenous communities, and other poor and vulnerable groups (UNCSD 2012, paragraph 58).

However, there is a contrast between these all-inclusive definitions and how the green economy concept is generally understood, with a narrower focus on only reconciling ecological issues and economic growth (see Brockington 2012). As such, a significant concern is that such a more limited understanding of sustainability inspired by ecological modernization may end up supplanting sustainable development as an ideal—if not in theory, at least in policy and practice. Although arguments have been made for not conflating the two concepts (see Langhelle 2000; Wright and Kurian 2010), they are most often bundled together, with ecological modernization usually taken as *the* approach to sustainability.[3]

Bioeconomy offers a lucid illustration of the above. For example, the European Commission's strategy explicitly highlights that "A sustainable European bioeconomy supports the *modernization and strengthening of the EU industrial base* through the creation of new value chains and greener, more cost-effective industrial processes" (European Commission 2018, p. 6, emphasis in the original). The choice of words could not have made its intellectual origins clearer. Sustainability assessments, in turn, have focused on economic, ecological, and technological aspects while generally overlooking issues of social equity, power relations, or conflicts among different actors in governance (Sanz-Hernández et al. 2019). It has become increasingly clear that there are different visions in society about what the bioeconomy represents and what it should mean (Bugge et al. 2016), yet governance and other socio-political dimensions remain relatively little studied.

There are at least two crucial gaps in knowledge that are only starting to be addressed. There is little understanding of how policy design relates to the distributive outcomes and social impacts of the bioeconomy. Even the few studies that generally discuss equity issues do not connect them to the particular institutional frameworks in place (see Ariza-Montobbio and Lele 2010; and German et al. 2011). There is consensus on paying attention to *how* the bioeconomy is gaining shape (see Sagar and Kartha 2007; Koh and Ghazoul 2008; FAO 2008; UNEP 2009). However, there is not enough clarity as to what institutional arrangements may work best under what circumstances—particularly concerning social sustainability issues (Bastos Lima 2018).

Moreover, there is little analysis of bioeconomy governance at national and international levels, especially on agency. There is insufficient attention to how different

[2]This definition has been embraced by other UN agencies, too. See un-page.org.

[3]See Baker (2007) for an analysis of how the European Union uses "sustainable development" or "sustainability" in its terminology while promoting essentially ecological modernization.

actors influence (and possibly steer) bioeconomy expansion and its related policy-making process (Dietz et al. 2018). Even studies that have dealt with bioeconomy strategies have rarely considered the broader political contexts in which policies are inserted (Santos 2020). As a consequence, many policy recommendations have made little sense in the real world. For instance, those who simply call for not using food crops in biofuel production may be disregarding the political importance of agricultural interests as a driver—and the fact that many countries have engaged with biofuel production primarily to benefit their farmers. Therefore, addressing these knowledge gaps contributes to a better understanding of bioeconomy governance and making useful policy recommendations.

Finally, although most assessments have focused on domestic contexts, there is also a global dimension to the bioeconomy. Ecological modernization has long been critiqued for tending to focus on local and national experiences while overlooking "leakages" of environmental impacts elsewhere (York and Rosa 2003; Salleh 2010; Foster 2012). This argument is frequently illustrated with the so-called "Netherlands fallacy," the false belief that such an advanced economy has emerged while maintaining a relatively clean and integral environment—when in reality most of the resources it consumes come from abroad (see Ehrlich and Ehrlich 1990; York and Rosa 2003; Foster 2012). Biofuels expansion, in particular, raised alarm bells when it appeared that developing countries could become major biomass feedstock providers for developed countries to become greener (Smith 2010). Recently, bioeconomy strategies may have become far more home-focused—creating jobs and expanding the domestic industrial base. Yet, in an increasingly economically and ecologically interconnected world, the global dimensions of bioeconomy promotion remain. Ecological modernization advocates have responded by paying increasing attention to global commodity chains and "ecological flows," which transcend national jurisdictions (see Mol 2007, 2010). However, there are also questions about how one region's bioeconomy pathway affects another and how the bioeconomy is governed on the international level—or left in a state of non-governance (see Bastos Lima and Gupta 2013).

1.3.2 Political Ecology

This book draws on political ecology insights in its approach to the bioeconomy. Although political ecology lacks a consensual definition, it is generally understood as a politicized view on environmental issues (Blaikie 1985; Bryant and Bailey 1997; Martinez-Alier 2002; Peet and Watts 2004; Forsyth 2008; Warner 2010). In other words, these issues are not seen as technocratic but instead placed in a broader socio-economic and political context, where there are likely to be winners and losers as well as various competing views and interests at stake (see Bryant and Bailey 1997; Forsyth 2008).

Bryant and Bailey (1997, pp. 28–29) identified three central tenets of political ecology:

1. The benefits and burdens associated with environmental change tend to be distributed unequally among actors;
2. Such an unequal distribution generally alters existing social and economic inequalities, reducing or reinforcing them;
3. That has political implications to the extent that it affects the relative power of different actors and, thus, their capacity to pursue agendas and control or resist others' actions.

Such inequalities have both material and immaterial dimensions. They may relate, for instance, to wealth creation or impoverishment due to improved or reduced access to natural resources, but they may also relate to whose norms and discourses become dominant (Peet and Watts 2004; Mann 2009).

This volume is among the first efforts to utilize such a political ecology approach to examine not a case of environmental degradation but an emerging ecological modernization strategy now being promoted under the bioeconomy paradigm. Its research analyzes and draws lessons from over 15 years of biofuel promotion policies to explore the overlooked socio-political and governance dimensions of the expanding bioeconomy. This examination is relevant not only because of the biofuel sector itself, which continues to grow, but also because biofuel policies and production strategies may be setting the pace and potentially creating path-dependencies for all further bioeconomy development. Therefore, this examination may help clarify the social needs and the political challenges of aligning governance to sustainability in these new sectors. It may help understand the determinants of international regime formation on the bioeconomy. It may also help unravel social equity's relevance to other governance issues such as vulnerability and agency.

1.3.3 Objectives & Scope

This study draws from an in-depth assessment of over a decade of biofuel production and governance strategies as a case to unravel the socio-political dimensions of the bioeconomy. In particular, it analyzes how biofuels have been produced and governed internationally, as well as in selected case study countries, to shed light on why specific production patterns have prevailed.

The objectives of this book are to: (1) map out ecological, socio-economic, and political issues related to biofuels and bioeconomy to understand what is at stake; (2) describe how selected case study countries have consolidated certain production patterns; (3) assess how biofuel governance institutions at international and domestic levels steer biofuel production, as a case within the broader bioeconomy; (4) investigate the distributive outcomes and social impacts of such prevailing biofuel production patterns; (5) analyze who the key agents are and how agency has been exercised in biofuel governance at national and international levels; (6) examine the relationships between institutions, distributive outcomes, and agency; and (7) offer recommendations for institutional (re)design.

The book focuses mainly on *liquid* biofuels (namely, ethanol and biodiesel). Their production has skyrocketed globally, accounting for most investments, political attention, praise, and criticism on the bioeconomy to date. Also, the research addresses essentially the so-called "first generation" technologies based on conventional crops. This pathway has consistently accounted for the lion's share of global biofuel production despite long ongoing talk of next-generation biofuels (OECD/FAO 2019). The commercial viability of these more advanced technologies, such as cellulosic ethanol production, may still need improvement and remains debatable (see Robertson et al. 2008; Paul and Ernsting 2007; Raghu et al. 2006). Although the impacts of an eventual mainstreaming of more advanced technologies would certainly be worth investigating, to date the debates on their sustainability remain mostly forecasts, and they do not (yet) reflect the way the bioeconomy has made inroads in the real world.

Finally, given the book's attention to equity issues, there is a justifiable focus on the rural poor in assessing social impacts. They are the most vulnerable actors that have been involved in biofuel production, meaning real-world bioeconomy implementation, and they usually carry the highest stakes. Focusing on weaker actors is in line with a political ecology approach (Bryant and Bailey 1997; Peet and Watts 2004). Moreover, bioeconomy advocates frequently flag local development opportunities as a rationale and moral backdrop (Dietz et al. 2018), akin to what promoters of agriculture biotechnology have long done. While those earlier promises have revealed to be mostly rhetorical and unfulfilled (see Jansen and Gupta 2009), it is critical to understand how the bioeconomy might repeat or avoid the same path.

1.4 A Focus on Emerging Democracies

Emerging countries have recently reshaped the global economy, changed the international political order, and muddled polarized divisions of the world that seemed comparatively clear-cut by the end of the twentieth century—between the Global North and South, developed and developing countries. Although most emerging economies continue to be identified—and to identify themselves—as developing countries (and therefore as part of the Global South), the distinctions between them and their less-developed counterparts have become increasingly visible and harder to ignore.

Emerging countries have been characterized primarily by high economic growth rates and increasing political relevance at the international level, as suggested by their alternative labels as "emerging *markets*" or "emerging *powers*" (The Economist 2008; OECD 2009; Hurrell and Sengupta 2012). For instance, thanks largely to them, the participation of developing countries in international trade more than doubled between 1994 and 2008, revealing their ascension not only in absolute but also in relative terms (Hanson 2012). Having navigated the 2008 financial crisis comparatively well, emerging economies strode further in getting the upper hand (Schmalz and Ebenau 2012), even if countries such as Brazil later succumbed to economic crises that were only aggravated by the impacts of the COVID-19 pandemic (UNCTAD

2020). Regardless, their political ascension in an increasingly multipolar world has continually made the G20 a new key forum for world leaders (Cammack 2012). Overall, there is a clear realization that contemporary processes of global environmental, socio-economic, and political change can no longer be sufficiently understood or addressed without reference to emerging countries (Hurrell and Sengupta 2012).

Three emerging economies are taken as in-depth case studies in this book: Brazil, India, and Indonesia. All three are major agricultural countries that have de facto embraced the bioeconomy and pursued the quick adoption of biofuels on a large scale. Sometimes, their feedstock-crop choices have even been similar—in some cases, identical. They all have targeted sugarcane as the primary ethanol feedstock and attempted to produce biodiesel from non-edible oilseeds (castor bean in Brazil, jatropha in India and Indonesia). The crops being more or less the same, there has been more room for analyzing other variables such as their particular policy frameworks and production strategies. All three countries have also experienced rapid economic development in recent decades while still facing severe poverty and inequality. Inquiries on distributive issues, therefore, become most relevant. That is especially true in the case of bioeconomy, as the production of biofuels and bioproducts increases the competition for key resources that remain inaccessible to significant parts of the population, such as water and food (see Table 1.1).

As emerging democracies, Brazil, India and Indonesia also offer novel contexts for the analysis of bioeconomy politics. They have been far less studied than developed countries in terms of bioeconomy governance or overall sustainability politics. Moreover, being functional—if imperfect—democracies, they are likely to experience more meaningful competition among different views and actors than in more authoritarian emerging countries such as Russia or China.

At the international level, too, North-South issues of the bioeconomy or particular to biofuel expansion have been studied almost exclusively concerning the global impacts of developed-country policies (e.g., Dauvergne and Neville 2009; Smith 2010). This book is amongst the first efforts to comparatively discuss the internal bioeconomy politics of various developing countries, regarding them as actors and global agents, not merely subjects of what developed countries decide to do. This investigation may also help understand whether emerging economies follow a pattern regarding bioeconomy sectors such as biofuels or sustainability more generally—and, if yes, what that pattern looks like.

The book applies a comparative case study methodology for this assessment. Case studies are useful empirical inquiries on complex and contemporary real-world contexts, serving both exploratory and explanatory purposes (Yin 2003). Each has relied on multiple sources of evidence and data-collection methods that are then cross-checked—or "triangulated"—to draw inferences. Four main sources of evidence have been used for this study: the scientific and grey literature on the specific countries; primary documents such as laws, policies, and company memos; key-informant interviews with a total of 104 policy-makers, NGOs, researchers, industry representatives, farmers and grassroots organizations in the three countries; and direct observations

Table 1.1 Socio-economic profile of the case study countries

	Brazil	India	Indonesia
Size and population			
Area (Km^2)[a]	8,514,877	3,166,414	1,904,569
Population (2020)[a]	213 million	1,380 million	258 million
Population density (people/Km^2)[a]	25	464	151
Economic data			
GDP (billion USD)[b]	1,869 (9th)	2,726 (7th)	1,042 (16th)
GDP per capita (USD)[b]	8,921 (70th)	2,010 (137th)	3,894 (110th)
Annual real GDP growth rate after the 2008 financial crisis (2008–2012 average)[c]	3.2%	6.5%	5.9%
Population on less than (PPP) USD 1.90/day[d]	4.8%	21.2%	5.7%
Distribution of family income—Gini coefficient[e]	0.54	0.38	0.39
Social indexes of access			
Human Development Index[d]	0.76 (79th)	0.65 (129th)	0.71 (111th)
Undernourished population[f]	13 million (<2.5%)	194.4 million (14.5%)	22 million (8.3%)
Population without improved access to safe drinking water[g]	4 million (2%)	82 million (6%)	21 million (8%)
Population without access to electricity[h]	0.4 million (0.2%)	74.5 million (5.4%)	4.39 million (1.7%)

[a]UN DESA (2019); [b]World Bank (2020, nominal 2018 data); [c]World Bank (2020); [d]UNDP (2019); [e]World Bank (2020, latest data from 2011 in India, 2018 in Indonesia and Brazil); [f]2016–2018 average (FAO 2019); [g]WHO/UNICEF (2019, 2017 data); [h]IEA (2019, 2018 data)

including field visits to feedstock cultivation and biofuel production areas where social impacts could at times be witnessed first-hand.

1.5 Book Structure

The remainder of this book is structured into two parts, followed by a conclusion chapter. Part I addresses the challenges raised by biofuels promotion and bioeconomy development globally, including how to approach it from a governance perspective. Chapter 2 reviews biofuels and bioproducts' sustainability, appraising the various ecological and socio-economic issues associated with their large-scale expansion. Chapter 3 develops a conceptual and analytical framework, drawing on scholarship

on access, allocation, power and agency, institutions, and overall earth system governance. Chapter 4 then uses this framework to assess biofuels' international policy context as a proxy for what exists to date on bioeconomy governance.

Part II contrasts bioeconomy promotion in the contexts of Brazil (Chapter 5), India (Chapter 6), and Indonesia (Chapter 7). These chapters will present in-depth analyses of the governance arrangements and political strategizing in each of these emerging countries—their institutional frameworks, distributive outcomes, and the role of agency. Chapter 8 then compares the three cases to identify patterns and draw lessons on biofuel production and bioeconomy governance while paying particular attention to emerging economies' characteristic features.

Chapter 9 concludes the book with its core messages, explaining why certain biofuel production patterns have prevailed. It discusses the importance of changing course early on to improve sustainability outcomes as bioeconomy pathways gain traction. The chapter draws various recommendations for institutional redesign and further research, and reflects on the vital importance of social dimensions for avoiding the bioeconomy's capture by narrow political agendas.

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