Environmental Humanities:
Transformation, Governance, Ethics, Law 3

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Forest Governance

Overcoming Trade-Offs between Land-Use Pressures, Climate and Biodiversity Protection

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Environmental Humanities: Transformation, Governance, Ethics, Law

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Sustainability, i.e. the demand for long-term and globally practicable lifestyles and economies, is increasingly being understood as the central challenge of our time. But just as today science is often simply equated with natural science, many people think only of the natural sciences when it comes to sustainability science. Undoubtedly, natural scientific and technical knowledge of problem relationships in dealing with nature, resources and climate is important. However, technical change does not happen on its own. In addition, the ecological challenges are simply too great not to aim for a behavioural change as well as technology. This is the starting point of this series of publications. Some questions are, for example, the conditions for individual and social change, the means or governance instruments and normative (ethical and legal) issues about the ultimate goals to be pursued. Transdisciplinary approaches should play a special role, i.e. approaches that do not operate from disciplinary boundaries but from questions of content without excessive subordination to established disciplinary dogmas. It is important to the editors that the present series stands for pluralism and expressly gives room to uncomfortable, unexpected and heterodox views and methods. In times in which sustainability research in particular (also) is increasingly influenced by the interests of clients, such openness seems necessary in the interest of truly finding knowledge.

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Preface

This book analyses an area of natural resource governance which is currently undergoing fast developments at the EU and international level, especially due to climate and biodiversity protection: forests and their governance. Forests are of high importance in terms of natural resources as well as regarding climate sinks and biodiversity, given that even zero fossil fuels usage and drastically reduced livestock farming would not take us to net zero carbon emissions without some additional forest or peatland management or similar. Current policies and particularly land-use policies – also in the EU and Germany which serve as an example in the present book – prove to be of little use in achieving the ambitious temperature limit set out in Art. 2 para. 1 of the Paris Agreement as well as the target from the Convention on Biological Diversity to stop biodiversity loss, despite all recent developments. Therefore, the present volume presents a critical analysis of the – highly contentious – natural scientific data on forests and of the status quo of forest governance (mainly in European and international law). Furthermore, some analysis of the background in the history of society, economy, philosophy and law is provided. In the end, we develop some optimising regulatory options for forest governance.

Our work since 1997 on sustainability issues – and on basic questions of human sciences in general – would not have been possible without many people, whom we would like to thank very much once again. Most of all, we thank our colleagues, the members of the Research Unit Sustainability and Climate Policy in Leipzig and Berlin. We would also like to thank our colleagues at the University of Rostock (Faculty of Law, Interdisciplinary Faculty, and Faculty of Agriculture and Environment), in particular our Leibniz Science Campus Phosphorus Research, which we are intensively involved in with our research on land-use issues. In particular, we thank Jutta Wieding, Anna Bochmann and Sascha Bentke for contributing aspects to earlier versions of our analysis. Last but not least, we thank Jutta Wieding, Katharine Heyl and Dean Nixon for proofreading. Of course, the responsibility for any errors or inaccuracies remains solely with us.

This book is the joint product of the four authors and not an anthology of different contributions. As far as can be said, Beatrice Garske contributed primarily to Sect. 5.2; Katharina Hagemann contributed primarily to Chap. 3; Felix Ekardt contributed primarily to Chaps. 1, 2 and 6; and Jessica Stubenrauch worked intensively on all chapters except Chaps. 2 and 3 and supervised the project together with Felix Ekardt.

Leipzig/Berlin, Germany
December 2021

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Contents

Problem Statement and Research Issues

1

Abstract

This book analyses and develops overarching concepts for forest policy and forest governance and includes a detailed investigation into the historical discussion on forests. Besides that, the book examines opportunities and limits for negative emissions in a sector that – like peatlands – appears significantly less ambivalent compared to highly technical large-scale forms of geoengineering.

The future development of the land use, land-use change and forestry (LULUCF) sector is of crucial importance for combating climate change and the long-term preservation of natural resources as well as protecting biological diversity (Rogelj et al. 2019; Bologna and Aquino 2020; Pörtner et al. 2021). This is even more the case for the overall land sector including agriculture in general, forestry and other land use (AFOLU). From a climate perspective, the unique characteristic of the sectors is that they do not only account for greenhouse gas (GHG) emissions but also serve as a sink for GHGs. There is an enormous potential for natural carbon storage by soils and the upstanding biomass, particularly forest ecosystems, peatlands and other wetlands as well as arable land, provided these environmental compartments remain intact or are restored and used in a sustainable way, preserving natural functions (Ekardt et al. 2020; Bologna and Aquino 2020; Forsell et al. 2018; Funk et al. 2019; Grassi et al. 2017; Verschuuren 2017). It must be noted, however, that the international law term LULUCF does, in contrast to AFOLU, not cover some core sectors connected to land use that represent high emission levels – namely livestock farming and fertiliser production (Ekardt et al. 2018a; Weishaupt et al. 2020).

In earlier analyses, we have taken a closer look at peatlands that bear the promise of combining negative GHG emissions with biodiversity protection (Ekardt et al.

J. Stubenrauch et al., *Forest Governance*, Environmental Humanities: Transformation, Governance, Ethics, Law,
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2020) – and problematic technological approaches to negative emissions called geoengineering (Wieding et al. 2020). In the present volume we will focus on the importance of forests, also considering the manifold interactions with other types of land use. This will include a critical review of the controversial natural scientific debate on the potentials of forests regarding climate (and biodiversity) protection. The contribution will serve – besides some historical examinations on the economic, legal, mythical, and societal background – as a basis for a status-quo analysis of forest governance. In the end, this will enable us to draft some optimising regulatory options. All governance analysis will focus on the international and European policy level as the overall framework of forest policy approaches. As we will show, there are manifold reasons why global challenges such as climate change and biodiversity loss should be addressed as far as possible by means of transnational policy instruments (see also Ekardt 2019). This is why, even though thus far forest policy as such is under the competence of the EU Member States, we will assess the EU's climate, energy and agricultural sector, that significantly influence the forest sector and provide an indirect competence for the forest sector on EU level (see also Aggestam and Pülzl 2018).

For decades, the world's forests have faced accelerating degradation and loss, impairing nature's balance, biodiversity and climate protection to a potentially life threatening extent (Grassi et al. 2017; Bologna and Aquino 2020). On the one hand, the irretrievable loss of flora and fauna is weakening functioning ecosystems as the basis of all life on earth (IPBES 2019; Wilkinson et al. 2018; Gómez-González et al. 2020). On the other hand, the sink capacity for GHG emissions – needed more urgently than ever in human history to fight the climate crisis – is steadily decreasing (FAO and UNEP 2020). Since 1990, approximately 420 million hectares of forest have been lost due to their conversion to other land uses (FAO and UNEP 2020). Primary forests, the lungs of the earth, decreased by over 80 million hectares during that time (FAO and UNEP 2020, 18). The development is therefore already close to passing irreversible tipping points (on the example of the Amazon see Staal et al. 2020; Leite-Filho et al. 2019, 2020; Gatti et al. 2014).

One of the main reasons for the ongoing land-use change causing deforestation is agricultural expansion for the production of animal food (cattle ranging, soy bean production). Other causes include palm oil production and various implications of the use of fossil fuels such as growing cities, expanding road construction, etc. (Weishaupt et al. 2020; Rajão et al. 2020; FAO and UNEP 2020, p. xvi; Teng et al. 2020; Taheripour et al. 2019; Ekardt 2019). Today, approximately 70–85% of the world's farmland is dedicated to animal-derived food production, such as meat and dairy products (Poore and Nemecek 2018; on the variation of figures on that: Weishaupt et al. 2020). This shows a tremendous impact on both the occurring GHG emissions from the LULUCF sector and the globally accelerating biodiversity loss due to increased land-use pressure (Hedenus et al. 2014; Poore and Nemecek 2018; Weishaupt et al. 2020). Concerning climate protection, there are estimates that 6.6 Gigatons CO_{2equ} per year, corresponding to 49% of the total GHG emissions of the food sector could be avoided, and sink capacity of terrestrial ecosystems could be enhanced by 8.1 Gigatons CO_2 on average each year in a 100-year timespan assuming a no animal scenario (Poore and Nemecek 2018). While livestock farming for several reasons could (and should) be drastically reduced, but cannot be cut back to zero worldwide, as we have discussed elsewhere (Weishaupt et al. 2020; Stubenrauch 2019; Ekardt 2019; Ekardt et al. 2018a, b), it nevertheless becomes clear that drastically minimised livestock farming and a phasing-out of fossil fuels are indispensable to combat the climate and biodiversity crisis and to protect and/or restore worldwide forests (Clark et al. 2020; Weishaupt et al. 2020; Heck et al. 2018; Mengis and Matthews 2020; Rogelj et al. 2019; Willett et al. 2019; Ekardt 2019). Besides carbon dioxide emissions (CO_2), livestock farming is a main contributor to non-CO_2 emissions such as methane (CH_4), nitrous oxide (N_2O), and nitrogen oxides (NO_x) (Blandford and Hyssapoyannes 2015, 175 et seq.; Frank et al. 2017, 5 et seq.).

However, the exact strategy on forests (and negative emission options in general) is always dependent on the targets that have to be fulfilled. According to Art. 2 para. 1 of the Paris Agreement (PA)[1] global warming should be limited to well below 2 °C compared to pre-industrial levels and efforts should be pursued to stay within a 1.5 °C-temperature limit. We have shown elsewhere (Ekardt et al. 2018b; Ekardt 2019; Wieding et al. 2020) that this implies a legally binding obligation to stay within the 1.5 °C limit. We will see in Sect. 2.1 that this requires zero emissions by 2035. To reach carbon neutrality, zero fossil fuels and a massive reduction of livestock farming are necessary, but not sufficient (see in detail Wieding et al. 2020; Mengis and Matthews 2020; Rogelj et al. 2019). In the future, all inevitably occurring GHG have to be compensated for by the creation of negative emissions in sinks (IPCC 2019; Rogelj et al. 2019; Ekardt et al. 2018b; Heck et al. 2018). The exact amount of negative emissions needed is still an open question as well as how they can be generated. This always depends on the efforts to cut down GHG emissions.

In this context, alongside enhanced soil carbon sequestration in agriculture (Fließbach et al. 2007; Scotti et al. 2013; De Mastro et al. 2019), reforestation, forest restoration and large-scale afforestation are increasingly discussed in IPCC climate scenarios as nature-based negative emission technologies (NETs) (Smith et al. 2014, 12, 18; IPCC 2019). Bastin et al. estimate that globally 1 billion hectares are available for additional forest without using agricultural or urban land. This could contribute to limiting global warming to 1.5 °C by 2050 (IPCC 2019; Bastin et al. 2019). However, there is a lively scientific debate on the degree to which forests and natural sinks in general can or have to contribute to climate protection or whether large-scale technical approaches in the field of geoengineering have to be considered as well (IPCC 2019; Bastin et al. 2019; Veldman et al. 2019; Scurlock and Hall 1998; Selva et al. 2020; Bond and Keeley 2005). Most geoengineering techniques are thus far still in development and might pose additional threats to human rights, while their effectiveness in climate protection remains largely unproven (Heck et al. 2018; IPCC 2019, 96; Wieding et al. 2020). In contrast, natural sinks like forest ecosystems already play an important role in stabilising the climate (Grassi et al. 2017). One focus of the book (Chap. 4) will therefore be a critical assessment of the

[1] Paris Agreement (PA), United Nations 2015, Paris, France.

potentials of forests ecosystems in climate as well as for biodiversity protection (IPCC 2019; IPBES 2019; Wieding et al. 2020).

Building on that in Chaps. 5 and 6, the most effective design of policy instruments that steer a respective land use which integrates forests as a key component for climate and biodiversity protection is derived. Potential trade-offs between climate, biodiversity protection, the need to globally secure food security and the increasing need for biomass in a post-fossil world are considered. Already existing legal instruments in the context of forests from international, transnational and in some cases (as an example) also national approaches will be assessed regarding their governance effect. The overarching research question is, how forest governance as one crucial part of land-use governance has to be designed to be in line with the climate target of Paris Agreement and the Convention on Biological Diversity[2] (CBD). The study will function as a complement to our earlier studies on peatlands, on large-scale geoengineering, on land-use-based mitigation and others (Wieding et al. 2020; Ekardt et al. 2018b, 2020; Stubenrauch 2019; Garske 2020; Ekardt 2019; Garske et al. 2020). In these studies, some problems in governing the land use sector have already been identified, especially the problem of depicting climate and biodiversity effects in highly heterogeneous landscapes. Such problems will also play a major role in the present study which will, by these means, contribute to the overall discussion in sustainability governance on various policy instruments such as regulatory law, subsidies, levies, and cap-and-trade schemes.

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2 Methods, Environmental Targets, and Governance Problems

Abstract

Our analysis shows that the climate and biodiversity targets under international law are much more ambitious (and legally binding) than most people assume. These targets alongside human rights obligations require a zero-emissions world before 2035. Methodologically, we apply a qualitative analysis of governance instruments (such as economic environmental instruments or command-and-control law). Prior to all this, there is a disambiguation of some epistemological questions. This seems necessary because especially (also) the sustainability discourse works oddly with the separations between "to be" and "ought to be", and objective and subjective, both of which are not congruent but transverse. Furthermore, social change depends on an interplay of various actors and the most important motives of all actors are not factual knowledge and values, but self-interest, path dependencies, collective good structures, conceptions of normality and emotions. This observation lead to the insight on certain central governance problems (rebound effects, shifting effects, enforcement problems, problems of depicting, and lack of ambition) that must be avoided to meet environmental targets. The problem of depicting plays a central role for forest governance (same for peatlands) since greenhouse gases and biodiversity of forest are very heterogeneous and therefore pose a great challenge for governance.

First of all, the methodology of the present volume requires some clarification. Based on a literature review, an overview regarding the history of forests and forest-related ideas in Central Europe and their implications on society, economics and law, is given. In a next step, the volume critically reviews the literature on the natural scientific debate on forest ecosystems and their potential contribution to climate

J. Stubenrauch et al., *Forest Governance*, Environmental Humanities: Transformation, Governance, Ethics, Law,
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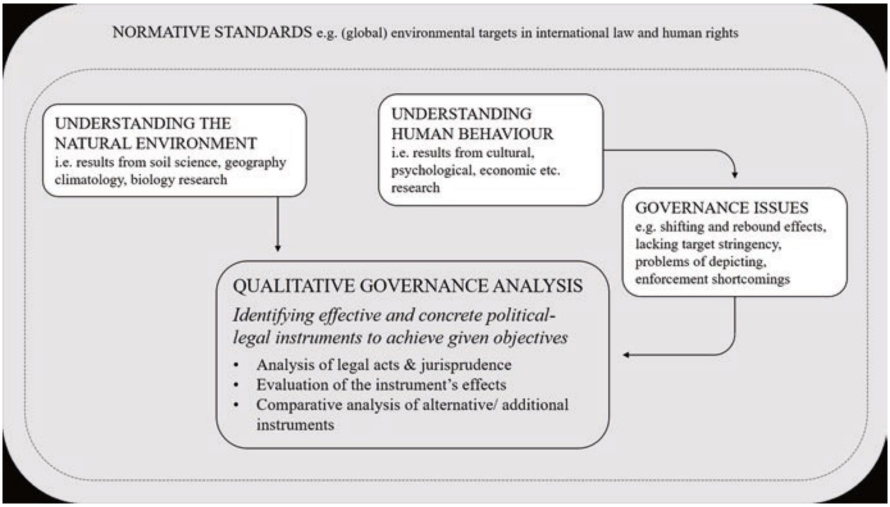

Fig. 2.1 Elements of a qualitative governance analysis. (Stubenrauch et al. 2021)

protection depending on the type of forests, their different phases of growth and varying climatic conditions including the maximum sink capacity to be achieved by reforestation, afforestation or the preservation of old or primary forest ecosystems. Building on this, a multi-methodological qualitative governance analysis (or steering analysis) will be applied to assess the effectivity of existing policy instruments and potential future policy instruments regarding forests and land use (Ekardt 2019; Ekardt et al. 2020). The effectiveness of existing and potential policy instruments is measured against (a) normative standards given by political targets, (b) the ability to avoid typically recurring governance problems, and (c) incorporates knowledge from different scientific backgrounds like natural science and human behaviour (see Fig. 2.1).

As the methodology of a qualitative governance analysis is, however, very often misunderstood (or even unknown) as we have learned during the last two decades in the context of various publications, conferences and further contacts, we will provide some more detailed insights regarding the single components of the methodology in the following.

2.1 Environmental Targets – Basis for Behavioural and Governance Findings

In the present contribution, Art. 2 para. 1 PA and the CBD that aims at halting global biodiversity loss serve as targets in the governance analysis. As mentioned in Chap. 1, according to Art. 2 para. 1 of the Paris Agreement global warming should be limited to well below 2 °C compared to pre-industrial levels and efforts should be pursued to stay within a 1.5 °C-temperature limit. As mentioned earlier, we have shown elsewhere (Ekardt et al. 2018b; Wieding et al. 2020; Ekardt 2019). that this contains a legally binding obligation to trying to stay within the 1.5 °C limit (the binding character and the focus on 1.5, not 2 degrees is also adopted by the German Federal Constitutional Court, Order of 24/03/2021, 1 BvR 2656/18 et al.). To meet this limit with a probability of clearly more than 66% (since 50–67% is not enough from the legal point of view; see Ekardt et al. 2018b; Wieding et al. 2020; Ekardt 2019) and given equal per-capita emission rights on a world-wide scale, globally net-zero emissions across all sectors are required within a probable maximum of less than two decades, probably clearly before 2035 (shown by Ekardt et al. 2018b – also on basic year and natural scientific uncertainties e.g. regarding tipping points and climate sensitivity – discussing limitations of the minimum consensus represented by IPCC 2019; Mengis and Matthews 2020; Rogelj et al. 2019; now in parts also accepted by the German Federal Constitutional Court, Order of 24/03/2021, 1 BvR 2656/18 et al.).

Art. 4 para. 1 PA requires parties to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century and in this sense to prepare, communicate and maintain successive nationally determined contributions that it intends to achieve (Art. 4 para. 2 PA). The question whether it is sufficient to achieve climate neutrality only in the second half of this century to meet the legally binding temperature target of Art. 2 para. 1 PA, declared as a long-term temperature goal in Art. 4 para. 1 PA was answered in an earlier contribution (Ekardt et al. 2018b) in favour of Art. 2 para. 1 PA. The authors conclude that compliance with the 1.5 °C limit needs to be reached at lot earlier that with a high probability and without an overshoot of temperature or the employment of large-scale and high-risk geoengineering options to be able to respect human rights with a high probability (Ekardt et al. 2018b; Randers and Goluke 2020; Wieding et al. 2020).

The Convention on Biological Diversity, signed at the 1992 Earth Summit in Rio de Janeiro and entered into force in 1993, is also legally binding. For the first time, it placed all species, genes and ecosystems worldwide under protection and linked this protection to the sustainable use of biological and genetic resources (Art. 1 CBD). According to Art. 6 CBD, the protection of biodiversity takes the form of national biodiversity strategies and action plans. The CBD in itself is not very precise with regard to targets. The tenth Conference of the Parties (2010) therefore formulated a strategic plan with 20 core targets for biodiversity, the so-called Aichi Targets They show many direct and indirect relations to the protection of forests and their sustainable management. Underlying drivers of biodiversity loss should be addressed (strategic goal A), direct pressures on biodiversity reduced (strategic goal B), the status of biodiversity improved, e.g., by safeguarding ecosystems (strategic goal C), benefits to all from biodiversity and ecosystem services enhanced (strategic goal D), and the implementation should be improved (strategic goal E). The targets 5, 7, 11, 14 and 15 are directly related and the targets 2, 3, 4, 9, 12 and 18 are indirectly related to this:

- Target 5 aims to at least halve the loss of natural habitats including forests by 2020. Halting deforestation by 2020 could not be met in the EU (EU Parliament 2020a, b).
- Target 7 aims to establish, among others, sustainable forest management in order to conserve biological diversity. Forest in this case includes "all types of forests from plantations to primary forests" (UNEP 2013). This is underlined by the definition of sustainable management as preventing the decline of biodiversity in a given ecosystem, i.e. a forest. The target also calls for sustainable agricultural management which indirectly affects forests (Hosonuma et al. 2012; Gerber et al. 2013; Alexander et al. 2015). Again, there is still a considerable need for action after 2020.
- According to Target 11, by 2020 17% of "areas of particular importance for biodiversity and ecosystem services" (UNEP 2013) are to be protected in connected and equitably managed protected zones. This particularly regards tropical forests and could not be met as well.
- Target 14 calls for the preservation and restoration of ecosystems relevant for livelihood, including the spiritual integrity of indigenous peoples and local communities. This Target would warrant far-reaching activities, especially because it includes not only halting ongoing destruction, but also restoration. The aspect of resilience stands especially at the forefront of safeguarding old forests and traditionally used forests, prohibiting economic exploitation. However, it is not specific enough to overrule economic activities such as mining or agricultural activities.
- Target 15 is dedicated to combating climate change harmful to biological diversity: enhancement of sinks, strengthening resilience by restoring at least 15% of degraded land. This draws a link to the climate mitigation activities on forests.

The overarching EU target for 2020 as a normative basis of the 2011 biodiversity strategy was to halt the loss of biodiversity and degradation of ecosystem services in the EU and restore them as far as possible, while increasing the EU's contribution to preventing biodiversity loss globally. However, it has repeatedly become clear that this target is being missed by a wide margin (European Commission 2015, 4; European Parliament 2018; UNEP 2019). As a follow-up, the Kunming Declaration[1] was announced on 13.10.2021 aiming to establish a post-2020 global biodiversity framework regarding biodiversity loss (CBD 2021). According to the declaration, inter alia biodiversity protection should be considered across all legal decision-making processes, harmful subsidies should be phased out and redirected and the rights of indigenous people should (finally) be protected in the future. Apart from that, the call to protect and conserve 30% of terrestrial and marine areas "through well-connected systems of protected areas and other effective area-based conservation measures by 2030" (Kunming Declaration 2021, p. 3) is noted.

[1] Kunming Declaration of 13/10/2021. Declaration from the High-Level Segment of the UN Biodiversity Conference 2020 (Part 1) under the theme: "Ecological Civilization: Building a Shared Future for All Life on Earth", CBD/COP/15/5/Add.1.

However, thus far the rather "vague commitments that lack accountability are hardly a step forward from the 2010 Aichi targets" (Greenpeace International 2021). However, in the end, the outcomes of the negotiation processes following the vison of "Living in Harmony with Nature" in 2050 in spring 2022 will be decisive as to how far the so far colossally missed biodiversity targets from the CBD can be achieved in the future.

It generally must be taken into account, that biodiversity is difficult to measure and therefore difficult to translate into an operationalisable ecological target (cf. Baumgärtner 2003; Forum Biodiversität Schweiz 2013; Trepl 2013). Ultimately, limiting global warming is easier to operationalise (via a GHG emission cap) than protecting biodiversity or restoring ecosystems. Nevertheless, it makes sense to consider the CBD as a complement to the Paris Agreement, because climate change is closely intertwined with other sustainability issues like biodiversity loss but also disrupted nitrogen (N) and phosphorus (P) cycles, and water and soil pollution (Stubenrauch 2019; Garske 2020; Ekardt 2019).

Admittedly, even if climate protection and biodiversity conservation predominantly point in the same direction, conflicts of objectives can also arise between them. This can be the case, for example, if monocultural forests are afforested for reasons of climate protection, large areas of energy crops are cultivated, or cultivated areas are expanded due to lower yields as a result of the abandonment of (fossil-based) mineral fertilisers, which runs counter to the protection of biodiversity and the creation of species-rich ecosystems (Hennig 2017). Therefore, the combination of the targets speaks in favour of more natural forests, although it is difficult to exactly quantify the required amounts, as already mentioned in the introduction, which will (as a substitute) take us to the question potentials later.

The climate protection target and the biodiversity target can also be derived from human rights (in international law, EU law and national constitutional law). Liberal democracies are essentially about balancing different spheres of freedom and its preconditions. Parliaments have considerable leeway in this respect, which is only limited by balancing rules following from freedom itself. One essential balancing rule, however, is that the political majority cannot dispose of the physical foundations of future balancing. This is exactly what could happen without an ambitious protection of climate and biodiversity (see in detail Ekardt 2019). In a landmark ruling, the German Federal Constitutional Court has now also explicitly recognised that spheres of freedom of different people – also intertemporally and globally – must be brought into an appropriate balance (Federal Constitutional Court, Order of 24/03/2021, 1 BvR 2656/18 et al.; Ekardt 2021b; Ekardt et al. 2021).

On the other hand, a natural forest condition (occasionally cited) would be unsuitable as a guiding star from the outset. In view of the processuality of ecosystemic events, this can be understood to mean completely different states and points in time in natural history since the last ice age. Given this, the implication of terms such as "natural" or "close to nature" is untenable that it can be decided scientifically which treatment of the forest is to be aimed for. Rather, this is an ethical, legal and political question.

2.2 Terminology and Epistemology: Misunderstandings About What Is and What Ought to Be, Objective and Subjective, Values and Normative Aspects of Sustainability Research

Generally, the pursuit of sustainability – meaning of a permanent and globally feasible lifestyle and economy (Ekardt 2019) – and its relative failure in terms of the size of the challenges, e.g., regarding climate change, biodiversity loss, soil degradation or disrupted nitrogen cycles, raises the question how human activities and human inactivity can be explained and how effective counter-instruments in terms of governance could look like. Governance in this volume refers to the question of effective measures and specific policy instruments to reach the respectively given targets. Therefore, governance is not used – as is sometimes done – to describe specific self-regulative processes, and also not as good governance in the sense of a normative system of liberal-democratic principles. Prior to the behaviour and governance analysis, all of this raises issues of epistemology, which are of significant meaning for both other questions. Both in the epistemological basics and in the methodology of behavioural research, this will result in a criticism of empiricism in the following, which dominates since the age of renaissance. It declares not norms, but only facts, meaning countable and reproducible facts, as objectively tangible objects of knowledge (on this Ekardt 2019, 2021a).

Criticising empirical paradigms might cause misunderstandings and create false friends. It is therefore important to be clear about what is not meant by the criticism in the following. At the same time, this allows to take a clarifying stand on some basic ambiguities, which occur in various sciences and also in the sustainability debate. It is often assumed that there is a postmodern, at least however some sort of subjectivist epistemological position behind a critical point of view on empirical perspectives, which considers facts and norms as not objectively discernible (classical Rorty 1989; Foucault 1965). Furthermore, it is often suspected, that criticism aims at claiming that research in human science is thus inevitably normative in all aspects including governance and behavioural research – and that sustainability research in particular is inevitably normative as is develops political proposals (exemplary on this Lang et al. 2014, 129 et seq.). Both of those assumptions will be contradicted in the following, helping meanwhile to clarify the state of findings on behaviour and governance.

The present volume will not defy the possibility of objective – meaning generally valid and not dependent on subjective (shared by individual persons or groups) preferences – perceptions, respectively of truth when asked for convincing methods of behavioural and governance research. Neither for facts and incidentally nor for norms (whereas the latter will only be shortly mentioned) are inevitably normative or subjective. Truth refers by definition that a statement is in accordance to a situation in the real world. Rightness or correctness, on the other hand, refers to the applicability of normative statements. Furthermore, justice refers to the correctness of social order without having an item of reference in the outer world, as is the case with truth (Habermas 2009; Stamp 1998, 30 et seq.; Ekardt 2019). Whether there is truth in the sense of objective facts at least principally, has nothing to do with the common (Berger and Luckmann 1966; Otto 2015, 35 et seq.) and for all of us familiar correct cognition that fact and norm perceptions are indeed frequently disturbed by our subjective perspectives including influences through personal wishes, power relations etc. and are tainted. Humans therefore tend to a subjectively distorted, instead of an objective perspective. This is undoubtedly true, proves however by no means that objectivity – e.g., through careful assessment and discourse with others – is per se impossible (on this separation also Berger and Luckmann 1966; unclear Scholz 2011; Habermas 1968, 262 et seq.). To give an example: It may be that there are natural scientists, which comment either pro or contra the existence of human-induced climate change, because they expect financial advantages from it, such as research contracts. Such a subjective bias does not prove however, that objective and impartial findings on climate change are possible. More formally, it can be said that truth sceptics confuse the genesis of a statement with the validity of a statement. It is for instance possible that the author – as son of a globetrotting physicist – only assumes that the earth is a sphere, because his father taught him while threatening beatings (genesis). Notwithstanding the above, the statement would remain true (validity) – regardless of the power relations, which caused the author to come to this conviction about the statement. The difference between genesis and validity does not merely apply to statements of facts, but also to normative statements: There is a difference between researching moral-sociologically the factual cause for the creation of a value (e.g., why human rights emerged in fact) – and asking ethically/ legally whether human rights (or race fanaticism) are valid, meaning whether they are normatively justified or much rather intolerable.

As trivially correct the typically subjective timbre of the actual genesis of statement might therefore be (this assessment can also be called sociological constructivism), as problematic is to derive from it the impossibility of objective perceptions (this would be philosophical constructivism, found in, e.g., Watzlawick 2004; ultimately also in Rorty 1989; Foucault 1965). As seen, one has initially nothing to do with the other. Besides this, defying the possibility of objectivity cancel each other out logically, and can therefore not be formulated as valid statement. Because the statement “there is no true or untrue, but only subjective perspectives” is obviously one which is not understood as purely subjective opinion, otherwise it will make itself irrelevant. In other words: The assessment of often very subjective perspectives logically requires that there are objective perspectives at all – otherwise it would be impossible to determine the subjective content of a subjective perspective. Equally, the talk of defying former knowledge and substituting it with new ones logically requires that there is objective knowledge.

These logical connections are neglected when particularly postmodernists, feminists or critics of capitalism express pointed Marxist thoughts for a long time that facts and norms are anyhow never objective, because everything is directed by a specific interest, be it power, capitalism, gender, ethnicity. Every criticism of this sort, that allegedly objective notions are per se tainted by intended power relation, can only be formulated, if objective notions – regarding the existence of those power relations – is nonetheless possible (accurate Habermas 1985 against Foucault 1965;

furthermore Ekardt 2019). Ergo, it is not possible to defy the proclamation without contradiction that facts are *not* dependent on the observer – but that our impressions are very well reflections of the real world (von der Pfordten 2010, 54–55; Stamp 1998, 57 et seq.; Klatt 2008; Habermas 1999; Ekardt 2019).

Apart from that, no one can live without necessarily assuming that the outer world and whatever people say about it can be coherent. How else can we explain that coordination among ourselves and our interaction with the world works quite well, if the world were "only subjective"? And, who would want to declare it dependent on a matter of opinion, or of certain power relations that somebody is dead after jumping off the 90th floor of a building? Also, that fact statements are necessarily attached to a language does not take away the possibility of them being objective. Of course, language might contribute to unclarities and even irritation; however, the problem can be mostly solved by sufficiently precise formulation.[2] This remains true, even if the language community – or each individual – is free to allocate a meaning to a word, if they wish. Still, language is a medium, which is responsive to precision if wanted. This is not changed by the circumstance that not all facts can be reproduced in experiments or even quantifiable. Such an ideal of facts has spread vastly within the last 300 years based on the philosophical empiricism, it is however in no way imperative (Lippert 2011; Ekardt 2021a). For example, taking the field of human motives – which is what this paper is predominantly about – there are many things which are not quantifiable or reproducible at will, as will be seen in the course of this paper.

It is undisputed that there are questions about facts that no one knows the answer to – and there are even questions, to which probably no human will ever know the answer. This might be the case for details of climate change for instance. That a question does not currently have a definite answer (that there are evidence issues), will not void the general possibility to objective knowledge. Generally, the fact – e.g., a changing climate or that someone murdered Ms. Miller in broad daylight – remains objective, even if no one knows it exactly (by the way, at least the murderer will know who did it). In other words: Should the Maldives drown one day

[2] It is also not possible to escape the said that as Rorty 1989 truth is understood as that 'which has proved successful'. Because, in order to determine when this is the case, an objective criterion would be necessary (if saying then 'no, for everyone is simply all plausible/ true which is evident from their personal life-story', this would again raise the question how this objective general statement ('for everyone …') comes about, if at the time, the content of the sentence states there are subjective discernments only; in this case, it is not about which factors influence me subjectively in my knowledge finding process, but about which is the objectively accurate finding). The coherence theory of truth represents a middle way between those pragmatic-sceptic prove-based theory and the correspondence theory of truth advocated in this paper. Coherence theory aims to grasp truth in a process of admitting and understanding, which will lead back from subject to object. Against such a procedure can be raised that it is prone to a hermeneutic circle; see also Esser 1972, 137–138. Also, the consensus theory, proposed by the older discourse theory as way out from the dissent between correspondence and coherence theory suffers frictions. It says that truth should be determined by reasoned (not only factual) consensus of the concerned people. Because what about the numerous historic cases in which all stakeholders or at least the vast majorities erred severely? The consensus theory was put therefore put aside by Habermas 1999, 239 and 286 et seq.

from climate-induced rising sea-levels, it was still a fact, even if millions of Germans would subjectively construe a scenario, in which the drowning had not happened. Also, it is not a matter of opinion (of an individual or a social group), whether climate change is the cause of the occurrence – or whether the drowning is due to excessive guitar playing of the islanders. Of course, with all that, not all kinds of facts are equally easy to put objectively. Causes and inner facts such as emotional states are, e.g., at times hard to *prove*, as well as the man who killed Grandpa Paul last night might be hard to find. Sometimes, we do not get a definite answer, at least not today. However, the cause does *exist*, meaning the causal connection of many exterior occurrences, even if we cannot always prove the cause (like some outer facts also). And just as little is it simply a matter of opinion, whether the emission of climate gases can for instance be more effectively reduced by phasing-out fossil fuels or by grand speeches.

A subjective estimate of facts is no valuation, even where (see above) no objectivity can be reached, even if the terms subjective and valuing are confused even at the core of scientific research. A scientist may subjectively estimate that climate change of this and that speed will cause exactly XY – this does not mean however that she normatively welcomes it or not.[3] Behavioural and governance research are not rendered normative by uncertainties in fact finding, but at most subjective (because of that, the traditional controversy about explaining versus understanding – more on that in von Kutschera 1981– is not about whether behavioural research is normative, but whether behavioural research is subjective, meaning whether there are methods to determine behaviour objectively).

Besides the separation of subjective and objective perspectives with regard to norms and facts, there is ergo the separation of facts from exactly norms/valuation/objectives/purposes (the terms are used cum grano salis interchangeably; in my opinion unclear in this regard Scarano 2012; von der Pfordten 1993, 48 et seq.). From climate change (fact) for example does not follow its imperativeness or its prohibition (norm): e.g., that climate protection is absolutely necessary. It is much rather needed to have a criterion for evaluation, meaning a norm, which says "No one shall kill a person" or "human basics of life and therefore a stabile global climate shall be preserved". And the criterion for evaluation cannot be observed from outside; it can only be reasoned (how is shown in the following chapters). Certainly, facts provide the area of application respectively grounds for subsuming under a norm. Those, e.g., who consider climate protection normatively as important, even when taking other objectives into account, has to also assess, whether climate change is at all a problem. Despite this, facts and norms remain two things in this case. Sustainability research is normative, if it is used to justify objectives itself ethically or judicially; ethics and law are undoubtedly normative fields. It is on the other hand not normative to determine the effectiveness instruments to achieve

[3] The separation between objective fact statements and subjective evaluation of uncertain facts is in its intention coherent with the separation risk assessment/risk evaluation/risk management. The latter is found in Risk Commission 2003. The current mix up is, however, found in Eidenmüller 1999, 53 et seq.; falling short in differentiating levels also Jaeckel 2010, 243 et seq.

objectives, which are not self-assessed. Because this is a matter of facts (not seen in Suchanek 2000).

Statements like those that a research field like sustainability research has to do with values should be therefore avoided due to their unclarities (Caniglia et al. 2017; Lang et al. 2014, 129 et seq.; Suchanek 2000; see also Hulme 2009). Because such a statement is not clear whether it means that values, which are in fact deemed right by people, influence human behaviour – or rather that sustainability research treats and answers normative questions as objectively resolvable questions. Both is true, but they are two different things. For example, it is possible to factually explain the occurrences of totalitarian wrongdoings (genesis), without justifying it, meaning approving of it (validity). By the way, the common aphorism "facts are objective, norms are subjective" (i.e. Häberle 1974, 14–15; Rühl 1998, 224 et seq.) is short-sighted,[4] not only because it equates subjective and valuing, although, as seen, fact statements can be subjective at times. The aphorism also neglects that norms may indeed have objective justifications; to examine this closer would however side-track the issue of this volume, even though it complies with a broadly shared opinion in ethics and law (see in place of many Alexy 1995; Habermas 1983; Rawls 1971; Ekardt 2019; Klatt 2008). Claiming validity of normative statements may not be mistaken for simply collecting moral-sociologically values which are subjectively shared by individuals or groups – or if in sociology of knowledge, tracing the genesis of discourses. Sociology of moral and knowledge allow for the question how e.g., non-sustainable lifestyle and economy evolved – normatively, the question would be, whether this lifestyle and forms of economy are justified and can therefore be labelled as fair.

Based on the before stated, a behavioural and sustainability research, which sees itself (in light of postmodernism, ethnology, feminism or other auspices) as criticism of the possibility of objectivity as alleged instrument and expression of power, would not be useful. Because, as seen, criticism with the aspiration of general validity can only be formulated if it makes use of objectivity itself (it is, as seen, as important to detect hidden – typical human – subjectivism but finding those is again only feasible against the scale of objectivity, because otherwise, it would not be possible to determine something as subjective). The wish for a criticism of power relations is furthermore problematic, because it equalises and latently mixes normative scales (which again require the possibility of objectivity) with the descriptive subject. All this may not be escaped by talking of partial truths, truths of situated positions and the like – it is only possible to perceive and determine something if objective perceptibility is somehow assumed possible.

[4] It is also correct that knowledge of facts requires a framework of theoretical hypotheses. However, this does not repute the distinctions made in the text: experience-based scientific theories are not norms. Much rather, they merely serve formulating hypotheses and if proved wrong, they need to be reformulated through empirical observations. Also, a hypothesis is not normative either way, but at best subjective.

2.3 Is It Necessary to Complement (Qualitative and Quantitative) Empiricist Methods of Analysis from Human Scientific (Behavioural and Governance) Research?

Even if objectivity in fact finding is assumed possible after the last chapter, it remains methodologically a large challenge to explain behaviour and, on this basis, to identify effective governance approaches – meaning to objectively determine the incentives of a behaviour (and build governance analyses on the findings later). Under the influence of especially economics, but following recent tendencies also psychology, the idea that behavioural research should per se based on natural sciences dominates. This implies: Research findings need to be reproducible and quantifiable (exemplary Mußhoff and Hirschauer 2011, 437 et seq.; Buchholz et al. 2014, 326 et seq.; critically on this Schubert 2015; Scheidler 2015, 106 et seq.; Lippert 2011; Ekardt 2021a). To achieve this, economics in particular conducts experiments using game theory. They simulate, like the name suggests, situations with real-life behaviour; for instance, the climate-related motivation of players is observed through playful arrangements in a laboratory situation. This way, climate conferences or daily consumption decisions can be simulated. Enhanced with many data from economics, social sciences and natural sciences, this also provides the basis to create complex scenarios, e.g., how to continue with climate protection activities. In contrast to this, many researchers in sociology and political science rather believe in questioning people. Either in great numbers via questionnaires, or in small numbers via extensive, and more or less free qualitative interviews (mostly equating experiments with science Caniglia et al. 2017).

The focus on countable and reproducible facts is, as touched on earlier, a result of the philosophical empiricism since the seventeenth century (extensively on this Ekardt 2021a; on criticism of observations and experiments already Ekardt 2019). In reality, it is philosophically not self-evident to accept facts alone (and not norms) as subject of rational thinking, as has been brought up earlier. More importantly, however, is another direction in the criticism of empiricism: Namely that experiments and questioning might possibly not be informative about human behaviour and about change.

If wanting to know how individuals and societies change (behavioural research) and how humans react to, e.g., certain newly designed political measures (governance research), one has to know their behaviour. Getting to know this generally has to be done in a way which does not falsify behaviour already, because the observed change their behaviour because they feel watched. Furthermore, not only the behaviour itself, but its motives and causes have to be understood, in order to determine how behaviour can be actually influenced by governance options. Human motives are however not visible in the outer reality. Likewise, the causality between motives and real behaviour is as such invisible, even though they belong to the world of facts.

Understanding behaviour will therefore oftentimes be a matter of conclusions: from behaviour to the motives as well as from behaviour and motives to the causality. Using a philosophical term, this can be called interference to best explanation

(Ekardt 2019).[5] Whether the players in a game-theory experiment act based on a motive like self-interest, altruistic values, and subconscious concepts of what is normal or entirely different motives, cannot be observed by watching the behaviour. Also, the assumption that participants of an experiment choose an option which is economically beneficial to them, does not show conclusively that self-interest and conscious calculation alone were the motives. There can be further motives. Statistically speaking: The correlation of two factors does not necessarily mean that these are the only factors correlating (this is neglected in, e.g., Otto 2015, 145 et seq.; Hamann 2014, 142 et seq.).

The problems opened up with this are of general nature, and they occur with experiments and interviews – whether quantitatively with many people or qualitatively in interviews with few people – more or less to the same degree (cum grano salis Meyer 2003, 149 et seq.; Hamann 2014, 250–251; Scheidler 2015, 106 et seq.; Ekardt 2019; neglected in Lang et al. 2014, 129 et seq.). It is an obvious problem of interviews that the answers often do not entirely reflect the behaviour and the motives – e.g., because the own behaviour and its social conditions cannot always be truthfully reflected (Ekardt 2019; Kelle 2008, 63). Additionally, there are other falsifying factors like the wish to please the interviewer, to meet expectations and to stay in accordance to social conventions. Also, the manner in which questions are posed and the context of a conversation frequently preform the possible answers. If, for instance, a questioning is supposed to be about environmental protection, this will be labelled from the beginning as relevant and socially desirable. Merely because of the active framing of a question, behaviour and motives are altered considerably – people seem therefore, casually speaking, more eco than they actually are. Such problems can be minimised by techniques of questioning, but not be eliminated. Also, there are clear limitations to the question of motives which are relevant to sustainability, due to the complexity and possible (periodical or permanent) subconsciousness of certain motives (on the current psychological debate of the subconscious also Kettner and Mertens 2010, 7 et seq., 77 et seq. and 109 et seq.). Furthermore, there might be wrongful perceptions about the own behaviour and its motives which are based on emotional mechanisms such as denial (on the different frictions also Stoll-Kleemann et al. 2001; Presser and Traugott 1992; Ekardt 2019; Veroff et al. 1992; Padfield and Procter 1996; Lee 2000). Conducting surveys strictly quantitatively, creating thus real statistics, other falsifying factors come into play. One is the arbitrary selection of test persons which is often not representative. Also, some segments of the population (especially the elderly) are more easily accessible via land-line calls than others. Prior questionings influence the statements as well, for example, if the interviewees know the specific result of a prior similar questioning. Even if, despite all this, the interviewees answer largely truthfully, which is already quite improbable, there is the additional problem of the

[5] While however the criterion for the 'best' explanation is almost as difficult to formulate abstractly as the criterion for 'correspondence' in correspondence theory of truth. As much as the possibility of objective truth cannot be logically overcome (because whoever disputed the possibility of truth is not able to claim the truthfulness for the disputation per se).

difference between preference and behaviour. Interviews can directly ask for behaviour and its (maybe ostensible or alleged) motives, but they can also ask for preferences such as the opinion on environmental protection and try to draw conclusions from that for the possible behaviour towards more ambitious environmental politics. The latter fails due to the gap between preference and behaviour and frequently also between different simultaneous preferences which specifically occur with regard to the environment but are generally human (more on the way to handle cognitive dissonances Stoll-Kleemann et al. 2001; Lübbe 1998; Ekardt 2019).

However, these considerable and not generally resolvable frictions do not imperatively lead to the consequence that the method of qualitative or quantitative questioning is completely void. There are, e.g., questions with a low tendency to trigger seeking the approval of the interviewer of society. Also, especially in quantitative questionings, interviewees have the potential to address structural connections and broad ranges of opinions. In light of the described problems, however, it seems primarily interesting to look at ways to combine them with other approaches which will be further developed in the following. However, before doing so, we need to elaborate on the second common empiricist method approach:

Namely in principle, the same described objections apply for experiments as they do for interviews. Experiments might be the mentioned game-theory models or so-called real-world laboratories, like the simulation of a low-resource lifestyle for a certain period in real life (Ekardt 2019; little regarded in Nowak and Highfield 2013, 225 et seq.). Thus, social desirability and the presence of observers will influence the test persons, which already showed in the so-called Hawthrone studies in the 1930s: The participants did not raise their work performance due to different lighting as assumed, but because of the presence of observers (Lee 2000, 5). Additionally, the translation of highly complex realities (with regard to an initial situation and options for action) in a necessarily reduced experiment setting is hardly possibly; it will also always maintain a fictive character. Imagine, e.g., a game-theory situation, in which the highly complex global climate negotiations are simulated (critically Kivimaa et al. 2015, 2 et seq.; affirmatively Milinski and Marotzke 2015, 93 et seq.). Neither social desirability nor observer expectations can be avoided, nor is the sensation of a player in such a constellation easily comparable to the situation of real decision-makers, nor is it possible to detect the motives from observing the moves – which are also fictive. Motives must rather be concluded again from their – fictive – actions.

Even though it is possible to vary single conditions of the experiment, allegedly just like in natural sciences, and try to filter this way the influence of single factors. But neither the issue of desirability, nor the fictive character, nor the under-complexity disappear that way. The issue with the fictive character is that, e.g., in reality, there is usually such a mass of factors to a decision, that they cannot be usefully reduced to a mock situation, which is, e.g., only determined by three factors. Even if the experiment – as real laboratory – is set in real life, none of these issues are resolved. Though the fictive character is reduced by some, the fact remains that it is something entirely different to pretend for a month to life on low resources, under the encouraging eyes of ecologically conscious scientists – or whether this is permanently so. At latest the real laboratories, but actually also experiments, show that it is much harder to achieve arbitrary replicability in human sciences than in natural sciences, even if this is aimed for under empiricist auspices (this goes all the more for qualitative approaches).

Finally, on all this, another example (which can only be generally outlined as the respective experiments have not yet been published). The second author of the present volume regularly takes his sons to participate in infant experiments at different research institutions in Leipzig (which are based among others in the research of Piaget and Inhelder 1972; Tomasello 2009). Following a current issue in behavioural science, a focus lies on the question how cooperative infants are in a given situation. The children are for example involved in ballgames which are supposed to show how much people act with or against each other. But, what is it really, that is proven: Is a finding on cooperation based on a ballgame really suitable to determine the degree of human cooperativeness in real – and much more complex and mostly not playful – real-life situations? What can be learned about the motives of cooperation – whether it is done to please the observer, or to serve self-interested calculations of advantages or much rather altruistic intentions of fairness? Or whether it is simply the notion of normality which a test person subconsciously has and which is shared in their environment no questions asked? Or whether emotional factors like empathy, the wish for recognition, convenience or habit play a role (on all possible factors Ekardt 2019)? Nothing of this is really revealed in those experiments. Exactly this information would however be crucial, if, e.g., in the process of a transformation towards sustainability, one wants to know what slows the transformation so far – and which kind of reactions should be expected to new political measures.

Like with interviews, all that has been said does not mean that experiments might not contain indications of behaviour, its causes and therefore the conditions of change. Nevertheless, further sources of findings are needed to make up for distorting effects. In comparison, their validity can be ranked high, if the setting is chosen in a way with hides the actual experiment from the test persons, like in the famous Milgram experiment on willingness to obedience to – alleged – authorities (Milgram 1974).

The described frictions are not only more or less neglected in many scientific discourses, or at least not treated in a way to acknowledge the substantial limitations of interviews and experiments. They are moreover not resolved if the raised methodological questions of behavioural research are left aside to just postulate a simple behavioural model like the homo oeconomicus also as a basis for governance analysis in mainstream economics. Meaning to assume an always consciously calculating and purely interest-oriented – and usually self-interest-oriented – individual. Even within the field of economics, this model is recognised as under-complex, e.g., within the behavioural-economics research (summarised in Ekardt 2019), even if the model is continually used. Anyhow, an under-complex model cannot substitute a methodologically verified determination of behaviour.

If behaviour is so hard to determine, and even more the motives and causalities can be primarily extrapolated by interpretation, essentials about motives, change and frequently already about the behaviour itself can be acquired by another less formal source of perception. This means participant observation in the sense of an external observation to the highest degree possible (Malinowski 1932; Bernard 1994; Aull Davies 2008; O'Reilly 2012; Robben and Sluka 2007; Ekardt 2019). Motives are concluded from the behaviour and it is therefore reacted to all described falsifying factors which obstructs from a quantifiable finding in said manner. Especially with regard to questions of sustainability, some is to be said for the fact that it will be hard to go without preferably unnoticed – and preferably frequent and extensive – observation. Because especially in this social area, many maintain a very environmentally-friendly self-image, which unfortunately stands in contrast to an unchanged big ecological footprint (on the empirical findings Ekardt 2019). This will be further pursuit in the following.

2.4 Integrated Methodology and Crucial Behavioural Insights into Human Motivation

Participant observation means according to the method encyclopaedia for social sciences (Diaz-Bone and Weischer 2015, 40; see also Breidenstein et al. 2015) an observation procedure in which the observer themselves contribute actively to the activities and is personally seen, however oftentimes not recognised as purposeful observer. We are thus talking of an approach, which can be used daily and unnoticed, but can also be used more similarly to experiments and interviews by observing a clearly framed process, often repeatedly and maybe revealing the observer intentions. Concentrating on outer observable actions will lead to more formalised settings, which will then raise the question, whether this formalised way of collecting outer connections really says something about underlying motivations of the observed – which is the key interest of behavioural research (see above). Because in some way, everyone participates observingly in their social interactions at least informally, this form of collecting knowledge can be described as continuum, beginning with simple day-to-day observations reaching up to several years of ethnographic observation studies. The observer is at the scene and is able to take in the occurrences by means of all senses. Participant observation categorises its subject and records the results in some way, whereas this can happen more or less systematically (see on one hand Breidenstein et al. 2015; and on the other hand Beer 2003, 129 et seq.).

The chances of this approach become clearer taking a look at sustainability issues (more on the empirical findings following Ekardt 2019). Asking people about their values regarding sustainability or conducting experiments on this, regularly show strong ecological values and a high information status of facts on the matter. At the same time, the ecological footprint per capita, which can be traced back statistically from the absolute ecological strain, shows that the actual behaviour does not comply with these values. This could mean that interviews and experiments lead to untrue results, because the test persons want to please the interviewer or want to comply with social expectations, while really thinking that sustainability is not important. Cumulatively or alternatively, it could be that test persons do in parts answer truthfully, however their motivation is much more complex which is not reflected in questionings and experiments. An explanation can be attempted by paying attention to the positioning of people on issues of sustainability in various day-to-day conversations – without activating particular social expectations and without creating an artificial situation. This will show, e.g., a clear focus on self-interest, besides all other very well existing values in favour of sustainability. At the same time, there are path dependencies and problems with public goods – creating the impression that there is no alternative to the actual behaviour, and also that the own contribution to the global problem is irrelevant anyhow. Equal findings can be attained through self-observation and by concluding from the biological origin of humankind, meaning socio-biological analysis, which show that people act selfishly on the one hand, but on the other also cooperate, that latter however also oftentimes with selfish, or at least group-selfish background. This knowledge is in line with the orientation towards values in the immediate social surroundings, but at the same time encounters limits, e.g., when it comes to climate protection in the interest of humankind as a whole. Coincidentally, interviews, experiments and participant observation show that people whose own life is brought into question with regard to sustainability, will declare their lifestyle as immutable and react defensively or even aggressively. Furthermore, it is possible to observe (in line with statistical data on environmental protection), that options for action which serve economic self-interest – like insulation for buildings, if the money is available – are still frequently not chosen. This shows clearly (again supported by self-observation as well as findings from evolutionary biology on human coping strategies for an over-complex world), that actions of sustainability and human behaviour in general are by no means always consciously calculatedly selfish or altruistic. Much rather, emotions come into play, like convenience, habits, denial or the ability to brush aside even the most obvious contradictions between talking and acting (which is, again, proven experimentally). Besides all this, there seems to be factor of conceptions of normality, of which, similar to emotions – and in contrast to values or self-interest – people are often only partially aware: High consumption of meat, holiday flights, and the daily car drive to work are simply "normal" in industrialised countries (and the upper classes of developing countries). This becomes very feasible when a number of observed find the hint that the observer does, e.g., not eat meat, not drive a car etc. simply amusing and somehow "abnormal".

Knowledge as one factor of motivational reasons for human behaviour is thereby typically overrated (Kanter et al. 2020), while egoistic calculations of the addressees of regulations, the addressees' emotions and values, path dependencies and conceptions of normality as well as problems of collective goods are regularly not taken into account sufficiently as motivational factors (Ekardt 2019). The latter determinants, are, however, often the reason why governance problems typically reoccur in sustainability governance and governance instruments are not as effective as wished for. Which of the (here very shortly mentioned) motivations is culturally imprinted and which are already engraved in human genetics, can be analysed, among others, by whether the certain factors occur globally or only regionally. Anyhow, all this shows that participant observation is very promising, especially used on the frequent – not only typical for the sustainability context – dissonance between positions, social expectations and actual behaviour; this was also demonstrated in contexts which are not related to sustainability (Beer 2003, 126; furthermore Breidenstein et al. 2015; see also Schultheis 2002; Stanley et al. 2013).

At the same time, it already became clear that it is precisely the described *combination* of participant observation with other approaches like interviews, experiments and self-observation or socio-biological deductions, which is necessary and useful in the interest of an ideally critical reciprocal verification of all findings. A formalised participant observation, where the participants are officially informed, might for instance lead to the same distorting effects as empiricist research methods (Hauser-Schäublin 2008). Even in a concealed participant observation, it is problematic that the observer has limited knowledge, a subjective narrow perspective, which tends to exaggerated positive image of themselves, the limitations of the own perspectives through social background etc. (O'Reilly 2012; Hammersley and Atkinson 2007; Hauser-Schäublin 2008, 54; Niewöhner et al. 2012, 13 et seq.). In addition, participant observation can hardly capture the spread of social phenomena in a society, as broad-aiming quantitative studies might do. These limits would go overlooked, if behavioural and society research were to be based on background knowledge in line with Luhmann alone. Helpful is therefore particularly the combination of participant observation with findings from neuroscience and biochemical research, as decisions coincide with various measurable electric or material processes (Harari 2014, 2016). The latter approaches are also subject to various limitations, especially in light of the recent research status (critical on this Hasler 2012; Ekardt 2019), which emphasise the necessity for reciprocal verification.

Alone the described combination of methods serves to avoid or reduce the subjective reduced point of view, as well missing broadness of participant observation. Besides that, participant observation as such has to be conducted as accurately as possible. It initially requires that researchers have access to the respective everyday-life field and participate in its routines and special activities and processes for a longer period of time (on all of that Jackson 2002; DeWalt and DeWalt 2002; Schensul and LeCompte 2013; Diaz-Bone and Weischer 2015, 41; Bernard 1994). The long-term presence in the field is essential to gradually adopt "foreign" point of views and routines and gain distance from the own presumptions (O'Reilly 2012; Bernard 1994; Kaschuba 2012, 207). To maintain the dialectics of participant observation, different techniques of intensifying the observation as well as analytical methods of abstraction are used (these methods are comprehensively featured in, e.g., Breidenstein et al. 2015). Therefore, issues like limited knowledge and the exaggerated positive self-image of the observer need to be deliberated and thus at least strongly minimised, especially in discourse with others (see also Kelle 2007; Steinke 2000, 322).

Another methodological addition to the described approaches seems appropriate. It consists in considering the fact that external (e.g., geographical and technical) as well as policy framework conditions will obviously influence the behaviour of consumers and enterprises for instance. Besides the natural circumstances, this also brings the alternating influence of all involved parties into play; because behind politics there are for example again people. With all this, broad assurance of analyses is possible, however not alone in using, e.g., experiments. If for example (Jakob et al. 2017), experiments result in the finding that in a day-to-day situation – which is not sustainability-related – parties concerned will rather clean up after themselves, it is not made plausible that people are generally prone to face the consequences of their actions and long for a massive climate policy. That this is not the case is shown simply by the fact that climate change is not addressed effectively, even though the issue is perpetuated daily by our usual lifestyle.

2.5 Does Human Motivation only Explain Individual Behaviour or Social Developments Including Governance Problems as Well?

The proposal of an integrated methodology in behavioural research provokes the reply whether such a methodology is really capable to explore the social macro level or will merely cover the micro level, especially when making statements on sustainability. After all, there are, ironically sharpened formulated, obviously a great many differences between the Second World War as macro phenomenon and, e.g., a marriage as micro phenomenon. This does not eliminate the possibility that people always follow the same set of behavioural instincts, regardless whether they act seemingly on a micro level or rather a macro level. Exactly this will be briefly shown in the following: The separation between micro and macro, respectively the clear division of individuals and structures makes less sense than sometimes assumed and is in last consequence not tenable in the context behavioural research in the sustainability discourse, which is why there is no objection to using the described methodological approach on seemingly small processes as well as rather large-scale processes (see already Ekardt 2019).

Such a thesis might cause astonishment. Apparently, one needs to choose whether to trace back processes in a society to individuals – or whether the society or at least the structural parts of society are viewed as autonomous, collective entity. Sustainability issues like climate change can serve as an example that the opposition of micro and macro does not follow through, if we ask ourselves the question: Which parties is social change really about? Merely about politics including its body of legal instruments? Or about the enterprises? Or about citizens? Or about the lobby organisations? At the bottom line, climate change and most resource and sink problems are caused by many small, in itself seemingly irrelevant actions, which most people, especially in industrialised countries and the upper classes of developing countries, do on a daily basis, frequently without thinking twice about them. This includes eating, heating, daily mobility, holiday planning or bigger decisions like the choice of a place of residence. Theoretically, every citizen of the Global North could massively speed up the climate and energy transition personally on a daily basis. I can avoid holiday flights, not use motorised individual transportation, minimise my consumption of animal products, heat little and insulate effectively, use energy-efficient products and live in the city centre instead of the periphery with the need to commute, cover the remaining need for electricity with climate- and resource-friendly solar power, and generally buy less. Houses can be built in a way that they need zero external energy and still keep cosy in winter. And do I really need all those kitchen and entertainment appliances, which are energy-intensive to produce? And the likewise very energy-intensive greenhouse-fruits in winter?

One could however also ask: Why politics, which consists just like citizenship and enterprises of people with human behavioural instincts, does not force people into a more sustainable way of life and economy? Or why do not enterprises switch faster to sustainable products? And this is where interdependencies come into play. There are always costumers to a certain type of economy, who will permanently buy many new products, without asking about circumstances of production and who find ecologically exemplary produced products too expensive. Likewise, enterprises are in the loop, as they make certain offers to customers or not, create certain desires for a product and aim to maximise their profits, thus keeping the spiral of growth and high resource use alive. However, the interaction of the involved is not as simple as to be able to say in Marxist tradition that this were one-sidedly created exploitation and estrangement. Production and consumption are, as suggestive the offers may be, not just one-sidedly forced (more so, because the achievement of freedom in modern societies are generally appreciated), and many smaller and bigger players provide demand and supply and play a role in the process. This is still true if one thinks that people today are determined like never before in a profound way by many subtle mechanisms in work, leisure, romantic relationships, emotions, identity. Even if this determination works by means of alleged autonomy (one-sidedly on this Schreiner 2020, 104 et seq.; Gorz 2009, 7 et seq.; Foucault 2006).

There is a similar interconnection between politicians and voters. A radical politics of sustainability, e.g., only stands a chance if it reaches a certain degree of support; this is even rudimentary true in dictatorships. In turn, I, as citizen am only able to induce such an option, if it is offered to me by political decision-makers, for instance in an election. However, it is also possible to become politically active myself. And no one is legally required to eat meat or fly on holidays, even if the legal permission (and the profit-interest of enterprises) have their share in creating these common desires. Another interaction takes place between the media and politics, in which gradual personalisation, production, aestheticisation of politics gradually push back social discourse about real material issues (Ulfkotte 2014, 114 et seq.; Bussemer 2007). And there are more interactions: Politics today is organised in an international multi-level system, so different policy levels can reinforce or slow each other – just like citizens, enterprises and lobby organisations influence or slow each other.

This shows initially that the complex interaction of different parties to a successful or failing transformation towards sustainability need to be expected. Negatively formulated, it can also be called a multiple vicious circle between political decision-makers and citizens, as well as customers and enterprises, which encourage each other in maintaining the status quo rather than to a transformation towards sustainability. This interconnectedness seems trivial. However, e.g., in economics, it is simply defined away in asserting that human preferences are purely egoist and also completely stable (more on the criticism of that Ekardt 2021a). Although this might help to create nice models, this is of little use to move forward empirically. This can be said without the necessity to explicitly assess and accurately explain the sociological actor-network theory with its many implications.

But, despite all interactions, is it really possible to think about change without a clear line between the personal and the collective level? The examples suggest that. However, it is an old dispute among the disciplines of behavioural research, whether explaining human conditions have to be divided into the individual and the collective/ social level (Giddens 1986; Habermas 1981; Greve 2015, 9 et seq.; Mead 1934). And yet, every controversy leads astray, which asks whether to use individualistic (according to, e.g., economists) or collectivistic terminologies (according to, e.g., sociologists) or combine both. Because even a collective or structural level would again express the concrete motives of people or the interaction of groups of people, or at least their side-effects and aggregated consequences of actions. In turn, every individual is of course a product of the structures, into which it is socialised. More precisely said: We will encounter all relevant motivational factors in ourselves, but also in structural – but again human – solidification. Capitalism, for instance, has evolved based on human intentions and is maintained by concrete people – knowingly about its (partially unintended) consequences. Also, those who believe that sustainability fails due to capitalism, have to understand therefore, what it is that drives people to establish and maintain capitalism.

Political retention of power or entrepreneurial accumulation of capital are therefore in lastly collective versions of factors, which can also be framed as, e.g., self-interest and path dependencies and also play crucial roles in individual lives. Another reason for abandoning talking of alleged micro and macro level is, that in last consequence, it is simply unclear where the line to be drawn between both. For instance, I contribute to capitalism every day with my seemingly small actions – is this micro or macro level? Or, how about if there is a political dispute about an individual person, like the Federal Chancellor – it remains notoriously unclear what is micro and what macro level. Of course, we can talk of social change, if all of us move, or of individual change, if only few people move. The idea that these are two entirely different levels, however, is not applicable.

It is clear that not every social situation was intentionally induced by someone. Certainly no one intended climate change in this way. Of course, individuals aggregate to structures. And individuals do not always act rationally and consciously (Ekardt 2019; Greve 2015 who points out that individual actions cannot draw their meaning from collective attributions alone, already because these attributions are again actions, thus causing an infinite regress). In this sense, this volume suggests neither a methodological individualism nor a methodological collectivism, but much rather assume that these are no empirically viable opposites (in its intentions similar: Habermas 1981; Giddens 1986; Mead 1934; lastly also Greve 2015, 26–27). In short: The individual person is simultaneously cause and effect of social influences and pressures. To reflect this and the reciprocal influence of individuals or for instance their orientation on (partially) shared values and conceptions of normality, no separation between micro and macro is needed.

If this were different, not only participant observation, but at least also experiments (and maybe surveys) would have to be thrown out entirely for analysing processes of society. Because the cooperation of millions of people can hardly be captured in an experiment, if assuming that such a cooperation is something categorically completely different that the actual interaction within a small group of people.

2.6 Typical Governance Problems, Based on Behaviour Analyses

The combined respectively triangulated approach to analyse human behavioural motives does not only result in an analysis of the causes of non-sustainability respectively the conditions for a transformation towards sustainability. As touched upon in the introduction, this is the necessary basis of a multi-method qualitative governance analysis in form of a search for effective measures and concrete policy instruments to reach the respectively supposed targets, especially for instruments that have never been put into practice and that can therefore not be observed in reality (see in more detail Ekardt 2019):

- First of all, with regard to existing or alternative policy instruments, the listed approaches to text content, implementation studies and possible comparisons are useful, but as already mentioned, these alone are usually not sufficient, especially when it comes to instrument concepts and levels of ambition that have never existed before.
- Then, as seen, human behaviour patterns and especially behavioural motives can be analysed multi-methodically. As seen, surveys and experiments, as economists like to conduct, can also contribute to this assessment (e.g., to price elasticities among the addressees), however, all of which have their limits described in detail above; and in particular it is not enough to assume that every actor is purely selfish and constantly consciously-calculating as the economic mainstream does with game theory. In this respect, the above-mentioned multi-methodological approach to behavioural research must take effect (see also Kuckartz 2014; relying too strongly on the formal methods up to real-world laboratories and experiments Lang et al. 2014; Schäpke et al. 2015; Scholz 2011).
- The behavioural motives (described in detail in Ekardt 2019 and briefly in the last section) that can be found with this methodology form a basis for making certain expected governance problems plausible to a high degree (e.g., rebound effects, shifting effects, etc.). The behavioural scientific access to governance problems is crucial for the examination of instruments for effectiveness on the basis of the given goals (and strategies) for sustainability. This applies not only to hypothetical governance options, but also to instruments that are already in place, because it is often difficult even in those cases to answer which social

developments can really be attributed precisely to the governance instrument to be examined. With regard to sustainability issues, these governance problems are particularly:
  – rebound effects (including welfare effects);
  – shifting effects to another region, another sector or another environmental strain;
  – lacking ambition, measured against the targets;
  – enforcement deficit;
  – the problem of depicting which means that the precise depictability, measurement, calculation and recognition of sustainability stocks can be challenging and make it very difficult to address single harmful actions and its consequences.
- The last two problems are especially relevant in the sector of land use, potentially including forestry, since this sector is characterised by highly heterogeneous structures – in general and in terms of biodiversity and GHG (Hennig 2017; Ekardt et al. 2018a, 2020).
- The existence of just those governance problems cannot be simply detected in reality, because, as stated earlier, we are dealing with governance constellations, which have never existed before (e.g., with a complete decarbonisation within a few years). At the same time, other empirical insights besides behavioural research are also important. The fact, that macroeconomically, e.g., GHG emissions can be shifted, actually can be measured in parts (however, with great difficulties), by determining the greenhouse-gas intensity of products based on technical data, and then combines them with statistical data on imports and exports (Peters et al. 2011). Regarding the rebound effect, this is admittedly already more difficult, because the causality between various single aspects is hard to pin down (on the discussion Santarius 2015). The therefore necessary approach for behavioural research is important even for the assessment of the effectiveness of currently practiced governance options, even if it is often hard to determine, which social developments are really just induced by the governance instrument.
- The references to the governance problems show that supplementary factors such as the obvious characteristics of the instruments and other scientific, technical and economic conditions significantly contribute to identifying certain instruments to likely be effective or ineffective. However, as mentioned earlier, there is much to suggest that the multi-methodological governance analysis outlined in this way should be carried out qualitatively and that supposedly exact quantifications should be used more cautiously than has been the case up to now. This is because the behavioural motives alone and the governance problems based on them cannot be quantified comprehensively and precisely, but only selectively. But then, it is also not possible to use them mathematically, or it can only be calculated by accepting the problem that a large number of assumptions are made that do not have to apply in this way. In doing so, even meaningful probabilities for the occurrence of certain factors cannot be mathematically determined, because these same probabilities are generally not known; however, this

then thwarts calculations. The same applies to other scientific, technical and economic findings. In each case unclear causal relationships between various factors and, especially in sustainability issues, the ultimately global framework of reference are further complicating factors (extensively and critically on all of this Dieckhoff 2015; Dieckhoff and Leuschner 2016; Ekardt et al. 2018b; as example of an approach in favour of calculations Bodirsky et al. 2015). This will often be exemplified in the following. Instead, it would not be enough to pay attention to external factors such as political majorities or characteristics of institutions (on these aspects Abson et al. 2017; Droste-Franke et al. 2015; Newig et al. 2016; Juerges and Newig 2015; Klein 2014; Klinsky et al. 2012; Herrmann-Pillath 2015a, b) – which are important, but which in turn are an expression of the motivational situations mentioned. In any case, only optimally designed instruments or instruments that are strongly deficient can be compared – the popular exercise of evaluating an idealised instrument against a misconstrued other in practice takes us nowhere.

With all this, there are finally two more implications. Firstly, the fixation on numbers of the empiricist paradigm encounters various limitations. Because, without exhausting space in this contribution on the details: Not only is behaviour not countable. Also, facts of climate, biodiversity, ecological assessment and scenarios are largely not countable either (on the letter again Dieckhoff 2015; Dieckhoff and Leuschner 2016; Ekardt et al. 2018b; on the first Ekardt and Hennig 2015). It is even less feasible (Ekardt 2021a) to substitute a normative justification of sustainability with an alleged cost-benefit analysis, which quantifies everything, meaning to make it countable. Also, the common search for seemingly empirically derived, but actually normatively intended (however generally not really legally or ethically based) sustainability indicators, which are in turn partial to the logic of quantification, thus raises manifold questions.

Secondly, the acquisition of knowledge in sustainability questions remains bound to be transdisciplinary due to the size of the challenge. Transdisciplinary means in this context to start thinking from the research questions at hand and not along the boundaries of a discipline, or even a school, which will accordingly have to work with a great number of approaches and arguments (on this also Bergmann et al. 2010). Citable literature exists for about any thinkable hypothesis, especially in behavioural research, while the respective fields of research often show certain tendencies to self-evidence, secured by notoriously leaving aside all other disciplines, schools and findings (on the problem of especially the human inclination of simplification, even in scientific circles Ekardt 2017). Seen in this light, there is no further justification that different behavioural sciences ignore each other oftentimes mostly. Reservations of most sociologists against socio-biologists, neurologists and economists therefore urgently need to be re-evaluated – this goes in the other direction as well. Comparing the findings of different disciplines, triangulating methods and thus assessing them critically, could bear the chance of actually interesting findings. It might be accurate that this might sometimes be challenging for the individual scientist – especially since sustainability issues profit from not just sweepingly believe the starting points in *natural sciences*, like scenarios with their thousands of underlying assumptions. Ultimately, this imposition seems unavoidable.

2.7 Focus on Transnational Level and Crucial Issues of Instruments – Insights from Debates on Negative Emissions on Wetlands and Geoengineering

The current governance analysis aims at determining to what extend various policy approaches such as economic policy instruments, subsidies and detailed command-and-control regulations are suitable within forest governance and in which exact combination they will reach maximum impact, measured against the climate and biodiversity targets and the above-mentioned governance problems (based on the resumed behavioural findings). Recognising the need for a coherent land-use policy, we also take the main drivers of deforestation into account (such as livestock farming and fossil fuels in various respects). As effective policy instruments addressing overarching sustainability issues should be implemented on a preferably broad geographical scale, the main focus of the governance analysis will be on the transnational policy level, using the example of the European Union (EU), as well as the international policy level (Ekardt 2019; Stubenrauch 2019; Garske 2020). So far, a consistent forest governance on transnational level is widely missing, as it is the case in the EU (see Sect. 5.2). By now, command-and-control approaches focusing on the regulation of single actions concerning forest management are mainly implemented on nation state level. For reasons of space, we discuss the national level only at some exemplary points though.

A main focus of this volume – in terms of governance problems – lies on the question of a reliable depictability and predictability of GHG fluxes (and biodiversity), in other words, on the already mentioned difficulty to precisely determine the amount of carbon additionally saved in forests as a sink over time as well as other ecological factors. The precise measurement of GHG fluxes is a precondition for the adequate design of policy instruments. This has to be considered within the qualitative governance analysis and the choice of the policy instrument. As mentioned earlier, the focus on opportunities and limits of negative emissions – and on the problem of depicting in particular – continues our earlier studies on peatlands, on large-scale geoengineering, on land-use-based mitigation and others (Wieding et al. 2020; Ekardt et al. 2018a, 2020; Stubenrauch 2019; Garske 2020; Ekardt 2019; Garske et al. 2020; Ekardt and Hennig 2015). These studies have inter alia discussed the status quo and possible solutions for the problem of depicting climate and biodiversity effects in land use despite landscapes are typically very heterogeneous. E.g., the targets on zero emissions and stopping biodiversity loss imply that not only emissions from degraded peatlands have to be avoided, but conservation and rewetting of peatlands are also necessary to figure as sinks to compensate for unavoidable residual emissions. With regard to peatlands, we have demonstrated that measuring, depicting, and baseline definition are difficult for greenhouse gas emissions. In the absence of an easily comprehensible governance unit such as fossil fuels or livestock products (see Weishaupt et al. 2020), economic instruments reach their limits. This is remarkable in so far as economic instruments can typically handle governance problems and react to various behavioural motivational factors very well. Still, peatlands can be subject to certain regulations and prohibitions under command-and-control law even without precise knowledge of the emissions from peatland use, which could be shown using the example of the EU and German legislation (see Ekardt et al. 2020). By these means, we contributed to governance research also by illustrating that even comprehensive quantity-control instruments for fossil fuels and livestock farming – which would address various environmental problems and reflect findings from behavioural research regarding motivation towards sustainability – require complementary fine-tuning through command-and-control law. One of the major intentions of the present volume is to transform this debate to the topic of forests and find out which governance solutions may work in this field.

Another intention is to strengthen our elaborations upon nature-based solutions in terms of negative emissions in contrast to risky geoengineering (on this see Wieding et al. 2020). Most scenarios on instruments limiting global warming in line with the 1.5 °C temperature limit of the Paris Agreement rely on overshooting the emissions threshold, thus requiring the application of negative emission technologies later on. Subsequently, the debate on carbon dioxide removal (CDR) in terms of geoengineering has been reinforced during the last years. It has been shown that the potential risks of high scale technological options such as geoengineering are huge and the effectiveness remains questionable. Furthermore, we have demonstrated that from the perspective of human rights, the Paris Agreement, and precautionary principle the phasing-out of fossil fuels and the reduction in consumption of livestock products as well as nature-based approaches such as sustainable – and thus climate and biodiversity-smart – forest, peatland, and agricultural management strongly prevail before geoengineering.

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3 Forest History and Related Ideas in Society, Economy, and Law

Abstract

Forest history shows diverse ideas and underlying motivations of humans interacting with forests. While a decline in human population affected deforestation, population growth was connected to fears of timber shortage and corresponding more difficult and even hostile living conditions. To avoid that, humans regulated timber and forest consumption through penalties and laws, set up administrations, invented artificial silviculture and developed technologies as well as sciences. Moreover, they introduced sustainable forestry as a form of using natural resources to guarantee future use and supply. Until today, changes in human culture and land-use profoundly impacts the condition and distribution of forests. In recent history, globalisation and the use of fossil fuels causing global warming affected forests in spatial and temporal terms. The history on forest use also illustrates that there have always been trade-offs which were addressed more or less sustainably and equitably. Presently, this leeway is not merely up to human values and self-interest, but increasingly shaped or limited by ecological consequences. The common history of humans and forests reveals not only a close interrelationship but also an existential dependence of humans on intact forest ecosystems which is valid for the past, the present and the future.

Following the variety of human motivational factors described in Chap. 2, forests are a matter of diverging values (or ideas and interpretations), emotions and self-interests. Furthermore, forests have a lively natural history. Some important aspects of this will be examined in more detail in the present section as a basis for the

J. Stubenrauch et al., *Forest Governance*, Environmental Humanities: Transformation, Governance, Ethics, Law,
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governance analysis taking place later on. Karl Hasel[1] called the forest in its various forms "history book of its own kind, which gives information about past and present goals and measures, about successes and setbacks, and which allows lessons to be learned for the future" (Hasel 1985, 211). According to Joachim Radkau, forest history must be understood as inseparable part of the entire human history, and "the diversity of world history is also reflected in the history of forests" (Radkau 2012, 30). Today, we become increasingly aware of the importance of forest for our own existence, as intact forest ecosystems are a decisive key in solving the climate and biodiversity crisis. Moreover, as biodiversity hotspots forests play a significant role in providing healthy ecosystems which in turn essentially contribute to human well-being while preventing the risk of zoonotic diseases and pandemics.

Despite this potential, the earth's forest coverage follows an opposing, namely declining trend. Indeed, the trend of forest loss started after the last ice age. As Michael Williams, author of a work on the history of deforestation, puts it, "it is as old as the human occupation of the earth, and one of the key processes in the history of our transformation of its surface" (Williams 2003, xxi). Chronologically, forest decline appeared as follows (for the following see Ritchie and Roser 2021): 10,000 years ago, 57% of the earth's habitable land, which corresponds to 6 billion hectares, was covered with forests. For a long time, forest cover decreased at a slow rate: Within 5000 years, coverage shrank minimally to 55%. A more noticeable decline began in 1700, since when humans used land increasingly for agriculture. Forest cover further declined to 50% by 1800 and to 48% by 1900. Hence, between 10,000 BC and 1900, the earth lost 9% of forest cover. After that, the decline became more striking: A half of the forest coverage's loss in the human history on earth occurred in the last century due to the expansion of agriculture. In 1950, forest cover was 44%, in 2000 it was 38%. In 2018, 4 billion hectares of the earth were covered with forests. In sum, the world has lost one third of its forests since the last ice age. Almost half of the earth's habitable land is used for agriculture, whereas over three quarters (77%) is used for livestock, hence for grazing and the production of crops for animal feed (for the European forest decline since the last Ice Age see Zanon et al. 2018; on the debate of the start of human impact on the environment see Headrick 2020, 1 et seq.).

Is forest loss a side-effect of human development, directly or indirectly linked to human nature or culture? Following Hansjörg Küster, forests are shaped by nature as well as culture, whereas culture means on the one hand the cultivating influence of humans and on the other hand the ideas that humans express towards forests (Küster 2019, 11 et seq.). Hence, there are features of forests that exist naturally, and there are others that result from past or present use. Over time, ideas and interpretations forests are associated with change: "Again and again, other people confronted the forest, they always had different ideas and intentions. They wanted to

[1] Karl Hasel (1909–2001) was a German forest scientist who is particularly known for his standard work on forest history 'Forstgeschichte. Ein Grundriß für Studium und Praxis', first published in 1985, which also this chapter largely relies upon.

use the forest, create it anew, connected political goals with its existence or its use, wanted to protect it" (Küster 2019, 13).

In this section, motivational factors in relation to forests are illustrated with a focus on forests in the history of society, economy, and law in Central Europe, also taking myths and natural history into account. The focus is on Central European due to several reasons. First, Central European has a special history with deforestation, as it profoundly changed its landscape from being densely forested to being largely cultivated. Moreover, this environmental conversion is a "distinctive feature of the European story that has few counterparts in any other age" being "linked with ideas, ideals and practical needs" (Williams 2003, 104). Furthermore, these ideas are basis of a forest understanding and management that spread to other world regions and eventually impacted global forests and forestry. Especially the concept of sustainability that is traced back to German forestry developed into a global doctrine far beyond forestry as such.

The section begins with a brief early natural history including the beginnings of forest and human co-existence followed by four clusters, in which human interaction with and ideas to forests are presented: Forests and resource supply, forests and power, forests and forestry, and forests as a cultural asset. Within each cluster, human ideas to and associated interaction with forests as the resulting impact on them are depicted. Although it is possible to narrow the ideas down in clusters with historical references, there is no sharp line in time or theme between them. The first cluster depicts the manifold resource uses connected with forests. The second cluster examines the idea of forests as a symbol and mean of power. Thirdly, the evolvement of forestry and its sustainability approach are presented. A fourth cluster shows forests as a cultural asset in German history. Lastly, with drawbacks to the previous clusters, today's ideas to forests are identified.

3.1 Early Forest History: Evolution, First Land-Use Systems and Human Population

Even without human influence, forests have changed over time. Forests have never been stable ecosystems in natural or ecologic balance, rather, ongoing change is a characteristic of forests (Küster 2019, 12; see also Küster 2013, 240; Radkau 2012, 33 et seq.; Williams 2000, 29). Nonetheless, the interaction of modern forests during the last 10,000 years and human interference are inseparable (Williams 2003, 5) and especially agriculture "made the greatest and most permanent impact on the world's forests because it led to the replacement of one vegetation by another" (Williams 2003, 37 et seq.; see also Williams 2000, 5; Ritchie and Roser 2021; McNeill 2001, 230).

3.1.1 How Forests Evolved

The evolution of forests is depicted by the biologist Küster as follows (Küster 2019, 30 et seq.; see also Küster 2003, 11 et seq.; more detailed in Willis and McElwain 2014, 92 et seq.): After life on Earth developed exclusively in water for over 4 billion years, the first land plants emerged about 400 million years ago, from which a vegetation cover gradually developed. It took another 30 million years from the first land plants to the first forests. Briefly, the development proceeded like this: Plants whose leaves protruded far from the vegetation cover and were not shaded were best able to use sunlight for photosynthesis and build up organic matter. Assuming other favourable factors – such as sufficient water in the root zone, a firm shoot and leaves that lost little water thanks to a wax layer – towering plants had an advantage over others and good chances of survival. In the course of time, the first trees emerged. Trees that stood isolated could be destroyed more easily by dangers such as heavy wind. Trees that conversely stood close together offered each other protection and created an interior forest climate. As a result, trees formed a plant stand, the forest. 370 million years ago, forests covered first smaller, then larger areas of the earth. Hence, more and more substance containing carbon was stored on the surface of the earth and more and more oxygen entered the atmosphere. The higher the oxygen content in the atmosphere and the less carbon dioxide there was, the more the temperature near the earth's surface dropped. The better water could be transported in the trees, the more locations could be colonised by forests. More and more different forests developed in which carbon was stored and oxygen was emitted. At the end of the Carboniferous period (298.9 million years ago), the precursors of today's conifers emerged which spread mainly in more temperate areas of the earth. During the earth's history, there were always different types of forests, whereby their coming and going was a very slow process. Overall, the earth's surface covered by forests increased (Küster 2019, 34 et seq.).

The post-glacial period is the beginning of the Holocene that began around 9600 BC. For Headrick, "it is (…) one of the most unusual [epoch] in the history of the planet, for its climate has been more placid for longer than any other period in the past several million years" (Headrick 2020, 352). The Holocene marks a general increase of mixed deciduous forest cover that reached its maximum between 8500 and 6000 years ago. With a forest cover of often above 80% in average, Central Europe had the highest forest rates in Europe (Zanon et al. 2018; Bork 2020, 11 et seq.; Williams 2003, 7). Central Europe became "wood land" (Küster 2013, 64). It was covered with dense forests with few glades and no forest edges in the sense of sharp boundaries to wood-free open land. Birches and pines formed the first forests in Central Europe, whereby birches tended to grow near the sea and pines inland. Next, hazel bushes began to spread, as did spruce and oak, followed by elm, lime, sycamore and ash. In a relatively short time, in about one to two thousand years, different forests spread, so that already 8000 years ago almost all tree species that occur naturally in Central Europe today were represented. Only fir, beech and hornbeam appeared later (Küster 2013, 66–69; see also Mantel and Hauff 1990, 46 et seq.; Williams 2003, 8).

3.1.2 Forests and Settlement Patterns

Changes in human settlement patterns have had drastic effects on the forest cover and their composition as it promoted or inhibited the spread of tree species in different ways (Küster 2013, 241; Williams 2000, 34, 2003, 12 et seq.; on the decline of forest cover due to human pressure see Zanon et al. 2018; Davis et al. 2015; Fyfe et al. 2015).

The beginning of the Middle Stone Age is dated to the beginning of the post-glacial period. The landscape of Central Europe, consisting almost exclusively of dense forests, limited the living possibilities for humans and possibly led to fewer people being able to get by in it at first (Küster 2013, 71 et seq.). Humans lived mainly on the banks of bodies of water and began to change their environment. A first land use system emerged in which forests and natural processes were little affected; people fetched firewood from the forests and promoted the spread of hazel bushes 9000 years ago by deliberately planting hazelnuts in soils (Küster 2019, 76 et seq.; on irreversible changes by hunter-foragers see Williams 2003, 15).

6000 years BC the first phase of agriculture began and with it the change from a hunter-gatherer culture to a farming way of life in Central Europe. The process of cultural change had its origins in the Near East. Within a short period of time, Homo sapiens changed its way of life and behaviour so fundamentally that this change is also called the Neolithic Revolution. How this neolithisation took place "is one of the greatest mysteries of human and landscape history" (Küster 2013, 76; on deforestation and Neolithic cultures see also Davis et al. 2015; Fyfe et al. 2015; Burke 2009, 35 et seq.). With their living habits, people also changed the surrounding landscape including forests that were cleared to make way for settlements and fields. In sparse forests where herbs grew, cattle, pigs, sheep and goats grazed. As there was only little food in each forest, cattle were wrangled further. Because it also ate acorns, young trees and bushes, natural regeneration of forests near settlements was impaired and they thinned out (Küster 2013, 73–77, 2019, 76 et seq.; Bork 2020, 11; Headrick 2020, 60 et seq.; Williams 2003, 47). After a few decades, people left existing settlements, possibly because the wood of their buildings became dry and thus there was a risk of catching fire when cooking (Küster 2019, 76). Another theory[2] for people to abandon their houses and settle elsewhere is that there was an increasing lack of wood in immediate vicinity of the settlements as well as a growing lack of nutrients in sandy or stony arable soils (Bork 2020, 11). New forest trees grew up in the abandoned clearings and gradually reforested, closing the forest and the forest floor again. This kind of land respectively forest use system, the so-called shifting cultivation, lasted for thousands of years (Bork 2020, 11; Küster 2019, 76 et seq.; on the power of regrowth see Williams 2000, 29).

Shifting cultivation impacted the local climate, water and biodiversity. Before the Neolithic, Central Europe had a particularly balanced climate. Due to the dense

[2] Another theory Williams advocates assumes that Neolithic settlements were already stable and lasted already long rather than being shifted regularly, as longhouses used for several hundred if not thousand years would show (Williams 2000, 31, 2003, 44 et seq.)

forest, summers were relatively cool and winters relatively mild. Roots and mosses under the trees released moisture only slowly to the groundwater and streams, which meant that they carried water evenly and rarely much. After the first forests were cleared, local weather extremes became more frequent. In the fields, water ran off and evaporated more quickly than in the forest. However, the forest soil kept the groundwater level sufficiently high even under the fields. Temperatures were also higher in summer and colder in winter on the forest-free areas, but balancing air currents between forest and field moderated the local climate (Küster 2013, 82). In the abandoned settlements, those woody plants that produced masses of seeds and grew quickly spread first, especially birch trees. Other trees grew up under them. Animals such as deer, stags and hares spread beech via beechnuts that stuck to their fur. As a result, beech forests spread in many areas of Central Europe. As an indirect consequence of shifting cultivation, beech forests are based on the cultural transformation in Central Europe (Küster 2013, 84 et seq.; see also Radkau 2012, 165; Bork 2020, 11; Küster 2019, 78). Humans intentionally and unintentionally spread numerous plant and animal species, whereupon highly competitive new species displaced low-competitive native species. For the whole region, Hans-Rudolf Bork determines the environmental impact of societies in the early Neolithic in Germany as noticeable on a small scale (Bork 2020, 11 et seq.). Indeed, there were noticeable changes in individual smaller regions, and settlement densities increased significantly in the course of the Neolithic in many Central European landscapes (Bork 2020, 11 et seq.).

The south of Central Europe became Roman provinces. In the Roman Empire, a land use system of permanent settlement prevailed. It had prevailed on the Mediterranean since antiquity and came into being at a time when written records were beginning to appear and state structures were emerging. Hence, two land use systems, separated by the Roman Limes, existed side by side in Central Europe: North of the Limes there was shifting cultivation, and on the side of the Roman Empire there were fixed settlements. While abandoned clearings in shifting cultivation reforested, in permanent settlements that were supplied with goods via fixed routes the forests could not grow back in their place. Due to permanent settlement, forests were increasingly used (Küster 2019, 79 et seq.; see also Fyfe et al. 2015). When Romans came to Germania in the middle of the first century BC, they found cultivated landscapes that had sometimes been used for more than five millennia. Due to strengthened agriculture and forestry in various provinces, the proportion of forest decreased to some extent (Bork 2020, 20). The unprecedented intensive land use in Roman-occupied regions led to various environmental changes: During heavy rainfall, soil without protective plant cover was washed away and flowed into bodies of water, making water temporarily undrinkable. Wood burned for heating, cooking and baking polluted the local atmosphere and people's respiratory tracts. Forest clearing displaced forest animals, plant species introduced by humans and animals spread into the open countryside and some plant species became rare in forests (Bork 2020, 20; see also Penna 2014, 90). Land use for agricultural purposes reached its peak from the first to the third century AD. Bork estimates that the proportion of forest in (present-day) southern and western Germany was 40–60%, in northern and eastern Germany 60–80% (Bork 2020, 20). Up to that time, the proportion of forest in Germany reached the lowest point of the post-glacial period (Bork 2020, 20).

After the Romans left Central Europe, it remained populated and did not become completely forested again. However, the population density decreased. Rural populations kept relocating their settlements and kept clearing new forest to do so. The prehistoric shifting cultivation ended at the transition from the Migration Period (375–568 AD) to the Middle Ages that lasted from the fifth to late fifteenth century (Küster 2013, 168 et seq.). Settlements in Central Europe became stationary, albeit this change did not occur simultaneously in all landscapes. The spread of beech occurred throughout the epoch with non-stationary settlements in Europe ended with the onset of stationary settlement (Küster 2013, 179, 2019, 79 et seq.). The transition to fixed settlements was accompanied by a new relationship between forests and people: Forests were managed in a fundamentally different way, as wood was permanently cut from the same patch of forest. As a result, coppice forest (see Sect. 3.2.1) use gained in importance. Tree species such as the hornbeam quickly sprouted from the stumps after felling and consequently spread in the early Middle Ages. Beech trees, on the other hand, did not survive the constant coppicing (Küster 2013, 180).

As long as humans used the forest in small numbers or nomadically, forestation was not affected (Mantel and Hauff 1990, 56). Shifting cultivation did not necessarily destroy the forest, but in many cases it even promoted single tree species and increased biodiversity (Radkau 2012, 165; Bork 2020, 11). Because sparse deciduous forest provided the first extensive settlement area – besides the few forest-free areas – on which Central European culture could spread, it is also considered the "cradle of Central European, especially German culture", according to Kurt Mantel[3] (Mantel and Hauff 1990, 57).

3.1.3 Forest Cover and Human Population

In connection with settlement patterns, human population growth was a driving force of forest clearing, degradation and cultivation. Next to technological and ideological factors, demographic factors "formed a conjunction of circumstances that were uniquely favourable to the growth and expansion of settlement in the forests" (Williams 2003, 107; see also Davis et al. 2015; Fyfe et al. 2015; on the link between world population and forest clearance see Burke 2009, 41 et seq.)

Even though Central Europe was never completely forested again after the Romans left, the forest was able to spread strongly again until the end of the Migration Period (Küster 2013, 168) and large-scale reforestation reached its peak in the seventh and eighth centuries (Radkau 2012, 165; see also Zanon et al. 2018;

[3] Kurt Mantel (1905–1982) was a German forest scientist who has taught at almost all forestry institutions in Germany. His last work, 'Wald und Forst in der Geschichte. Ein Lehr- und Handbuch' that is cited in this chapter was edited for print by Dorothea Hauff after his death.

Fyfe et al. 2015). After the end of the ancient world and until the first centuries of the early Middle Ages, between the fourth and seventh centuries AD, the weather was often cool and damp. Harvests often turned out badly and countless people died due to hunger or epidemics. People migrated, and where farmland was abandoned, forests spread again. While being detrimental to human population, weather extremes and climatic conditions were favourable for the growth of crops and woody plants. In this time, from 536 to about 660 AD, there was the "Late Antique Little Ice Age" (Büntgen et al. 2016; Bork 2020, 21). An increased concentration of sulphuric acid cooled the atmosphere, probably triggered by several strong volcanic eruptions (Büntgen et al. 2016; Bork 2020, 21; Headrick 2020, 115; Sigl et al. 2015). The climate anomaly led to rainy periods in Central Europe, it was exceptionally cold even in summer and there was frequent heavy rainfall. Human population decreased and with it the intensity of land use lowered. The time marked a phase of largely undisturbed natural development in which forests grew and new soils formed. The near-natural forests better stored the water masses of heavy rainfall. There were no more severe floods, rivers and streams were clean again. Displaced animal species returned. For the last time, near-natural forests were spreading strongly (Bork 2020, 20 et seq.). Bork assumes that more than 85% of the surface of Central Europe was covered by forests in the sixth century (Bork 2020, 20).

After the Late Antique Little Ice Age, it gradually became warmer and the number of people living in Central Europe increased slowly. Epidemics occurred less frequently. This is followed by a long phase of climatic favour, which lasted from the early ninth century until the thirteenth century. During the medieval warm period, human population grew strongly and with it the demand for food. As a result, land expansion increased massively. This was accompanied by eminent environmental changes, among other things in the form of heavy forest use and widespread forest clearance (Bork 2020, 21 et seq.; Headrick 2020, 127 et seq.; Penna 2014, 98) During this period, two major clearing periods[4] took place. In contrast to early forest clearings, medieval clearings were larger and more concentrated (Mantel and Hauff 1990, 57). The first clearing period was from 500 to 800 AD. Clearing and settlement was perceived as a significant cultural achievement, and the forest accordingly as a cultural obstacle (Hasel 1985, 43; Mantel and Hauff 1990, 61). In this time, forests that grew on land that had already been partly settled were cleared. Clearing took place mainly on the edges of what was then primeval forest, resulting in a slowly but steadily pushback of it. After the death of Charlemagne, population growth stagnated and so did forest clearing. The second great clearing period was from 1100 to 1300. Land development and settlements penetrated into primeval forest that had remained until then and opened it up (Hasel 1985, 43; Mantel and Hauff 1990, 58; see also Headrick 2020, 132 et seq.; Williams 2000, 39). For Williams, in line with Lynn White, Christianity played a major role in forest clearings; "the

[4] Williams, however, defines three clearing periods; from the end of the Roman Empire to the Merovingian (500–750), the Carolingian (700–950) and the High Middle Ages from 1000 to ca. 1300 (Williams 2003, 106 f.)

spread of Christianity and the cultivation of the land went hand it hand" (Williams 2003, 104). The Christian belief, promoting a doctrine of human domination on land, encompassed agricultural developments in the eighth and ninth centuries in Europe in which "humans shifted from being a part of nature to being her exploiter" (Williams 2003, 105; see also Williams 2000, 36; similarly Headrick 2020, 2).

While deforestation varied regionally in Europe, for Western and Central Europe Williams estimates a forest cover of four fifths in 500 that had declined by half within 800 years with most deforestation from 1000 to ca. 1300 AD (Williams 2003, 107; Headrick 2020, 134). Similarly, Bork estimates that after the large-scale clearings in the early and high Middle Ages the proportion of forest reached the minimum of the entire post-glacial period with barely 15% of the surface of Central Europe in the thirteenth century (Bork 2020, 22). In Germany, the proportion of forest in most landscapes reached a low point in the Middle Ages – because of increased settlement density and the rise of cities, which had an enormous demand for wood and led to the decimation of all woody plants – that lasted to the eighteenth century (Küster 2013, 241).

In the 1330s, the Great Plague spread from Central or East Asia to Europe via the trade routes. If the plague reached a place, 60–80% of the people usually became infected and 75–90% of those infected died. The death of about a third of Germany's population marked the largest population decline since the sixth century (Bork 2020, 37). Forests, on the other hand, spread (Bork 2020, 37). After 1351, presumably only half as many people live as at the beginning of the fourteenth century (Bork 2020, 38). Within a few decades, the proportion of forest tripled (Bork 2020, 39; see also Headrick 2020, 146 et seq.; Williams 2000, 30). After the Great Plague, decreasing population and clearing pressure made forest protection less urgent for more than a century (on the connection between plagues and reforestation in Europe see Williams 2003, 136). Radkau, however, states that the clearing movement ended already before the Great Plague and the resulting deep population collapse in many regions (Radkau 2012, 166). He assumes that the forest soils were more or less exhausted and cites Marc Bloch, according to whom people had realised that it was in the interest of their own vital needs to preserve the remaining forest (Radkau 2012, 166). In response to the clearings, forest protection ordinances were enacted at the height of the clearing movement. This is why Radkau sees the clearing movement in the High Middle Ages as the culmination and endpoint of thousands of years of clearing processes that began with early agriculture (Radkau 2012, 165; similarly Williams 2003, 134). However, Williams emphasises that "although the Middle Ages signalled the end of the "deep past" of deforestation in a chronological sense, in a thematic sense they were merely a prelude to an even bigger episode that was yet to come, when Europe began reaching out across the wider world" (Williams 2003, 145; see Sect. 3.4.5).

In the late thirteenth century, a period called the Little Ice Age began. It was a global phenomenon that lasted until 1850 in which the weather wars abnormally cold and fluctuated unusually (Headrick 2020, 144 et seq., 187 et seq.; see also Penna 2014, 284 et seq.). Being especially bad in the seventeenth century, the weather resulted in multiple complex crisis and conflicts, among others to the Thirty

Years' War in Germany (1618–1648) that "reduced the population so much that farmlands were abandoned and forests grew back" (Headrick 2020, 194). While global population stagnated in the seventeenth century, it rose again in the eighteenth century so that by the middle of the eighteenth century, the population as well as their economic activities had recovered. Since then, they are growing continuously (Headrick 2020, 199).

3.2 Forests and Resource Supply: Wood, Food, Energy

Forests served as suppliers for multiple resources, especially wood. For thousands of years, wood was the most important resource used by humans and even often the only material that could be used as fuel and for tools and buildings. The so-called wooden age[5] lasted from the Stone Age to the eighteenth century and indicates the wooden basis for life, economy and culture in Europe and other world regions (Radkau 2018, 21 et seq.). In the medieval, forests and their products, e.g., agricultural land, timber, or fuel, were the most important. Using these, "the forest was either diminished or more valued, or both" (Williams 2000, 106).

3.2.1 Food and Farming, Heat and Housing

As early as 7500–6500 years ago, humans used wood to generate heat, cook food, boil salt and as a building material for houses, tools, boats and wells (Bork 2020, 11). The forest was not only important for people's survival because of its wood, but also because it served as a source of food. In the Middle Stone Age, people were not only hunters but also gatherers that subsisted to a large extent on plants and plant parts. While it is known that they gathered hazelnuts and probably consciously contributed to the spread of the hazel bush in Central Europe, only in a few cases it is known which plants they also collected. There were probably scattered blackberries, however, raspberries or strawberries were probably not present due to hardly any forest glades where they could grow (Küster 2019, 71). This was still the case in medieval Europe, when especially landless peasants lived close with the forest as they used it in their everyday life. Forests were used as a source of heat and materials as well as arboreal by-products like honey, wax, fowl, small animals, and grazing. Moreover, as forests were a source of land, they served as a source of food (Williams 2003, 105).

From the Middle Ages to the eighteenth century, forests were used and overused in a variety of ways. While some forms of use could be combined, others were mutually exclusive. Many forests disappeared completely, others did not (Küster 2013, 242). Until the eighteenth century, people used the forest mainly as a pasture

[5] The term originates from the social scientist Werner Sombart (1863–1941), for whom the entire culture of the pre-industrial era possesses an inner unity in its "distinctively wooden character" (cited from Radkau 2018, 21).

for cattle and as a source of firewood (Radkau 2018, 40). The largest quantities of wood were needed for building and heating. The further north they lived in Europe, the more people resorted to wood for building and heating, which is why it was a particularly important raw material there (Küster 2003, 79). Primarily, wood was used for fire. As a fuel wood ranked before wood as material: approximately 9/10 of wood was consumed as firewood until the nineteenth century, also in the form of charcoal (Radkau 2018, 21; see also Radkau 2012, 166; similarly Williams 2003, 179). With permanent settlement, human cultivation led to new types of forests that differed according to their use: Pasture woodland, coppice and plenter forests (Küster 2019, 79 et seq.).

Before meadows were established, the forest was the only existing grazing area (Radkau 2018, 21). People have used forests as pasture for livestock for thousands of years. Pasture woodlands in which livestock grazed were vast in the Middle Ages. Because the cattle ate seeds, fruits and young plants the forests thinned out. The sparse forests provided space for a lot of undergrowth, which served as fodder. While hardly any young trees grew back in the pasture woodland, old trees died, so that the grazed forests became increasingly sparse (Radkau 2012, 171; Küster 2013, 242 et seq.). Another form of tree use related to feed livestock was the so-called pruning. To feed their cattle in winter, humans dried leaves from trees. For this purpose, mainly branches of lime, ash and elm trees were used; their branches were cut off and then hung up to dry. This process injured the trees. Elms reacted sensitively to this; the elm splitting beetle penetrated the wood at the impact points and elms infested by it died. As a result, most elms died in Germany about 5000 years ago (Bork 2020, 11; Küster 2003, 83, 2013, 247 et seq.). After the plague, new forests suitable for keeping livestock grew on former farmland. People promoted trees such as pedunculate oaks, sessile oaks and beeches, which are considered valuable fattening trees. In recurrent cycles, the trees produce large quantities of fruits, resulting in cyclical mast years. However, according to Bork, reliable data on forest grazing and livestock density in forests do not exist until modern times (Bork 2020, 39; see also Küster 2013, 144). Livestock fattening promoted the degradation of forest soils. Due to forest grazing and the need for wood from the late fourteenth to the sixteenth century, the naturalness of the early medieval forests was not nearly reached (Bork 2020, 39).

In forests that were used for firewood trees as a whole or their branches were repeatedly cut back. This resulted in coppice forests. The trees were also felled at young age, hence the rotation period, i.e., the time between planting or growing and felling, was short. As a result, they grew only a few metres high and then sprouted again. While not all trees, for instance beeches, survived such use over a long period, oaks, hornbeams and hazel bushes did (Küster 2013, 246, 2019, 79 et seq.).

Because wood was the most common material and almost the only heating material in the Middle Ages and the early modern period, there were soon hardly any forests with tall trees left in the vicinity of settlements that could be used for building. In contrast to firewood, timber could only be obtained from tall trunks, which is why the use of forests for building required a long rotation period. One form of forest utilisation that did justice to different uses of wood was the middle forest utilisation, or plenter management, resulting in a mixture of trees of different species and trees. In middle or plenter forests, people used different trees for different purposes. Trees whose wood was used as building material, e.g., oaks, were initially left standing. Those used for firewood, e.g., hornbeam, were repeatedly cut back like in a coppice forest. The larger growing trees reached fruit maturity and rejuvenated the forest. The trees that were regularly coppiced, on the other hand, were cut down before they could produce fruit or seeds, but they could also grow old (Küster 2013, 246 et seq., 2019, 79 et seq.; Radkau 2012, 171).

Coppice and plenter forests and pasture woodlands were used and cultivated by peasents, with pasture woodlands being the largest in terms of area. According to Radkau, the peasant forests were richer in species than the forests of modern forestry with cultivated high forest pure stands. The diversity of forest interests, which also involved the use of almost every type of wood, branches, leaves and deadwood, may also have tended to maintain a diverse, species-rich forest (Radkau 2012, 171, 2018, 27).

3.2.2 From Tools to Crafts to Industries

Wood was needed for the production of tools and other things humans used in their daily life (Küster 2003, 82). Humans processed wood already 400,000 years ago as wooden spears discovered in Germany in 1997 prove (Radkau 2018, 19). Centuries later, in Roman provinces of Germania, wood was still an important raw material. Apart from its use to warm the house in winter and to heat the kitchen cooker for food preparation all year round, wood was used to build palisades of the Limes, ships, buildings, bridges, plank paths in wet locations, pit timbers for stabilising galleries in mines, weapons, fences, agricultural implements, tools, writing tablets, charcoal and much more. Beyond that, handicraft and metalworking businesses also needed a lot of wood (Bork 2020, 12; see also Headrick 2020, 100 et seq.).

Through permanent settlements in fixed places, agricultural production could be intensified, and the production could exceed the peasants' own consumption. During the Middle Ages, urban culture developed in the midst of the village hinterland. The intensification of agricultural production in the surrounding rural areas made it possible for monasteries, castles and towns to flourish (Küster 2013, 196 et seq.; see also Radkau 2012, 179 et seq.). Between village and town dependencies developed: The town was supplied with material by the countryside, the countryside needed the trade conducted in the town to earn money. The problematic wood supply had, according to Radkau, structural compensatory effects: while cities were disadvantaged, wooded peripheral areas were favoured (Radkau 2012, 176 et seq.). Because their fate depended on mass wood supply, cities specialised in wood procurement (Radkau 2012, 177). Their wood supply depended on whether they were located on a river, because transporting wood by water was much easier than by land. Moreover, it was advantageous if wood could be obtained from surrounding forests over which the city had rights and no great competition (Radkau 2012, 175). In the thirteenth century, more and more urban centres arose with many kinds of crafts that needed wood as a raw material, alongside a growing population with growing needs. Wood was still the most important raw material; it was needed for building houses and ships, for making barrels in which perishable goods were stored, for making fires, in salt boiling, for smelting ores, in the production of charcoal and in many other crafts. The pressure on forests increased enormously as a result (Küster 2019, 82 et seq.).

In the course of time, more and more uses for wood were added and existing utilisations intensified. Several large industries with high wood consumption developed, which increased the use of forests. To preserve food, people needed salt. For this purpose, salt works were built, where a lot of wood was needed to fire the salt pans and to dry and pack the salt (Bork 2020, 22 et seq.). In the ninth and tenth centuries, not only the need for food grew, but also the demand for metals. Mining begins to flourish, whereupon the demand for wood increases enormously (Bork 2020, 27; see also Burke 2009, 42; Williams 2003, 106). Before blasting powder was developed, pit wood was piled up in front of large rocks and set on fire in order to use the released heat to make the rock brittle and mining easier (Küster 2003, 157). Pillars to secure tunnels were made of coniferous wood, especially spruce, pine and larch which had the special feature of making a groaning sound when pressure was increased and thus gave the miners timely warning of an impending collapse of the tunnel. Later, British miners would initially resist steel supports. Coniferous forests spread in mining areas already in the early modern period (Radkau 2018, 40). Because of mining, until the early nineteenth century extensive deciduous forests disappeared, and a few new ones grew up with a changed tree composition. In connection with mining, wood was used for the construction of the buildings and to smelt the ores (Bork 2020, 27 et seq.). The wood demand was particularly burning in iron production, as the melting point of 1528 °C was much higher than for most other metals and the trend was more towards mass production (Radkau 2012, 179). In the High and Late Middle Ages, glassworks emerged which required a huge amount of wood, consuming more than 2 t of wood to produce only 1 kg of glass (Bork 2020, 23). According to Bork, glassworks stood for significant local environmental changes, especially the overexploitation of forests and local air pollution (Bork 2020, 23). Other sectors which used forests mainly for firewood were the dyeing of textiles (Bork 2020, 41), the production of earthenware and stoneware, porcelain, or lime (Küster 2003, 161). Timber was also used for furniture, cooperage, and several other manufacturing and fabricating processes (Williams 2003, 136). Certain types of wood were used for specific purposes, e.g., coniferous wood for resin, tar, pitch or other woods for carvings, musical instruments and baskets made of willow (Williams 2003, 163 et seq.).

In addition to newly developed industries, wood consumption increased with growing living requirements of the people. As living standards rose, people needed more wood. The construction of buildings became larger and more representative, ships became more spacious and transported more and more goods from distant countries, and larger had to be heated. More and more items were made, and even if they were not made of wood, firewood was needed for their manufacture. Moreover, more wood was used to extract more salt to preserve more food (Küster 2003, 155; see also Williams 2003, 246).

3.2.3 Wood Shortage: Regulation, Technology, and (Instrumentalised) Fears

The increasing need for wood led to disappearing forest areas and to competition among its users. People perceived the dwindling forest areas as a threat, although it is unclear whether the lack of wood was only feared or had already occurred (Küster 2019, 89; Radkau 2014, 14). In response to wood shortages, regulations were issued, production facilities were relocated and savings through technologies were attempted.

Küster supposes that it must have been tremendously complicated to reconcile the various interests in forest use: The responsible sovereigns had to strike a balance between the individual users, which resulted in forest regulations being issued in the late Middle Ages, which was not primarily about protecting the forest, but about resources for the diverse uses (Küster 2003, 165 et seq.). The sovereigns themselves, first and foremost, wanted to continue hunting in their forests and prohibited any use in order to nurture their game, which, however, bit young trees and greatly hindered the regeneration of the forest (Küster 2019, 89).

The problem of over-exploitation of forests had been known for a long time. As early as the thirteenth and fourteenth centuries, attempts were made to regulate the management of individual forests, especially near towns (Küster 2019, 92 et seq.). A sufficient supply of wood in towns became increasingly difficult, although not all wood was equally desirable (Küster 2013, 252). Sources regarding urban forest protection increased in the late Middle Ages, which according to Radkau had to do not only with increasing problem pressure, but also with a regulatory eagerness of city leaders (Radkau 2012, 177; similarly Headrick 2020, 203). Urban forests were predominantly managed according to the principle of subsistence farming; the needs of the citizens took precedence over exports. The subsistence economy of the cities was also considered by royals who banned the clearing of forests at the beginning of the fourteenth century also under pressure from the cities. Growing energy-intensive industries regularly fuelled fears of a wood shortage. In France, out of consideration for the urban subsistence economy, a front was even drawn against wood-intensive industries: in 1339, forges and smelting ovens were destroyed by order to secure the wood supply of Grenoble (Radkau 2012, 175 et seq.). Radkau sees a stabilising effect in the limitedness and threating nature of wood as a resource that has been something very vivid for many centuries; fear of timber shortages, which regularly accompanied economic growth, tempered unrestrained ambitions for growth. Urban economy had no urge for limitless growth, but production constraints (Radkau 2018, 28). Nonetheless, forests in the immediate vicinity of old towns appear still rather meagre in modern terms (Radkau 2012, 176).

In the sixteenth century, the shortage of wood became a special problem for the first time, requiring special solutions. In connection with wood production, relocations, replacements and first shifting effects occurred. Factories were relocated to places where there were still forests and wood-processing companies and businesses settled along rivers over which wood was transported (Küster 2003, 155 et seq.) By relocating ironworks, e.g., attempts were made to preserve forests close to the city (Radkau 2012, 175). In trades, where very high temperatures were needed for smelting, charcoal was used as fuel rather than wood. Because it is light, it could be transported more easily and the production of charcoal could be carried out in remote forest regions (Küster 2003, 158 et seq.). Shifting effects occurred, e.g., in the production of glass. The glass raw material quartz melts at 1700 °C. Adding potash lowers the melting temperature. However, potash was also produced from wood ash, whereby the area of forest burnt to ash was even larger than that whose wood was used as firewood or in the form of charcoal to heat the smelting furnaces. The nearby forest used by the glassworks for wood could therefore be smaller than the more distant forest used for ash (Küster 2003, 159 et seq.).

In saltworks and mining, wood-saving methods and machinery were developed. The attempt to keep wood consumption low happened also due to economic reasons because wood was a significant cost factor (Bork 2020, 22 et seq.). The reduced consumption of wood led to the manufactured products becoming cheaper, which meant that larger quantities were produced and, as a result, more and more wood was consumed (Küster 2003, 156–159). Hence, first rebound effects arose.

Radkau describes the time around 1800 AD as the peak of the fear of wood shortage and the technological efforts of wood saving (Radkau 2018, 34). The concern that ironworks would overtax the forests was widespread by the eighteenth century at the latest. In France, many communities waged a battle against the ironworks, labelling them as insatiable wood-eaters. This was linked to a general fear of wood shortages spreading throughout Europe (Radkau 2012, 178 et seq.). The fear of a wood shortage is probably related to the fear of winter cold as a primal fear in the North. For Radkau, the annual winter frost in the north explains an almost inevitably development of a precautionary mentality that people of warmer regions were not forced to adopt to the same extent (Radkau 2012, 166).

If there really was a wood shortage is disputed. According to Küster, wood consumption in the Middle Ages and early modern times was greater than the amount of wood that could be regrown and Central European forests did not produce as much renewable raw material as was needed (Küster 2013, 253). For Germany, Bork states that a shortage of wood never affected all German states and all social groups at the same time, not even in the second half of the eighteenth century and in the early nineteenth century. Some wood was temporarily unaffordable for certain social groups, also because importing it from other states would not have been profitable due to high transport costs (Bork 2020, 101 et seq.). Radkau, in turn, claims that there were indeed local supply bottlenecks, due to the growing population, the fire industry (such as metalworks, glassworks, saltworks, glass and brick distilleries) and a steep rise in rafting and timber transport (Radkau 2012, 168). The supply of wood, however, had been more a question of distribution and transport, and in many places rafting worsened self-sufficiency because the wood was detoured. The danger of a shortage of wood seemed all the more urgent because the easily accessible forest, which was in sight of the towns, had been cleared out most quickly. And Radkau suspects that the threat of a shortage of wood made it easier to play politics: In large parts of Europe, the shortage of wood was stylised as a spectre of terror in order to anchor territorial rule more firmly and to tap into levies for forest offences as a source of money. The precarious timber supply was used as a lever to make money out of the mining industry and to gain influence. In doing so, authorities invoked the scarcity of wood, but by imposing restrictions on forest use they contributed greatly to making wood scarcer in their own fiscal interests (Radkau 2012, 168; see also Radkau 2014, 13 et seq., 17; similarly Headrick 2020, 203; Williams 2003, 169).

The millennia-long age of wood – as well as the recent emerged wood shortage – came to an end with the invention of the steam engine and coal as an alternative to using wood for heating. The beginning age of fossil fuels made reforestation possible (Küster 2019, 96 et seq.; see also Headrick 2020, 216 et seq.) and "released humans from their dependence on organic materials and from the trade-offs between heat, food, and raw materials" (Burke 2009, 42). Accordingly, wood shortage was not solved through regulations or wood-saving technology, but through switching to another raw material. This is insofar remarkable as today the world faces the challenge to overcome the fossil fuel age and forests are once again coming into focus, also with regard to renewable energy production (see Sect. 5.2.3). It already highlights that (1) the drivers of forest destruction have to be addressed accordingly, (2) efficiency gains alone will not suffice and (3) alternatives, e.g., for energy production need to be found. Back in the times, the shift to fossil resources also impacted the idea of growth: "Faced with natural growth, people had to learn to live with the limits of growth and to use regenerative resources in a sustainable manner" (Radkau 2014, 17). As long as organic growth happened before people's eyes, "the limits to growth were a banality" (Radkau 2014, 17), which fundamentally differs from resources, e.g., oil, gas, or the atmosphere, today.

3.3 Forests and Power: From Free Use to Possession to Subject of Regulation

With diverging interests regarding forest use, forests became subjects of possession and regulation. The right of disposal of a forest or its possession was associated with power, domination and political influence. During the Middle Ages, claims to power over forests arose, and different types of forest ownership developed that developed in different time strands and existed parallel but also replaced each one another in some cases. With forms of forest possession, also forest regulations were issued.

3.3.1 Forests in Possession: Community, Royal and Manorial Forests

In the originally ownerless forests, Germanic tribes could clear forests at will. This changed with the development of property rights to the forest (Hasel 1985, 51 et seq.). According to Hasel, that increasingly scarce land was a necessary presupposition for forest ownership to develop (Hasel 1985, 59); as land cultivation progressed, human population increased, land space became scarcer and different interests of use clashed. As a result, demarcation was necessary. This did not happen everywhere at the same time – in areas that were more densely populated, the process began earlier than in less developed areas (Hasel 1985, 59).

Notabene, Radkau states that the modern concept of property, which excludes the rights of use of other persons, did not yet exist in the Middle Ages. In contrast, the poorer population held the view until the nineteenth century that forests were given by God or nature and could be rightly used by everyone (Radkau 2018, 58). According to Mantel, a private right of possession or even ownership of the forest by individuals cannot be assumed in the early and high Middle Ages[6] (Mantel and Hauff 1990, 161). Possession and ownership of the forest in the form of private law were still not very prominent in the later Middle Ages. Instead, the power of disposal, from which possession and use-property were derived, was decisive (Mantel and Hauff 1990, 162).

As early as the Roman period, lordship over land developed with claims for exclusive forests use. Since they developed differently from region to region, it is not possible to precisely date the claims and the associated supervision (Franz 2020, 57). After the Romans left, royal families appropriated claimed ownerless possessions including land. Based on Roman law and beyond, they additionally claimed all lordless land for themselves. As a result, large untouched forest areas became imperial estate. As it merged with the household property of the royal families, an immense landed estate was created which laid the foundations of the power of the Merovingians and Carolingians.[7] It was additionally expanded by conquered territories by Charlemagne or after defeated uprisings. When a ruling house died out, its possessions went to the imperial estate, which enabled kings and later emperors to become the largest landowners in their empire (Hasel 1985, 59 et seq.; Mantel and Hauff 1990, 153).

After the Migration Period, forests were not yet anyone's property (Hasel 1985, 59). Settlement communities used forests communally; they cleared the forest, used the forest around their settlement communally and took possession of it by

[6] According to Mantel, the literature is of the opinion that under the influence of Roman law, in the areas that came more into contact with the Roman legal and economic constitution, such as the Roman provincial areas in the Rhineland and southern Bavaria, the idea of private property rights to the forest arose early on (Mantel and Hauff 1990, 161).

[7] The Merovingians were the oldest royal dynasty of the Franks from the fifth century to 751 ('Merovingian period'). They were succeeded by the dynasty of the Carolingians, which held the kingship in the Frankish Empire from 751 to 911 ('Carolingian period') and to which Charlemagne also belonged.

demarcation. The “free” forest developed into a common forest, which was used by the community members to the exclusion of outsiders. In terms of area, forest was the main component of communal used land (Franz 2020, 54–56). Smaller forests that, i.e., were used by the inhabitants of a village, were usually referred to as common forest (Allmendewald). Mark[8] forests were larger communal forests often shared by several villages, the margraves, that formed a mark cooperative (Franz 2020, 55; Mantel and Hauff 1990, 152). Unlike other parts like agriculturally used land that were used privately by single peasants soon, forest use remained used communally (Hasel 1985, 59). Mantel states that the fact that peasant private forests did not exist in general is clearly shown by the Weistümer, that described regulations in community forests, in which the creation of private forests for the individual was rejected and only common forest were acknowledged (Mantel and Hauff 1990, 161 et seq.) Behind and between common forests, there were still large forests that were not claimed by anyone and that offered space for possible expansions for settlers (Hasel 1985, 59). Between the eleventh and thirteenth centuries, cooperative use of the forest was widespread in marks (Franz 2020, 56), however, it is not clear since when, where and to what extent mark cooperatives existed (Franz 2020, 54 et seq.). According to Thorsten Franz, the gradual disappearance of forest commons can be, next to the tragedy of the commons, attributed above all to the emerging and strengthening upper class who claimed an exclusive use of the forests (Franz 2020, 56 et seq.).

In the early Middle Ages (ca. 500–1050), forests were vast and inaccessible. There were two predominant forms of forest possession: Common forest and royal forest, with royal forests being the most prevalent (Mantel and Hauff 1990, 161). During the Carolingian period, the population grew strongly, so that there was a greater need for space for settlements and fields. The clearings that took place in Charlemagne’s time were carried out by rulers themselves as well as by monasteries but also margraviate cooperatives (Franz 2020, 68; on clearing by secular powers see Williams 2003, 111 et seq.; Headrick 2020, 132).

Like community forests, royal forests were not sharply demarcated. Accordingly, anyone could use them for their own interests. To avoid that, the royal families, the Carolingian and Merovingian, used their power of disposal and declared royal forests (lat.: silva regales) to be “Forst” (forestis[9]). The process of taking the forest into possession was called inforestation (German: Einforstung). Through inforestations, large forest areas were brought under direct royal control (Mantel and Hauff 1990, 154). In medieval deeds, two different terms for forests were associated with different forest rights and uses: The term silva was used for royal forest, the use of which was possible for everyone. Forestis, on the other hand, referred to the part of a forest

[8] A mark described an area within certain boundaries (Franz 2020, 54).

[9] The term ‘forestis’ is a neologism of the seventh century; it is not known classic Latin, as well as forests owned by a manor were not known in the Roman Empire. Originally, a ‘Forst’ referred to large forest areas that were located outside settled areas, which later also included cultivated fields, pastures and villages (Hasel 1985, 59 et seq.; Mantel and Hauff 1990, 153 et seq.; Küster 2003, 124).

area in which free hunting was abolished in favour of the king or a respective benefactor (Hasel 1985, 59 et seq.). In some cases, a Forst and associated rights were conferred to others while kings reserved certain uses for themselves, or certain rights of use were conferred to individual third parties in return for fees or for a limited period of time (Hasel 1985, 60–62). The extent of a Forst was not rigid; many became smaller and torn into individual parts in the course of the Middle Ages, some became larger again or grew together. Because they also included open spaces, meadows, fields and villages, one cannot conclude the extent of forest areas from the size of the forests (Küster 2003, 131; Williams 2003, 102). Since the beginning of the eleventh century, instead of Forst, the terms Wildbann (wildernis ban) or Forstbann (woodland ban) were used (Hasel 1985, 65; Küster 2003, 125). The forest ban took place within the framework of inforestation. With putting a forest out of use trough banning it, kings, respectively nobles or clergymen who had been authorised by a king, intended to prevent further clearings or settlements (Mantel and Hauff 1990, 62, 155). The king's ban of forests respectively the inforestation continued until the twelfth and thirteenth centuries (Hasel 1985, 71; Mantel and Hauff 1990, 153 et seq.; Franz 2020, 57 et seq.).

During the Middle Ages, royal forests were given away to secular or ecclesiastical lordships, which resulted in another predominant form of forest possession: the manorial forest. Like the royal forests, this medieval form of possession was based on authoritarian sovereign rights (Mantel and Hauff 1990, 162). Various reasons were given for the granting. One reason could be that the donation was linked to a commitment, i.e., it could have been aimed at influencing other rulers (Hasel 1985, 62). Another possibility is that the king's land holdings were simply far too large and could not be maintained, or that a ruler could simply have lost interest, e.g., due to a move. Küster suspects a geographical connection between the construction of a castle, a palace or a monastery; it was only when nobility or monastic communities were given forests that they were able to settle there (Küster 2003, 125). In the course of the centuries, royal forests continued to decline while the possession of forests by secular and ecclesiastical lordships continued to increase. By the end of the fourteenth century, only fragments of the former important imperial estate remained. Instead, manorial forests were most extensive; nearly all secular and ecclesiastical lords possessed ban forests which created a new class of forest owners (Hasel 1985, 62 et seq.; Mantel and Hauff 1990, 162). Territorial rules also expanded their territory through forest clearing; by forest clearing, forests were taken into possession. In areas where there was no clear ownership, there was at times a real race to clear the land among territorial lords. Many of the forests cleared had been sparse pasture forests, which were of great use to the farmers for fattening pigs (Radkau 2012, 165). In the centuries that followed, manorial forest possession continued to increase as ownerless land was appropriated, margravial cooperatives divided up and church estates confiscated, especially after the Reformation (Hasel 1985, 65 et seq.). The Reformation as such lead to more independent thinking that spread to other areas of life than religion, thus it also impacted land and forest use (see Küster 2019, 92 et seq.). Forests played a major role for the formation of territories; disposal of forest meant lordship, and lordship meant disposal of the forest (Mantel and Hauff 1990, 155).

At the end of the Middle Ages, a large part of the forests was in royal or manorial possession. Locally, there were communally used forests in which lordships were later also involved. Peasant small private forest was rare (Mantel and Hauff 1990, 162 et seq.). Also, cities possessed forests, which went back to the founding of the city and often came from underlying village communities. In some cases, cities bought forests from royal or manorial property (Hasel 1985, 97 et seq.; Mantel and Hauff 1990, 163; see also Radkau 2018, 175 et seq.; Küster 2003, 133 et seq.).

3.3.2 Forests as Subjects of Regulations: Rights of Disposal and Rights of Use

When possessions of forests established, the free use of forests changed. With issuing rules to the access to the forests' resources, forests became subjects of regulations. The regulations restricted forest use and led to first forms of forest administration.

In prehistory and early history, the forest was no subject of regulation. Germanic tribes used the forest freely. Forest areas were large, and game, wood and forest fruits were abundant. Germanic folk laws (lat.: leges barbarossa) prohibited to take away wood that had already been collected, but not the taking away of wood in general, since it was not a matter of property but only of wood (lat.: quia non de re possessa, sed de ligno agitur) (Hasel 1985, 104).

Since the early Middle Ages, there were royal hunting regimes with the aim to preserve forests. Originally, they did not include the control of forest use. Settlers should be prevented from free clearing and settling. In 795, Charlemagne issued an order, "capitulare de villis et curtis imperatoris", according to which forests, where they are necessary (lat.: ubi sylvae debent esse), may not be excessively cleared and damaged (Radkau 2012, 165 et seq.; Franz 2020, 65; see also Mantel and Hauff 1990, 61 et seq.). According to Radkau, these early regulations prove that the connection between forests and power in Germanic-Celtic Europe is very old (Radkau 2012, 167). From the ninth century onwards, royal and imperial forest deeds contained more and more regulations that prohibited and punished unauthorised use of forests that had been declared to Forst. The deeds entitled to sole control over a Forst while excluding non-entitled persons from its use. Primarily hunting but also other uses like clearing or forest grazing were prohibited without prior permission of the beneficiary. Thereby, authorities wanted to preserve their right of disposal, prevent unauthorised encroachments, and collect levies for authorised uses (Hasel 1985, 59 et seq., 104).

With the second great clearing period from 1100 to 1300, an unusual development occurred in Central Europe according to Radkau: at its peak, forest clearing became a legal, regulated and widely documented process, resulting in forest to become an area of law and clearing a subject to authorisation (Radkau 2012, 165). In the following late Middle Ages (1250–1500), there was also a major change in the way forests were governed: While in the Carolingian period the power associated with the forest was related to its clearing, the protection of forests became basis for lordship (Radkau 2012, 167).

In the High and Late Middle Ages there were more and more prohibitions on clearing. In the twelfth century, kings began to block forests, prohibit wild clearing and impose heavy penalties on violators. The restrictions were first enacted in more densely populated regions, became established over time and existed almost everywhere by the end of the Middle Ages (Hasel 1985, 51 et seq.). Secular or ecclesiastical lordship issued forest regulations as well and regulated forest management (Hasel 1985, 106). The main reason of lords to restrict forest clearing was presumably to preserve their forests for hunting. Because the obligation to obtain permission for clearings was related to the payment of a levy, to ban forests was mainly intended to secure taxes. In addition, while preserving the forest other revenues were ensured, like the leasing of beech and oak forests to farmers for fattening or providing timber for lucrative salt works and mines. Moreover, to keep the rural areas under control may have played a role in preserving the forest (Hasel 1985, 106, 51 et seq.). Another aspect came up with the increasing expansion of land for which also royal forests had to be cleared; as this was only done with the permission of the lord of the forest, he was able to consciously direct the expansion and link it to taxes. According to Hasel, political and financial aspects of authorisation requirements in the hunting woodlands thus became more important in the course of time. Aspects of land development and land planning were combined with financial and hunting interests of the forest lords (Hasel 1985, 62; see also Mantel and Hauff 1990, 154).

In community forests, old customary law in form of the Weistümer, which was passed on orally, applied. Originally, these regulations were an expression of a cooperative will, jointly decided by the members in a margrave assembly. Accordingly, the orders were local (Hasel 1985, 107). The regulations were intended to keep the demand for wood low. Regulations concerned among others the distribution of use or countermeasures in the event of overuse and were intended to ensure an organised use of the forest in the face of often very different interests (Hasel 1985, 104–106; Franz 2020, 56 et seq.). In addition to kings and nobility, margravial cooperatives community forests also began to establish preliminary forms of forest protection, although the exact time is unclear due to great regional differences in the developments. According to Hasel, forest clearing became subject to authorisation in cooperative forests in the twelfth century and, in general, permission was granted by the head of the mark[10] (Hasel 1985, 52). In order to prevent overuse and to preserve the forest, the free use of the commons was increasingly restricted, and the admission of new comrades limited. The tragedy of the commons in the form of overuse of the common property and the interest in preserving the status quo led to the free use of the commons being increasingly restricted and the admission of new

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[10] The so-called Obermärker was elected by the margraves in the mark assembly and was the highest mark official with special rights of use to wood and pasture, more on this see Hasel 1985, 91 et seq.

comrades also becoming more and more limited (Franz 2020, 56 et seq.). The age and origin of the oral law of community forests are disputed. The first records of Weistümer date from the eleventh and twelfth centuries, reaching their peak in the sixteenth century[11] (Hasel 1985, 104 et seq.; Mantel and Hauff 1990, 156 et seq.). Hasel states that the writing down itself represented a compromise between different interests of the lordship, who gained more and more influence on community forests in their territories, and the mark community (Hasel 1985, 105). Around 1500, sovereigns took over the head margrave and gradually gained sovereignty over the margrave forest. The Weistümer were replaced by sovereign forest regulations that applied to the entire territory and to all types of forest ownership (Hasel 1985, 107; Mantel and Hauff 1990, 155).

From 1500 to 1800, landlords dominated forest regulation. With the strengthening of the territorial power from the sixteenth century onwards, sovereigns took on the task of protecting forests and more and more forest ordinances were issued. They restricted clearing by means of prohibitions and regulating the distribution of fields and forests (Hasel 1985, 52, 110; Mantel and Hauff 1990, 166, 155). Because every sovereign wanted a forestry rule for his territory, there was a large number of forest regulations. Some of them were copied almost word for word from each other. The regulations applied to all forests in the respective territory (Mantel and Hauff 1990, 165).

The enactment of forest regulations was mainly justified by concerns about a timber shortage. The lords of the territories wanted to sustainably ensure the wood supply of the population and the wood-processing trades and industries, which is why they strived for an economical use of wood. As the raw material was often already in short supply, it had risen in value. Hence, among preserving hunting privileges, the lords expected higher revenues from the sale of more wood to wood-intensive trades (Hasel 1985, 109–111; Mantel and Hauff 1990, 165; see also Franz 2020, 84 et seq.). Consequently, the forest regulations contained numerous provisions on wood conservation and organised use. In almost all forest regulations of the sixteenth century, the reforestation of clear-cuts is prescribed (Mantel and Hauff 1990, 67), as are restrictions on forest clearances (Hasel 1985, 52). In part, provisions were taken over from the Weistümer. For example, the regulations encouraged the cultivation of living hedges instead of wooden fences, the use of softwood for coffins instead of precious oak, the establishment of community ovens to save firewood, or they forbade the construction of new houses. Wood-saving stoves were also advertised (Hasel 1985, 114).

However, the forest was not only a legal object with restrictions, but also with rights of use. This was not otherwise possible, as the population had been dependent on forest products for centuries. In many areas, the forest had already become the property of a lord early on, but the local inhabitants were allowed certain uses in the lord's forests, even if general use was excluded by a ban. Forest use rights were also granted to monasteries, parishes or clergy, as well as to businesses with salt works,

[11] A collection of around 3000 Weistümer was published by Jacob Grimm between 1840 and 1869 (Hasel 1985, 104; Franz 2020, 81).

mines and metallurgical mines, which had a large demand for wood (Hasel 1985, 98). Rights of use for peasants were often granted informally and without a precise description of the quantity or the circle of recipients. Because there was initially still a lot of forest and wood, forest was worth little and the claims on it were low. It also happened that uses in the manorial forest were tacitly tolerated or not even noticed. Accordingly, the rights of use were not a legal problem for forest owners and peasants. The question of whether the rights were to be regarded as irrevocable or whether they represented a revocable benefit did not arise (Hasel 1985, 99). As the population, economic development and also needs and demands on the forest increased towards the end of the Middle Ages, supply difficulties arose locally or were feared. This led sovereigns to place greater emphasis on their right of ownership of the forest and to restrict the uses of the peasants. As a result, forest use rights were more precisely circumscribed and limited (Hasel 1985, 99 et seq.).

3.3.3 Enforcement of Forest Regulations: Forest Police and Forest Administration

For the implementation of forest regulations, a forestry organisation was crucial. Already in the early Middle Ages, Merovingians and Carolingians appointed foresters, the so-called fosterarii, who were to protect the forest and direct forest use locally within the framework of an orderly property administration (Mantel and Hauff 1990, 158 et seq.; Hasel 1985, 132). In the Carolingian period, royal domains (lat. fisci) were formed, which primarily served self-supply and combined agriculture and forest use. The separate administration of the domains was carried out by royal officials who represented the forest sovereignty and also had a political function of representing power (see Franz 2020, 60 et seq.). According to Franz, the need for an administration occurred because kings wanted to manage their forests that were located distantly from them (Franz 2020, 60). These first attempts at forest administration in the early Middle Ages were primarily aimed at protecting hunting interests (Franz 2020, 60 et seq.).

Fosterarii were subordinate to the heads of the domains and had additional forestry personnel, e.g., woodworkers, under them (Franz 2020, 62 et seq.; see also Hasel 1985, 132). In the ninth century, forest masters (lat. magister forestariorum) took place of the royal officials. As early as the Carolingian period there was a threefold division of forestry bodies into forest masters, foresters and forest servants, which existed throughout the Middle Ages. In addition, there were independent forest courts, which were responsible for all forest matters (Hasel 1985, 132 et seq.). With the development of the feudal system[12] in the Middle Ages, the office of forest master was granted as a feud from the twelfth century onwards. Most of the

[12] Feudalism is a social and economic form of the European Middle Ages in which peasant families (the majority of the population) were designated to cultivate land without owning it. This land was owned by a few landlords to whom the peasants were subordinate. The peasants were personally dependent from the landlord and not free.

holders of the office came from noble families. When the feuds began to become hereditary, this often also applied to the posts of forest master (Hasel 1985, 133). The administration of forestry and hunting were separate in the Middle Ages, however, it can be assumed that the lower forestry personnel had both forest protection and hunting protection tasks (Franz 2020, 65).

To ensure the enforcement of forest regulations landlords issued in the fifteenth and sixteenth centuries, landlords employed forest servants in the early modern era (Küster 2003, 131). The two great clearing periods made the rulers aware of the scarcity of wood as a raw material, and thus also of the value of the forest as property, as well as the need for its protection from foreign encroachment and, more essentially later, for organised management. Accordingly, approaches of forest administration increasingly served interests of timber utilisation in addition to hunting interests (Franz 2020, 67 et seq.). In contrast to the medieval foresters, they were no longer feudal holders, but were permanently employed as forestry servants of the sovereign (Hasel 1985, 133; Mantel and Hauff 1990, 166). Posts of forest masters were mainly filled by noblemen who had no forestry training. Foresters and forest servants assisted them in their supervision and management. Their main task was to protect against encroachments and infringements. The foresters' service lands could become hereditary, and often forester posts remained in the same family (Hasel 1985, 133). According to Hasel, the hereditary forester system could have had the advantage that forestry experience was passed on as long as there was no regular training (Hasel 1985, 134).

The forest police appointed by the sovereigns to enforce their forest regulations was initially weak due to a lack of personnel. After forestry officials had been trained throughout the country, the forestry police became more intensive, so that eventually forests not under the sovereign's control were also administered by forestry officers. As a result, all timber use had to be ordered by a sovereign administrative or forestry body. Every timber levy and other forest use had to be approved (Mantel and Hauff 1990, 166).

3.3.4 Effects of Forest Regulations: Conflicts, Conservation and Consciousness

How effective forest regulations actually were is difficult to say (Küster 2019, 93). According to Küster, many forestry regulations from the fifteenth and sixteenth centuries were not very effective because they contradicted each other in parts. By trying to reconcile as many different forest use interests as possible, the landlords could not, did not want to or were not allowed to follow a clear line (Küster 2003, 131). Hasel sees the frequent repetition of logging restrictions in forest regulations between the sixteenth and eighteenth centuries as an indication that they were not always successful (Hasel 1985, 52). And also Radkau states that the history of forestry regulations can also be seen as a history of their transgressions: The enactment of new regulations was often justified by the fact that previous ones were no longer being observed (Radkau 2012, 169). Many forestry officials, however, had no interest in complying with them, because they earned their money by their violations (Radkau 2012, 169).

The regulations led to continuing conflicts with the estates (Radkau 2012, 167; on forest conflicts in general see Williams 2003, 130 et seq.). The later powerful forest police was unpopular and even hated by the population (Mantel and Hauff 1990, 166). In general, the unilateral, power-based seizure of forests by the upper classes at the expense of margravial cooperatives or communities naturally led to conflicts. According to Franz, the land seizure and its disapproval remained in the consciousness of the ordinary population for centuries (Franz 2020, 57, fn. 238). The conflicting interests of landlords and peasants were generally a major problem of forest regulations and fuelled conflicts. If peasant use of the forest did not serve sovereign use, it was forbidden. At the same time, there were no regulations on how the population was to obtain enough wood, so that when there was a shortage of wood, the peasants were the first to suffer (Küster 2003, 166). This also manifested itself in the course of the Peasants' War in 1525, in which peasants demanded in one of twelve articles that the forests be returned to communities, assuring that this would not lead to them being cleared since the deputies elected by the community would watch over logging (Radkau 2012, 171; see also Hasel 1985, 93; Mantel and Hauff 1990, 156; Williams 2003, 175). Whether the restrictions on forest use were a trigger of the Peasants' War or merely included is disputed (contradicting Hasel 1985, 93; Küster 2003, 166).

Due to their rights of use, which the peasants demonstrably exercised for a long time and without hindrance, it was difficult to force the peasants completely out of the forests. According to Roman law, the rights of use had given rise to irrevocable restrictions on ownership, even if they had once been meant as a revocable benefit. The written determination of the rights of use as well as their scope and conditions by the forest owners took place partly in agreement with the entitled persons, partly by sovereign order. Attempts were also made to oust the right holders. In order to counteract the further expansion of forest rights, among other things, rights were reduced, levies were limited to low-grade timber, or a certain period of timber extraction was set. In some cases, entitled persons had to declare their timber requirements annually by species to an authority that decided on the authorisation. Entitlement and utilisation possibilities were often far apart. Forest use rights were often granted free of charge or as compensation for certain services. Consideration could be money or goods in kind (Hasel 1985, 99 et seq.; Mantel and Hauff 1990, 155 et seq.). According to Hasel, "forest use rights were a never-ending source of dispute and litigation through the centuries" (Hasel 1985, 100). It happened that the scope of an entitlement exceeded the possibilities of using the forest, so that the forest owner no longer had a return from it. This called into question the meaning of ownership, which is why the redemption of the rights of use was finally considered (Hasel 1985, 100).

But, apart from compliance, did regulations by the landlords serve the conversation of the forests? That the regulations ultimately led to the protection of the forests is widely accepted among historians, albeit for different reasons. According to Küster, forests would probably have been practically pushed back completely if the nobility had not taken action against it (Küster 2013, 249). Mantel states that as early as the sixteenth century, forestry ordinances which were carried out in particular in the sovereign forests brought numerous positive measures of forest maintenance and sought to ensure the orderly use of the forests (Mantel and Hauff 1990, 165). Moreover, special attention would have also been paid to the reforestation of devastated forests through sowing and planting (Mantel and Hauff 1990, 165). He concludes that the forest police saved the forest from clearing and complete devastation; increasing timber use and land claims would have destroyed the forest, as sufficient measures for regeneration and maintenance were still lacking for a long time (Mantel and Hauff 1990, 166). Hasel sees emerged counterforces at the height of the medieval clearing movement with the aim of preserving the forest as decisive for the future fate of the forest in West Germany; this made it possible to preserve the forest to the extent that seemed necessary to fulfil its functions (Hasel 1985, 82, 52). Against the background of the feared timber shortage, the forestry regulations of the sixteenth century, which also included the felling of trees, the natural and artificial regeneration of the forest and measures for stand maintenance, would have created the transition to ordered forest management (Hasel 1985, 115 et seq.). According to Radkau, intensive forest use does not per se lead to destruction, but can also lead to sustainable management of forests, "but even in Germany with its masses of forest records, it is not easy to find out when and where in forest history one and the other was the case" (Radkau 2012, 19). He states that, under Central and Western European conditions, mere restrictions on use have been usually enough for forests to regenerate and primary hunting interests had at least the effect of severely restricting the economic use of some forest areas so as not to disturb the game (Radkau 2012, 170). Furthermore, European forests would have regenerated not only due to regulations, but also through their transgression and through forest conflicts – e.g., the non-removal of deadwood served their fertilisation, plenter management (see for definition Sect. 3.2.1) and the removal of individual logs as needed instead of felling promoted the natural regeneration of the forest, and poachers enabled the emergence of mixed deciduous forest by reducing increased game populations (Radkau 2012, 170). With forest legislation, both, the authorities and other forest rightsholders, could defend themselves against encroachments from above and different users could fight for forest rights by legal means. As a result, Radkau sees a sharper view of what was happening in the forest developed from mutual reproaches, and the forest awareness that developed from this had practical consequences (Radkau 2012, 219).

3.4 Forests and Forestry: Reforestation and the Cradle of Sustainability

The increasing demand for wood and the resulting heavy use of forests prompted the shortage of wood, whereupon the first forestry measures were initiated. "In simple terms, one can say: The timber shortage gave birth to forestry" (Mantel and Hauff 1990, 322; similar Hasel 1985, 187).

3.4.1 The Beginnings of Forestry and Reforestation

Forests had developed more or less under the indirect influence of humans for a long time (Küster 2003, 188). And for centuries, forests were used without people thinking about their regeneration. In coppice and middle forests, humans induced regrowth for the first time. In high forests, on the other hand, it was left to nature to provide for offspring. However, with increasing forest use and larger felling operations that left large bare areas, natural rejuvenation was no longer sufficient. As people began to cut down whole stands instead of individual trees, it became possible to reforest areas that had become barren land by sowing or planting. This led to a complete change in forest management and its methods with far-reaching consequences: From then on, people were no longer bound to tree species given by nature but could change the tree population in the forest according to societal needs. As a result, not only the forests but also entire landscapes were changed (Hasel 1985, 189 et seq.).

The invention of coniferous wood seeding at the end of the Middle Ages made decisively contributed to the development of forestry. Overexploitation and devastation had degraded forests in densely populated regions, wood became scarce and large wastelands developed, also in the Imperial Forest of Nuremberg. In the fourteenth century, the Nuremberg trading and commercial company Stromer operated iron hammers, mines and smelting works, all of which were wood-intensive activities. These consumed large quantities of pit timber and charcoal, driving up the price of wood. In search of solutions for a sustainable timber supply, Peter Stromer (1310–1388), the main lord of the company, began to research on forest ecology and conducted forest culture experiments. In 1368, he succeeded in sowing fir and pine seeds for the first time. The conifer seeds put an end to the wood shortage in Nuremberg and established the triumph of the pine in the Nuremberg Reichswald, which was decisively strengthened in the early nineteenth century at the expense of the still existing deciduous trees. The art of the fir saw, spread to many other areas in Central Europe, especially in mining regions and in the densely populated areas of the time, which had a great need for wood and charcoal. Throughout the centuries, the doctrine of coniferous sowing was spread mainly through forestry regulations, some of which contained instructions, and contemporary literature (Hasel 1985, 115, 199 et seq.; Bork 2020, 41 et seq.; see also Küster 2003, 129).

The sovereign forest regulations determined forest and forestry management from about 1500 to 1800 and thereby laid the foundation for German forestry through forest conservation and management measures (Mantel and Hauff 1990, 164 et seq.). The transition from occupational interventions in the forest to planned forest management cannot be dated in a universally valid way, however, there were beginnings in the late Middle Ages and increasingly in modern times measures (Mantel and Hauff 1990, 323). Forest maintenance measures appeared early on in densely populated areas; due to the occurrence of local or regional wood shortages, these measures were largely economically motivated and aimed at wood supply (Mantel and Hauff 1990, 323; similar Küster 2003, 129). The main idea of the first forestry measures in the Middle Ages, which were carried out by ecclesiastical and secular lords as well as by cooperatives, was to preserve the forest for the use of wood and for secondary agricultural uses. The efficiency of the forest sought to be maintained above all through careful use and avoidance of harmful uses (Mantel and Hauff 1990, 324). Seeding and planting in forests became the dominant method of forest regeneration. According to Hasel, forms of natural forest regeneration continued to be highly valued, but lost practical importance (Hasel 1985, 189). For a long time, sowing was preferred to planting in the case of coniferous wood; it was not until the second half of the eighteenth century that planting prevailed in the case of pine and spruce, and finally took over in the nineteenth century (Hasel 1985, 200).

The Thirty Years' War was a setback for forestry. Forest regulations around 1650 no longer contained instructions for artificial timber cultivation, the implementation of forest maintenance measures was interrupted and could only be further developed in the eighteenth century (Hasel 1985, 115 et seq.; Mantel and Hauff 1990, 165). Interests of royal hunting determined forest management and forestry, the population was authoritatively patronised by forest regulations (Hasel 1985, 111, 115 et seq.) and forest regulations tried to push back the private use of state forests (Bork 2020, 101). Due to a continuing population growth, the demand for wood had increased. The soaring consumption of wood in some areas made the raw material more expensive, and parts of the population suffered. According to Bork, several German states deliberately brought about a wood shortage debate in order to protect their forest stocks, on the one hand to reduce the waste of wood and on the other hand to reduce the interference with manorial hunting (Bork 2020, 101). The population, and no longer the state, was to ensure that the seemingly scarce wood was used sparingly. Scholarly societies asked price questions about necessary forestry reforms and wood-saving by civically households. As a result, wood-saving stoves were created, household fathers joined wood-saving associations and exchanged ideas with like-minded people, and housewives had to heat, cook and bake with less wood (Bork 2020, 101).

In the eighteenth century, the proportion of forest in the cultivated landscape had declined to a minimum. Although the destruction of forests was counteracted by the state, more and more wood was needed for heating and as building material (Küster 2013, 321). A renewed fear of a shortage of timber and the emergence of rational thinking led to a return to old sources. A new generation of foresters and claimants and personalities close to them "gradually developed a new forestry theory out of the spirit and needs of a new age" (Hasel 1985, 116). The profound changes in forest regulation, forest ownership, forest use, forestry and the timer market were the beginnings of a liberal understanding of forestry. While they were prepared and introduced by philosophical ideas like the enlightenment and rationalism as well as economic academics like Adam Smith and David Ricardo, they were triggered by the French revolution. The goal was to promote free individual forest ownership and forest use. As a result, the strict forest police was disestablished and more liberal forest regulations were issued (Mantel and Hauff 1990, 179 et seq.; see also Agnoletti 2006, 384). A reforestation movement led to forestry regulations that increasingly included provisions for reforestation (Radkau 2012, 170) and forestry administration no longer only supervised the felling of trees, but also tried to control the growth of the forests (Radkau 2018, 35). Nota bene, sovereigns saw in the forest above all an economic value to be preserved. For the forest administration, timber extraction became the real purpose of forestry at an early stage (Küster 2013, 321; Radkau 2018, 36). The forest regulations, however, did not prevent the forest condition from deteriorating further in the course of the eighteenth century (Hasel 1985, 116).

3.4.2 Forestry as the Cradle of Sustainability

"Around 1800, sustainability became a magic word in German forestry; two centuries later it became popular worldwide" (Radkau 2014, 17). Forestry includes forest management which plans both, the current and future use of forest stands. Even though the objectives of forest management are different, the idea of a permanent and thus sustainable performance of the forest is usually in the foreground. The term sustainability has long been used in forestry and has taken various forms in its development and use (Mantel and Hauff 1990, 379). Sometimes the idea of sustainability has even been called the "soul of forestry, with which it stands and falls" (Heske 1931, 1 quoted from Mantel and Hauff 1990, 379) or the "spirit" and "supporting idea" (Baader 1942, 4 et seq. quoted from Mantel and Hauff 1990, 379) of forestry.

In 1713, Hans Carl von Carlowitz (1645–1714) published the first German work solely on forestry, Sylvicultura Oeconomica, in which he called for sustainable forest use. Hasel states that his work represents a promising new beginning after previous experience was largely lost in the 30 Years War (Hasel 1985, 222). Carlowitz was not a forester but worked as a mining chief who, due to the close connection between mining and forestry, supervised forest use (Hasel 1985, 222). His work contained important instructions for a permanently successful, i.e., sustainable, silviculture; a core recommendation is to take from a forest at most the amount of wood that grows back. Today, Sylvicultura Oeconomica is seen by many as the discovery of the principle of sustainability and the beginning of sustainable forestry[13] (Bork 2020, 66 et seq.; Radkau 2018, 161; see also Williams 2003, 205 et seq.).

Mantel describes sustainability in forest politics as a system of ideas, and states that the idea of sustainability has been typical for the objectives of German forestry throughout the history of forestry up to the present (Mantel and Hauff 1990, 379).

[13] In fact, already before Sylvicultura Oeconomica, there were demands for a sustainable use of forests, e.g., in the Reichenhall Forestry Ordinance of 1661: "God created the forests for the salt spring, so that they may continue forever like him; so man should keep it: before the old one is exhausted, the young one has already grown up to hack again" (Bork 2020, 22 f.). Beyond that, there were even forest ordinances that connected a sustainable forest use to a responsibility towards future generations, as forestry regulations from the Oberpfalz of 1565 and the Rheinpfalz of 1572 show, stating that "the subjects should not cut down more of their own forests so that not only they but also their descendants, heirs and children can fulfil their needs to build and heat and always have the same wood" (see Mantel and Hauff 1990, 380).

From the Middle Ages to the nineteenth century, the key principle of sustainability was to meet the local demand for timber. As wood was a basic necessity in the Central European climate for a long time, a year-round supply of wood in approximately equal quantities was fundamental. In the nineteenth century, a form of sustainability was partly advocated in which the production of wood was decisive and thus sustainability was limited to permanent wood production. In this case, the production, not the use and the associated equal supply of wood, was decisive. The sustainability factor is considered to be fulfilled here if regeneration and thus production is ensured (Mantel and Hauff 1990, 380).

3.4.3 The Beginnings of Forest Science and the End of Secondary Uses

Fears of a timber shortage fuelled by overexploitation of the forests led to the demand for planned and expert forest management in the second half of the eighteenth century (Hasel 1985, 187; see also Agnoletti 2006, 384). Because of the realisation that experts were needed to preserve forests, forestry science developed as a teaching discipline under state influence around 1770. Forestry officials received both economic and botanical training at the academies and became civil servants who were now responsible for the forests alongside hunters (Küster 2003, 185 et seq., 2013, 321 et seq.). The principle of sustainability, i.e., one was never allowed to take more wood than would grow back, was taught in forestry training institutions. In order to enforce the principle in practice, it was first necessary to observe forest use as a whole and furthermore to stop the numerous secondary uses of the woody plants (Küster 2013, 322). All other uses of the forest were declared secondary uses or even disqualified as forest degradation, according to Radkau, especially by scientific forestry (Radkau 2012, 36). Replacing the numerous secondary uses in the forests was one of the most important tasks of forestry officials (Küster 2003, 186 et seq.). Küster states that in the end, secondary uses were abandoned because they no longer brought an economic return, e.g., because the establishment of paddock pastures fertilised by mineral fertiliser was cheaper than the use of litter and driving animals into forests, for which shepherds had to be paid (Küster 2003, 187).

The land use area of fixed settlements could only exist if there was always enough wood available. If this was not the case, only two options remained: restrict consumption or change the land use system. According to Küster, this situation introduced a new land use system: “Since consumption is reluctantly abstained from – then as now, by the way – only the introduction of a new land use system came into question, in the context of which forests took on a completely new appearance and meaning” (Küster 2019, 90). The total deforestation of Central Europe could have only be prevented with great effort in the form of a state-controlled landscape change (Küster 2013, 321). Such state intervention was usually justified by the acute crisis in the forests and the threat of a disaster in the timber supply (Radkau 2012, 245). Forests were no longer part of the property of an individual village or a margraviate but became state property or the property of private forest owners or individual farmers. Only in exceptional cases did common forest use remain (Küster 2013, 322). The forestry reforms led to serious conflicts; because they advocated converting previously jointly used land into forests, thus prohibiting any agricultural use of it, foresters were unpopular with the rural population (Küster 2003, 187; Radkau 2012, 250). In the context of the transfer, a separation of land use between agriculture and forestry took place from the eighteenth century onwards, which was not yet completed in the early nineteenth century (Küster 2003, 186 et seq.): It was determined which part of the land, which had been called forest before the introduction of forestry, was now pure pasture and which pure forest. According to Küster, it can be assumed that the designated areas were barren and hardly covered with trees (Küster 2013, 323). The gradual transitions between densely and less densely tree-covered areas had become strict divisions between forest, meadow and field, with boundary lines to be drawn on maps (Küster 2013, 325 et seq.).

The previous overexploitation was thus replaced by sustainable forest management that ensured a balance between logging and regrowth in the eighteenth and nineteenth centuries (Radkau 2018, 245). The active reforestation policy was often accompanied by a conversion of forests to high yielding tree species; since the mid-nineteenth century, new forests have been planted mainly with conifers and coppice forests have been reforested. Coniferous wood was useful wood, it was urgently needed for industry and became more and more a technical goal of forestry. Spruce, identified by forest scientists as the highest-yielding tree, was cultivated in large pure stands (Hasel 1985, 209 et seq.; see also Küster 2013, 323; Radkau 2012, 245; Agnoletti 2006, 384). According to Hasel, many foresters saw the transition to coniferous wood as only a temporary measure and wanted to return to deciduous wood after the depleted forests had recovered. It soon became apparent that a reversal was not possible, partly because the old forest could not supply the quantities and types of wood that the technical age demanded (Hasel 1985, 208 et seq.).

3.4.4 Impacts of (Sustainable) Forestry on Forest Conservation

Forestry gradually and profoundly changed the composition of the forests at the expense of deciduous forests. While the goal of forest conservation and the associated plans began in the eighteenth century, their implementation took decades, so that reforestation had effects on the landscape character in the nineteenth or even twentieth century (Küster 2013, 326). Since the nineteenth century, the proportion of coniferous species in Germany increased considerably, though coniferous species have been advancing since the end of the Middle Ages. Forest areas that were once predominantly deciduous forest became predominantly coniferous forest and fundamentally changed the landscape character (Hasel 1985, 206). Economically, the advance of spruce and pine since the nineteenth century has been a great success. Ecologically, this often means large-scale, more or less even-aged, often uniform and frequently pure coniferous stands on the expense of biodiverse forest ecosystems (Hasel 1985, 210).

Whereas the conversion from deciduous to coniferous forests occurred for the most part actively, the proportion of deciduous forest also grew through indirect human action, e.g., by clearing for settlement and fields that occurred primarily on fertile deciduous forest soil. Where conifers were already, they could more easily re-grow bare areas due to light seeds. This also applied to forests that had become sparse due to grazing or wood-consuming industries. In general, forest growth declined due to the high use by agriculture, trade and industry, and the thinning of the forest grew into great bare areas. These areas could only be reforested by sowing or planting. While degraded areas could be reforested by coniferous seeding since the fifteenth century, artificial planting of deciduous forest was less successful. There were several factors for this. The forest soil had suffered due to previous litter use, so that more demanding deciduous trees did not thrive on it. Thus, there was often no alternative to coniferous wood because the impoverished soils only allowed planting with less demanding woody plants. Moreover, the regeneration of deciduous forest was also not successful due to high game population, which can be traced back to the hunting passion of the sovereigns. With the old forest ecosystems, predators such as bears, wolves and lynxes had also disappeared, so that other game, such as deer, proliferated due to a lack of natural enemies. These and other animals gnaw on young wood, especially shoots with little resin, e.g., fir, beech and maple. Spruce and pine have a higher resin content, so they tend to be spurned. As they were more resistant to browsing, conifers were more suitable for large-scale afforestation (Hasel 1985, 208; Küster 2013, 324 et seq.). After the Thirty Years' War, forests were extensively used for grazing, which had led to a decline in particularly deciduous forest. Furthermore, water management measures, e.g., straightening and canalisation of rivers in the nineteenth century and later, lowered the groundwater level so that the soil became too dry for deciduous forest (Hasel 1985, 208).

Hasel states that only in retrospect did it become apparent that the coniferous forests that had taken the place of devastated deciduous forests were more vulnerable to storms, snow, insects and other pests and thus less resilient. Although the performance of the forests had increased in an economic sense, operational safety eventually decreased (Hasel 1985, 210; similarly Headrick 2020, 384). According to Küster, however, even at the beginning, coniferous reforestation was often criticised, and forest scientists were aware that planting pure coniferous cultures was not ideal (Küster 2013, 324). Radkau, too, points out that coniferous forest has often prevailed behind the back of forestry science under the incentive of short- and medium-term financial interests (Radkau 2012, 247). He adds that reforestation with coniferous forest was also the best means to make peasant forest grazing impossible (Radkau 2012, 247), accordingly, to stop secondary use. Grazing in forests of dense coniferous monocultures is not possible because grasses, herbs and fruit trees such as oaks are missing (Bork 2020, 41 et seq.). Radkau names the forestry professor Johann Jakob Trunk (1745–1802) in this context, a critic of the new foresters who degraded traditional peasant forest uses to secondary uses (Radkau 2012, 246). Trunk criticised that the reduction of the former diversity of uses did not necessarily benefit the ecology of the forest, because most secondary uses – more than clear-cutting or coniferous forest monocultures – had been forest-preserving (Radkau 2012, 246).

Actually, forestry science soon recognised the detrimental effects of pure coniferous forests on forest ecology. As early as 1878, the doctrine of mixed forest was developed by Karl Gayer, who is considered the founder of nature-based silviculture. Hasel states that in fact, development has virtually run counter to the demand for mixed forest and forest segregation has been going on for centuries (Hasel 1985, 210). Bork expresses a similar view; according to him, in the two and a half centuries after the first publication of the Sylvicultura Oeconomica, forestry science and practical silviculture focused on maximising timber yields while taking into account forest performance but neglected ecological aspects (Bork 2020, 67). The transformation of forests into monocultures, mainly of spruce and pine, by the middle of the twentieth century led to several ecological problems: biodiversity declined, calamities and severe storm damage occurred frequently, and conifers acidified the soil. Nevertheless, the forestry concept did not change until environmental awareness grew in the 1970s and a discussion about forest dieback led to a rethink (Bork 2020, 67).

Yet, Hasel and Küster emphasise the positive aspects of the nineteenth century reforestations despite all the ecological problems (Hasel 1985, 210; Küster 2013, 325). Küster states that the reforestations are even the reason why there are still or once again large forests in Central Europe (Küster 2013, 325, 389). The moderating effect of the forest on extremes of climate remained; the forest continued to stabilise the ecological conditions throughout the country, albeit in a heavily modified form (Küster 2013, 325, 389). Mantel summarises the forestry developments of the end of the eighteenth century as follows: On one hand, there are silvicultural and economic successes that created closed and productive high forests from desolate and thinning forest areas. On the other hand, however, the ecological consequences were negative, resulting from the change in wood species and the change from coppice forests to high forests. Mantel describes the conversion into pure spruce forests as a "severe, hardly reparable violation of ecology, landscape protection, plant and animal protection and soil protection" (Mantel and Hauff 1990, 474). Radkau, moreover, criticises a historical self-confidence of institutionalised forestry that is based on the idea that it once acted as a saviour in the face of forest ruin (Radkau 2012, 245). According to him, reforestation was often more a matter of replanting existing forests to achieve higher timber yields and at the same time, the area of woodland actually decreased in some German regions due to the division of common land and the clearing of peasant forests. Seen in this light, he states that the nineteenth century was more an era of deforestation than of reforestation in Europe and worldwide (Radkau 2012, 245). Moreover, the forestry reforms, which were legitimised with the threat of a timber shortage, would have exacerbated the timber shortage of the poor, as they lost their customary rights in the forest (Radkau 2012, 247).

According to Radkau, initially, economic and ecological interests ran parallel to the guiding principle of sustainability: by limiting logging in accordance with the new growth, not only was the forest substance maintained, but also the price of wood at a high level – as long as the wood market was regionally limited. However, as soon as wood could be imported from afar and exported to afar, economy and ecology tended to fall apart (Radkau 2012, 248).

3.4.5 Impacts of Industrialisation, Colonialisation, and Early Globalisation

After all, according to Küster, the reforestations could never have succeeded if it had not been for the Industrial Revolution, through which coal replaced wood as a fuel and new building materials as a construction material (Küster 2013, 326). As a result, the pressure on the timber market decreased and the forestry administrations were able to build the forests according to plan. Furthermore, by importing cotton, areas used as sheep pastures could be reforested, as could the edges of fields that no longer needed to be cultivated due to increased arable yields from mineral fertilisers (Küster 2013, 326). As England was unable to meet the great demand for wood at the beginning of industrialisation by buying wood from Central Europe, it began to import wood from its colonies. In the nineteenth century, deforestation of the tropical rainforest began in the English colony of India, while wood was also imported from North America (Küster 2003, 197). English industrial enterprises established in the colonies produced many products cheaper and in larger quantities than on the European continent. Because precious metals could be mined in larger quantities in other continents, old forest industries such as mining came to a standstill, whereupon wood was no longer needed in Europe to smelt ore. This reduced the demand for charcoal, and glassworks and small paper mills disappeared. Particularly in the regions far from industrial centres where the forestry trade had developed, e.g., the Erzgebirge, there were economic crises, as a result of which many people left their homes. Those who stayed looked for new trades, which gave rise to woodcarving and the making of cuckoo clocks, among other things (Küster 2003, 197; see also Penna 2014, 175).

Already before the Industrial Revolution, wood and wood respectively forest intensive products from colonies were imported. As mining was relocated to colonies, so was deforestation, e.g., in the context of silver mining in Mexico, gold and diamond mining in Brazil (Headrick 2020, 180 et seq.; see also Burke 2009, 42). Deforestation in the context of colonialization took place widely in terms of geographic, product-related and transformational terms (see, among others, Williams 2003, 210; Ross 2019, 275; Headrick 2020, 185). With the surge of imperialism beginning in the late nineteenth and early twentieth century there was a period of unprecedented forest clearing in colonialised areas with a forest loss rate that was four times higher than over the previous 150 years that resulted from "collective effects of commercial growth, transport innovations, and the agricultural settlement" (Ross 2019, 274). Williams assumes that between 1850 and 1920 approx. 152 million hectares of the world's tropical forest were cleared and converted into crops or grassland (Williams 2003, 335). According to Corey Ross, European "imperialism was as significant as industrialisation for transforming the global environment" (Ross 2019, 15). Again, forest use and clearing were connected to power, as they "were a key focal point of colonial attempts to control conquered territories and profit from their natural resources" (Ross 2019, 275).

Radkau explains Germany's pioneering role in forestry – and accompanying originated decisive scientific impulses for reforestations – by the fact that Germany was late in owning colonies and had to make do with its native forest resources (Radkau 2012, 199 et seq., 224 et seq.). Timber traffic and trade expanded worldwide in the nineteenth and twentieth centuries (Mantel and Hauff 1990, 288 et seq.). The amount of imported timber increased 80-fold from the sixteenth to the eighteenth century. Because they had the means to import timber, there are hardly any forest conservation efforts in countries that became colonial powers as in Central Europe. Sustainable forestry was thus less prevalent in countries such as Spain, the Netherlands and England but most prevalent in Central Europe (Radkau 2012, 222 et seq.). Germany, which had been self-sufficient in wood for centuries, became a wood importer from 1864 onwards, timber was imported because the domestic market could no longer meet demand. Since then, Germany's dependence on imports has continued to grow. The demand for timber continued to rise and with it the prices. By the turn of the millennium, one third of Germany's wood supply came from abroad (Hasel 1985, 209; Mantel and Hauff 1990, 288 et seq.). Besides importing wood respectively deforestation to Germany, colonised areas were impacted by German forestry. Facilitated through the structures of European imperialism, the ideas of modern forestry were distributed worldwide during the nineteenth century. To establish centralised forestry systems was a cornerstone of colonial state building; on the one hand, they were essential for economic growth as they provided revenue and raw materials, on the other hand they extended the reach of state power. This resulted in "some of the most extensive apparatuses of resource management to be found anywhere in the world" (Ross 2019, 275) created by foresters in Europe's tropical colonies which encompassed multidimensional and interlinked ecological, social and political transformations (Ross 2019, 275; see also Agnoletti 2006, 385). Mauro Agnoletti points out the German influence on imperial forestry: "It was German foresters, as well as German scientists in many other disciplines, who were subsequently engaged to implement modern forestry in many countries. In addition, students from different countries were sent to Germany and France to study forestry. As other countries gradually set up their own professional forestry education, they drew heavily on translations of German textbooks or the presentation of their ideas" (Agnoletti 2006, 385). Furthermore, German foresters impacted the development of an imperial forestry model in British India that was a major step in the development of imperial forestry. In 1865, the Forest Law that covered most of the country was passed, a Forest Department was set up and as Inspector-General of Forests, German foresters were appointed. The model was applied in many parts of the world, e.g., in the USA, Canada, Australia and New Zealand. Moreover, German foresters influenced American forestry; North America's first professional forester, who was the leading forester from 1876 to 1923, was a German, and it was a German forester who established the first forestry school in the USA in 1898 (Agnoletti 2006, 385; see also Barton 2002, 35, 39, 62 et seq.; Headrick 2020, 264 et seq.).

While temperate forests could stabilise or expand after 1910 or 1945 the latest, tropical and boreal forests shrank, most rapidly after 1960. Next to a slower population growth and less farmland requirement due to yield improvements, the emergence of overseas sources for timber supply stabilised temperate forests. Hence, the "stabilisation of forest are in temperate lands promoted the deforestation in the tropics" (McNeill 2001, 232). And although long after becoming independent from colonialists, there are still colonial-era patterns of intervention form above and afar, in particular in agriculture, forestry and wildlife protection (further on this see Ross 2019, 380 et seq.).

3.5 Forests as a Cultural Asset: Myths, Identity and Ideology in German Forest History

As already seen, ideas and intentions (mentioned as values, and identity as emotional aspect in Chap. 2) shaped the history of forests besides physical human interaction and natural developments. Following Küster, there are many ideas associated with the forest which, although they are not exact sciences, nevertheless influence thinking. Nature – and thus also the forest – is constantly changing. The only things that remain constant, however are the ideas that we associate with the forest (Küster 2019, 7 et seq.). Particularly in Germany, the forest is attributed a cultural significance that has been revived time and again, albeit in different interpretations and with different intentions. In the following, the origin of this special relationship and its impact on forest and human history is illustrated.

3.5.1 The Myth of the Battle of the Teutoburg Forest

A Roman perspective on Germanic forests by the writer Publius Cornelius Tacitus (ca. 55–120) turned out to shape German ideas on forests over centuries – although Tacitus had no personal knowledge of Germanic territories and their inhabitants because he has never been there (Zechner 2016, 17). In the treatise Germania (ca. 98), he described the Germanic landscape – from the point of view of a Roman familiar with the Italian countryside – as "either horrifying by its forests or ghastly by its swamps" (Tacitus 1972; Zechner 2016, 17). Tacitus wrote that the customs of the massively built, light-haired and blue-eyed Germanic peoples had been shaped by the harsh climate and barren environment. Their ethnic purity was justified by the fact that simply no volunteer wanted to move to Germania "with its ugly landscapes, harsh climate, bleak exterior" (Tacitus 1972; see Zechner 2016, 17).

In Annales (ca. 110), Tacitus reported on Roman military campaigns in the north. He justifies the difficulty of pacifying along the Rhine with the natural conditions of the dark forest valleys and forests and swamps with obstructive forest thickets, which would have worked in favour of the Germanic warriors. He briefly mentions the battle in the Teutoburg Forest in the year 9, which was to become a legend (Zechner 2016, 17 et seq.) since it was probably the most catastrophic Roman defeat beside the ones against Hannibal in the Second Punic War (218 to 201) so far. The background to this battle, also called the Battle of Varus, is still disputed today and continues to be investigated. The following statements are taken from the homepage of the museum on the Varus Battle in Kalkriese, that describes the battle as "a military tragedy" (Varusschlacht Museum 2015a). The Romans had conquered provinces in Germania around 7 AD and Publius Quintilius Varus was appointed as vicegerent. In the autumn of 9 AD, Varus was on his way to winter quarters with his troops, the 17th, 18th and 19th legions. In the process, the Cheruscan Arminius, a confidant of Varus, lured the Romans into an ambush. Copying a strategic idea developed by Hannibal in the Battle of Lake trasimeno against the Romans (217), Arminius let the Roman soldiers walk into forest (to force them to walk in single file) where he and Germanic tribes attacked them. Arminius was born as the son of the Germanic Cheruscan chieftain and grew up in Rome, where he received knighthood and became familiar with the strengths and weaknesses of the Roman army. Though he has been warned, Varus trusted Arminius. The battle is said to have taken place at several locations in the Teutoburg Forest and lasted several days. The three Roman legions were almost completely wiped out and Varus took his own life on the battlefield. After that, the legion numbers were never given again (Varusschlacht Museum 2015a). Arminius' victory over the Roman Empire in its golden age was instrumentalised several times in the course of German history. Johannes Zechner describes Tacitus' assessment that Arminius was "indisputably the liberator of Germania" from the world power Rome as "heavy with consequences in terms of the history of ideas" (Zechner 2016, 18).

Tacitus cites the impassable swamp and forest terrain, with which Varus was unfamiliar, as the reason for the defeat (Zechner 2016, 20). According Zechner, a description of wild landscapes and people that was as dramatising as possible had the political function of emphasising one's own bravery in the event of a victory or of excusing it after a defeat (Zechner 2016, 20). Küster, too, states that eerie forests had to be used to give Roman citizens a feeling and a reason why the Romans could hardly gain a military foothold in the land of the Germanic tribes. He also argues that it was not because of the forests that it was difficult for the Romans to extend their civilised territory into the land of the Germanic tribes, but because there was a lack of natural traffic routes on which transport was possible. In the north of Central Europe there was no river on which to advance, and extensive land routes did not yet exist in Roman times (Küster 2019, 100 et seq.). The museum's homepage on the Varus Battle points out that all descriptions and mentions of the Varus Battle and its aftermath trace the events from the Roman perspective. Since the Germanic tribes left no written records, descriptions from a Germanic perspective are missing altogether. Tacitus had not experienced the Varus Battle as a contemporary but reported second-hand and using older descriptions of quite different and no longer verifiable quality (Varusschlacht Museum 2015a; see also Dreyer 2014, 11 et seq., 27 et seq.).

3.5.2 Germans in Search of Identity or: Forest Romanticism

Around the turn to the nineteenth century, Germany became the land of forest romanticism. A connection to the reforestations is "surprisingly difficult to prove" and according to Radkau, "forest romanticism may have been a subliminal reflex from the preceding wave of warnings about destruction of the forest. But what finds clearer expression in it is the idea of infinity" (Radkau 2014, 19). Forest romanticism found its origin in the battle of Teutoburg Forest and drew connections to Arminius' victory over the Romans.

The basis for the glorification of Arminius' victory was the rediscovery and publication of Tacitus' ancient writings around 1500 (Dreyer 2014, 103). Italian authors initially used them to prove Germanic lack of culture. Pro-national German-speaking humanists, on the other hand, increasingly understood Tacitus' descriptions as a history book and identity document. The Germans saw themselves as cultural descendants of the Germanic tribes and retrospectively located their origins in the Hercynian Forest and the Teutoburg Forest.[14] Particularly influential was the work "Germania Generalis" (ca. 1500) by Conrad Celtis (1459–1508), a humanist scholar whose work explicitly complemented and commented on the writings of Tacitus. According to Zechner, Celtis uncritically accepted the vague statements of ancient authors according to which ancient forests had once almost covered Germania and interpreted Tacitus' Germania selectively (Zechner 2016, 19). Nevertheless, Celtis' works were taken up soon after his death and, together with the forest references they contained, shaped consciousness in multiple ways. Zechner points out that the humanists' interpretations of ancient writings were inspired by national politics and ignored the contexts of these (Zechner 2016, 19). Instead, they repeatedly quoted a few short passages suitable for their respective purposes, especially from Tacitus, in order to contrast the less glorious present with an idealised Germanic past. In their uncritical reading of Germania, the humanists had also overlooked the fact that the Roman observers had a different perception of nature, shaped by their far less forested homeland. For this reason, the descriptions by Tacitus, among others, are by no means objective. Trees and forests initially functioned as symbols of the foreign image of Germanicism drawn by Roman ethnographers. Those described in turn took up these prehistoric origins of their people and the forest nature associated with them as a positive view of themselves (Zechner 2016, 19–21). The history of the Germans was equated with the history of the Germanic peoples. Martin Luther (1483–1546), among others, was of the opinion that the name Arminius was a Roman version of a sound-similar Germanic name, and derived the actual name Hermann from it (Dreyer 2014, 103; see also Varusschlacht Museum 2015b).

The figure of Hermann the Cheruscan as the liberator of Germany was taken up by the German poet Friedrich Gottlieb Klopstock (1724–1803), who incorporated it

[14] 'Hercynian Forest' is an ancient collective name for the low mountain ranges north of the Danube and east of the Rhine. The Teutoburg Forest is a low mountain range in Lower Saxony and North Rhine-Westphalia.

into his occupation with questions of identity. He saw Arminius as a republican freedom fighter and a folk hero close to nature. Klopstock used the "patriotically useful heroic figure of the Cheruscan" (Zechner 2016, 22) several times, both in poems and in the stage play "Hermann's Battle". In the play, he used both the diction and the forest references of Tacitus' writings. He also made symbolic use of the oak tree and its leaves, adding a new layer of meaning to the forest image. So, he wrote of tribal warriors "rooted like the oak" and compared the fatherland to the "highest, holiest oak" (quoted from Zechner 2017, 5) He used the symbolic power of oaks in both lyrical and non-lyrical works (see Zechner 2016, 21 et seq.). Radkau sees Klopstock's Hermann trilogy, in which a druid evokes the oaks as the residence of the German gods before the battle, as the "birth of forest romanticism and at the same time of the German National Socialism that was gathering in bundles" (Radkau 2012, 249; similar Küster 2019, 101 et seq.).

While the forest was initially used metaphorically and described, among other things, as a place of refuge with positive connotations, forest texts with explicitly political, military and also nationalistic tendencies developed in the nineteenth century. In doing so, they reflected the search for national identification and the desire for demarcation from other nations (which represent typical aspects of human emotions). The beginning of the nineteenth century was marked by the aftermath of the French Revolution (1789–1799), the end of the Holy Roman Empire of the German Nation in 1806, Napoleon's subsequent occupation policy, and wars of liberation against France (1813–1815). The occupation of Central Europe by the French evoked the desire for freedom and national self-determination. The Germans associated their Germanic past and connections to the forest with this. This was reflected, among other things, in the fact that oak leaves were awarded as a special distinction and oaks were planted on special occasions. On the one hand, the oak was considered a symbol of the German fatherland, and on the other hand, it continued to establish connections to the Battle of Hermann (Küster 2019, 103 et seq.). In the search for a historical and cultural identity clearly distinct from France, German poets, philologists and publicists began to link the nature of the forest with Germanness. With the "German forest" they found a suitable symbol for tradition and continuity, which with principles of subordination and inequality created a counter-image to the values of liberté and egalité that belonged to the social order of the French Revolution. According to Zechner, the wars of liberation can be regarded as the ideological breeding ground of German forest patriotism, in which the thought patterns of national nature and natural nation were momentously combined (Zechner 2017, 5). Furthermore, in 1800 the already existing ideological links between natural forests and national identity were further taken up by Romantic poets, including Joseph von Eichendorff, the Grimm brothers, Ernst Moritz Arendt and Wilhelm Heinrich Riehl – all of whom would have used an image of ideal forest landscapes to construct their own collective identity and distinguish themselves from other nations (Zechner 2016, 125).

The most important and most widely read German author of the nineteenth century was Joseph von Eichendorff (1788–1857), who is considered the "singer of the German forest" among the Romantics (Zechner 2016, 44). In numerous poems and songs, he combined the forest with emotions and metaphors. In search of a national identity, Eichendorff began a play about the battle of the Teutoburg Forst, called "Hermann and Thusnelda" (1811/1812), in which he related the Germanic-Roman conflict to the conflict between Germany and France. 1813 he volunteered to fight against Napoleon (Zechner 2016, 47). Eichendorff created the image of a freedom forest, symbolised in particular by natural German oak trees, which at the same time was intended to symbolise old German virtues such as freedom, loyalty and unity. He used this symbolism in both literary and non-literary texts (Zechner 2016, 60). According to Zechner, Eichendorff abstained from nationalistic ideas (Zechner 2016, 46). Küster, on the other hand, also recognises a patriotic and nationalistic statement in Eichendorff's song "The hunters farewell" (in German: Der Jäger Abschied, 1810): while the first stanza of the song reads "you beautiful forest" (du schöner Wald), the poem concludes with "you German forest" (du deutscher Wald) in the last stanza (Küster 2019, p. 106 et seq.).

During the wars of liberation, in 1812, the first volume of Grimm's Fairy Tales was published, written by the brothers Jacob and Wilhelm Grimm (1785–1853 and 1786–1859), who were philologists and co-founders of German studies. Grimm's most famous work, "Children's and Household Tales" (in German: Kinder- und Hausmärchen, 1812/1815), a collection of fairy tales, were widely read in Germany. In the introduction, Wilhelm Grimm wrote that the "forests in their silence" were the region of origin of the collected cultural heritage (quoted from Zechner 2017, 5 et seq.). Zechner emphasises that the fairy tales must not be understood as an expression of anonymous folk history, but as the result of numerous revisions in content, language and style (Zechner 2016, 93). The fairy tales contain many motifs relating to the forest and the creatures living in it, which were associated with the forest especially in Germany, even with remark to the Teutoburg forest (Zechner 2016, 93). The forest of fairy tales and metaphors, borrowed from Germanic-German tradition, was intended to counter the French occupation with a much more glorious vision of the past. The Grimm brothers also took up the forest in other, scholarly publications (Küster 2019, 106; Zechner 2017, 5 et seq.). For their work "Germans Sagas" (in German: Deutsche Sagen, 1816/1818), they used Tacitus' publications Germania and Annales as an important source basis (Zechner 2016, 90).

According to Radkau, "romanticism and a commitment to protection of the forest are most closely united in the person of Ernst Moritz Arndt, the pioneer of German nationalism" (Radkau 2014, 19). Arndt (1769–1860) was an influential publicist and "one of the prophets of German nationalism" (Radkau 2012, 249). The theology scholar focussed on identity issues, particularly on the demarcation to others. He created enemy images of the French and the Jews and linked natural landscape characteristics with the ethnic-national characteristics of peoples and also linked peoples to the trees of their environment, e.g., Germans with oaks, Scandinavians with spruce, Indians with palms (Zechner 2016, 67 et seq.). Arndt's forest thinking was influenced by Tacitus' Germania, which he understood as a basic historical text, and interpreted the Germans to be the grandchildren of the Germanic tribes (Zechner 2016, 71 et seq.). Moreover, he suspected a conspiratorial fighting alliance of nature and nation, which Hermann would have made use of in the fight against Rome. He thus claimed that in addition to the human community, the natural landscapes would also suffer under foreign occupation (Zechner 2016, 75). Arndt also used climate-related arguments for his view, as he saw the forest areas as the root foundation of the nation and emphasised their importance for the climate and for fertile soils (Radkau 2012, 249; Zechner 2017, 5 et seq.). He called for national forest maintenance and detailed demands for extensive reforestation. In this context, he was critical of capitalism and at the same time hostile to Jews, who he saw as forest-destroying factory owners. His concern, however, was not the preservation of the forest for its own sake, but because he saw it as a guarantee for the preservation of the national collective (Zechner 2016, 80). In order to preserve the nation and protect it from social change, he said, it was necessary to defend the nation's roots against clear-cutting. In doing so, Arndt glorified the national collective and created a metaphorical fear that the axe in the forest would "often become an axe laid to the whole people" (Radkau 2012, 249; Zechner 2016, 81, 2017, 6). Arndt passed on his ideas to his student Wilhelm Heinrich Riehl (1823–1897), among others, who wrote in his multi-volume magnum opus "Natural History of the People" (in German: Naturgeschichte des Volkes) "we must preserve the forest (...) so that Germany remains German" cited from (Zechner 2017, 6) and created a demarcation to the English park and French field (Zechner 2017, 6). According to Radkau, Riehl viewed the new forestry zeal from the nineteenth century onwards with mixed feelings, as he associated the forest with wilderness and freedom, in which Germans were allowed to cast off the constraints of civilisation (Radkau 2012, 249).

In addition to writers, artists also took up the forest symbolism. The painting "The Chasseur in the Forest" (in German: Der Chasseur im Walde, 1814) by Caspar David Friedrich (1774–1840), for example, was created in 1814 after the Battle of the Nations in Leipzig and shows a defeated French soldier dragging his sabre behind him through a snow-covered forest. The forest consists of spruce trees of the same age, so it is an artificially created forest. This is to show an image of a densely planted forest in which Frenchmen lost their way (Küster 2019, 106 et seq.).

3.5.3 "Eternal Forest – Eternal People": Forest Ideology of German National Socialists

In 1923, the German Forest Association – Association for the Weaponry and Consecration of the Forest (in German: Deutscher Wald e.V. – Bund zur Wehr und Weihe des Waldes) was founded, which moved the creation of identity through the German forest into the radical nationalist spectrum. Even before the Nazis came to power, racist and anti-Semitic thought was given to the German forest and enemies of the forest and the people were defined at the same time, especially the French and the Jews (Zechner 2017, 6).

The Nazis recognised the propagandistic potential of forest images early on and used already existing forest images. The German forest became a projection surface for right-wing values that were critical of modernity, nationalistic, racist and biologistic. In this context, the forest represented the Germanic origin of the German people and their homeland, as well as the pagan sanctuary and a racial source of power. The forest was also used as a model for social order and as an educator for community and was supposed to be a counter-image to progress and urbanisation. In his speech "Eternal Forest – Eternal People", Hermann Göring (1893–1946), Chief Officer for Hunting and for Forestry (Reichsforstmeister and Reichsjägermeister) and Commissioner for Nature Conservation Chief Officer for Hunting and Forestry and Commissioner for Nature Conservation, spoke of National Socialism as the ideological underpinning of forestry. He also claimed that there was a close relationship between the forest and the Germans, which he contrasted with an anti-Semitic image of Jews who were supposedly far from trees (Zechner 2017, 7). In general, the Nazis repeatedly made connections between the land and its people, creating contrasts between the Germans as a forest people and the Slavic steppe people or the Jewish desert people (Zechner 2016, 134 et seq., 191, 176, 2017, 7). The "German oak" is the symbolic tree species of the Nazis, to which they attribute loyalty, hardness and strength (Bork 2020, 165).

In 1936, the Nazi cultural community released the film "Eternal Forest", which restaged Germanic-German history. The message of the film was: forest destruction also means the destruction of the people – reforestation means collective rebirth. In the film, the Battle of Herman is portrayed as a battle to defend the sacred groves against Rome. The natural order is even declared to be the model for social construction, because those who live according to the laws of the forest will recover from the essence of the forest and be eternal (Zechner 2016, 187; see also Radkau 2003, 47).

Forest propaganda was used to legitimise and enforce the goals of various projects. For example, the traffic planners of the Reichsautobahn in the forest attributed an aesthetic-ideal role to trees "as the green frame of Adolf Hilter's roads" (cited from Zechner 2016, 176). Meanwhile, the forests at the edge of motorways had the function of visual protection against enemy attacks (Küster 2003, 218 et seq.). Conversely, the Nazis destroyed 20 million hectares of forest in occupied regions of the Soviet Union, partly to divest hiding areas (Headrick 2020, 290). The reclamation of Polish territories for the German people through the "eastward expansion" was another Nazi project linked to the forest, as the forestation of the territories was seen as an indispensable precondition for the settlement of the German population. The goal of a planned reforestation of one million hectares of forest was to achieve a degree of forestation of 30% like in the rest of the Reich. In preparation for the afforestation, hundreds of thousands of previously resident Poles were deported, which was justified by the planners of the deportations with the claim that people who were not of German spirit and blood would destroy forests as planned (Zechner 2016, 176 et seq., 191, 2017, 7 et seq.). Another forest-related genocide took place in Białowieża[15], where Göring, who was an enthusiastic hunter, personally pushed for the creation of a Reich hunting area. The area came under German control after

[15] The district was already the seat of the German Military Forestry Administration during the First World War, see Zechner 2016, 177. On current risks for the forest, see Sect. 5.3.3.

an attack on the Soviet Union in the summer of 1941, whereupon large parts of the population living there were shot or deported and most of the settlements were destroyed – on the basis of arguments of nature conservation (Zechner 2016, 177). Zechner states that the Nazis used forest arguments as an additional justification for genocide, whereby National Socialist forest thinking can be traced back to, among other things, the literary texts from the Romantic period (Zechner 2016, 191, 2017, 7 et seq.; see also McNeill 2001, 329).

Because the majority of people did not come to terms with the past, less charged ideological motives were able to continue to have an effect after the Second World War, even after the change of political system. In 1947, e.g., the German Forest Protection Association (in German: Schutzgemeinschaft Deutscher Wald) was founded – primarily as a reaction to the reparation blows of the Allies – that declared German forest thinkers and poets such as von Eichendorff, the Brothers Grimm, Arndt and Riehl to be crown witnesses for a more forest-minded attitude. The idea of a special relationship between the forest and the people lived on here, e.g., in 1949, in the anthology "The Forest Calls Us" (in German: Uns ruft der Wald), it was claimed that the Germans had been a forest people from time immemorial and remained so in their innermost being. Until the 1960s, such references existed, but then they were increasingly questioned by new political environmental movements (Zechner 2017, 9).

In the 1980s, when there were fears of a forest dieback in Germany (Sect. 3.6.3), it was again referred strongly to forest images from poems and fairy tales as well as to a specifically German forest relationship. In general, since the 1970s, an increasing mental and actual distance to the forest can be observed, especially among younger people and city dwellers; only a part of the population continues to understand the tree world as culturally formative and tradition-building. According to Zechner, explicit identity-forming references outside the extreme right-wing political spectrum no longer play a role (Zechner 2017, 9).

3.5.4 Effects of Ideological Ideas on the Forest

The history of ideas on the German forest is essentially a pattern of thought founded by Romanticism around 1800, which became increasingly radicalised until 1945. However, the references to the forest were guided by respective interests that usually took little account of the original historical contexts. Zechner states that the German forest depicted had less and less to do with the monocultural real forest growing over a wide area (Zechner 2017, 10). In fact, already during the emergence of forest-romantic thinking at the beginning of the nineteenth century, there was a contrast between the imagined deciduous forest wilderness and actual forestry development, in which economic efficiency and the statistical ascertainability of coniferous plantations predominated (Zechner 2017, 10). According to Radkau, too, "there is no clear connection (…) between afforestation and forest romanticism" (Radkau 2014, 20). The popular forest romanticism created by the poets contrasted with the forest that foresters strived for from 1800 onwards with a view to high timber yields. The favourite tree of forest romanticism, the free-standing, old, gnarled oak with spreading branches, corresponded less to the new forest created by foresters than to the old peasant pasture woodland (Radkau 2012, 248 et seq.).

When forests began to be artificially created in Germany in the eighteenth and nineteenth centuries, one of the reasons given was that Germany had always been a land of forests. It was referred to the Germania by Tacitus, also Carlowitz spoke of rebuilding the dense forests of Germania. Tacitus' expression of the eerie forests when looking at the vast expanse of Germania's tree population stimulated the imagination of many people but did not create objectivity. However, Küster states that it became the basis of an idea to prevent civilisation in Central Europe from leading to a similar destruction of forests as had presumably taken place in the Mediterranean in antiquity (Küster 2019, 99 et seq.). According to him, at the time of the reforms, facts about the economic necessity of having wood for economic sectors and the associated livelihoods of many people in the future were not enough to make the public understand why forests were needed (Küster 2019, 101). The poets, however, would have managed this better with the ideas about the German forest that had a greater impact than mere facts – even if these were not based on objective truths (Küster 2019, 101).

Küster also states that the principle of sustainable forest management was suspended during the Third Reich (Küster 2003, 231). In all the forest propaganda, armament and war interests had absolute priority over nature conservation (Radkau 2003, 49, 2014, 59 et seq.). Though the Nazi-Regime enacted forest protection laws, like the Reich Law against Forest Devastation (in German: Reichswaldverwüstungsgesetz) in January 1934 and in December the Forest Species Law (in German: Forstliches Artgesetz) against the introduction of non-native species, and they planted Hitler trees and swastika forests, the forest protection was more propagandistic than real. Rather, trees were cut down en masse for rearmament and war preparations during the Second World War (Bork 2020, 165; see also Headrick 2020, 445). Due to the protracted course of the war, ultimately only about 7000 hectares of forest were afforested in the East (Zechner 2016, 177). Overall, Zechner concludes that the patterns of thinking about the German forest were largely removed from reality; like this, they allowed the poetic evocation of a romantic landscape of desire and also the political justification of the Nazi practice of domination (Zechner 2017, 10). As soon as influential actors used it as a projection surface for social or political goals, the natural ideal of the German forest took on historical relevance (Zechner 2017, 10).

3.6 Forest Ideas Today: Multifunctional Solution for Multiple Crises?

In the following, today's ideas on forests and their functions are depicted. Under new circumstances – in especial regarding emerging environmental crises – new ideas to forests develop, some are maintained, and others are going back to the roots – confirming Radkau in his statement that “the history of man’s relationship with the wood [is] a story without end” (Radkau 2018, 29).

3.6.1 State, Ownership and Multifunctional Use of Forests Today

Overall, the trend of deforestation beginning after the last ice age further continues, albeit the average rate of net forest loss declines and differs locally; while forest cover in the European Union increased by almost 10% (approximately 11 million hectares) from 1990 to 2020 (European Parliament 2021), regions like South America and Africa lost 4 respectively 3.4 million hectares from 2000 to 2010 per year (FAO 2010, xvi; see Sect. 4.1.2). Only 4% of forested area in the EU has not been modified by human intervention (European Parliament 2021), and while there is in total 0.7% of primary forest left in the EU, there is nearly none in the former forest land Germany (Sabatini et al. 2018, 2021). Germany’s forest cover was 32% in 2011/2012[16] (BMEL 2014). However, the condition of German forests is deteriorating due to climate change: In 2020, due to an ongoing drought since 2018, storms and pest infestations, only 21% of trees were left without crown thinning, and more trees have died than ever before (BMEL 2020a; for tree mortality and thinning beyond Germany see Sect. 4.1.2).

In the EU, most of forested land (approx. 60%) is privately owned, the remaining forests are publicly owned (European Parliament 2021). Likewise, in Germany nearly a half (48%) is private forest which is predominantly small-structured and fragmented. Almost a third (29%) is owned by federal states and 19% by entities like cities, and 4% by the state. It is estimated that there are over 2 million corporate and private forest owners in Germany. The diversity of forest owners results in different forest management objectives, which in turn lead to differences in the forests’ tree composition, timber stock or use (BMEL 2014, 9).

As forests are used to fulfil a variety of demands (Chap. 1), they are referred to as multifunctional. For the European Parliament, forest multifunctionality comprises an environmental, social and economic role of forests. The environmental role of forests means their provision of numerous ecosystem services (soil protection, water purification, climate regulation, biodiversity protection). Their socioeconomic role embraces the provision of resources, particularly timber. Timber is mainly used to generate energy (42%) and wood accounts for about half of the renewable energy supply. Nearly a quarter of the timber volume (24%) is used for sawmills, 17% for paper and 12% for the panel industry (European Parliament 2021). In addition to timber, forests provide non-wood products like food, cork, resins and oils. Beyond such products, there are specific forest services like hunting, tourism or recreation by forests (European Parliament 2021). The German Federal Forest Act (Law on the Conservation of Forests and the Promotion of Forestry,

[16] The forest cover was investigated during the federal forest inventory (Bundeswaldinventur) that is conducted every 10 years. The next, fourth federal forest inventory started on 01 April 2021 and collects data until the end of December 2022.

BWaldG)[17] determines three forest functions: Utility function, recreational function and protective function. Utility function means economic benefit, protective function stresses particularly "the long-term efficiency of the natural balance, the climate, the water balance, the maintenance of air purity, soil fertility, the landscape, the agricultural and infrastructure" in Art. 1 para. 1 BWaldG.

Among direct degradation and deforestation, forests are increasingly impacted through human-induced environmental changes like global warming and biodiversity loss (see Sect. 4.1.2). However, they are not only to be protected from these but are also regarded as protectors from them; today, ideas attributed to forests and their use are increasingly coined by attributing them value as (partial) solutions for multiple current crises. As so-called nature-based solutions, forests are seen as climate change mitigators, preservers and promotors of biodiversity and providers of health protection (see Sect. 4.1.1). Their carbon capacity makes forests interesting for several climate change mitigation approaches, for instance including the forests' carbon storage in accountings for net-zero targets, planting trees in order to offset emissions or curbing wood production to store more carbon in trees (on the potential of forests to be carbon sinks see Sect. 4.2.1). Wooden products are seen as replacement for former fossil-based products that do not only not emit but store carbon, e.g., as wooden commodities like furniture but also as building material.[18] Beyond that, wood is also considered as a sustainable resource in bioeconomy[19], as well as a renewable resource in form of biomass for heating (see Sect. 4.1.1 for raw material uses, Sect. 5.3.5 for the EU Renewable Energy Directive and Sect. 6.3 for the EU Taxonomy for sustainable activities). An already ongoing expansion of wood markets in Europe is linked to an increased rate of forest harvest since 2015, affecting negatively ecosystem services and climate mitigation measures (Ceccherini et al. 2020; see also Sect. 4.2.2).

[17] Gesetz zur Erhaltung des Waldes und zur Förderung der Forstwirtschaft (Bundeswaldgesetz) of 2 May 1975 (BGBl. I S. 1037), as last amended by Article 4 of the Act of 09/06/2021 (BGBl. I S. 1730).

[18] In the EU, the 'New Bauhaus' was launched, an initiative for a sustainable way of designing and building the future (EU 2021) which promotes the use of wood for building and lead to the launch of the Wood Alliance for the New European Bauhaus (Wood4Bauhaus) by the European wood-based sector (wood4bauhaus 2021). In Germany, there are also competitions held for timber buildings (BMEL 2020b).

[19] Bioeconomy is a concept for a sustainable and circular economy that is not commonly defined yet, but to date means "the production, utilization and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions (information, products, processes and services) within and across all economic sectors and enable a transformation to a sustainable economy" (IACGB 2020, 9).

3.6.2 Multifunctionality vs. Conservation? Forests Between Solution and Protection

Forestry (and forest policy) in Central Europe emphasises the multifunctionality of forests and promotes to operate as multi-purpose forestry which combines the production of timber with the supply of further forest ecosystem services (Ammer and Puettmann 2009; Hanewinkel 2011; Simons et al. 2021; BMELV 2011, 5). Despite it lacks a clear definition, the term multifunctionality introduced by the German forest scientist Viktor Dietrich in 1953 highly influenced the development of German forest policy (Hanewinkel 2011; Benz et al. 2020). A definition that considers changing temporal and spatial interests is provided by Wiggering et al. stating that multifunctionality addresses "environmental and economic services as long as society expresses a demand for them" (Wiggering et al. 2006).

There are actually two ideas how to realise multiple demands on and therefore the multifunctionality of forests: One is to separate forest areas and use different parts for different demands, as not all interests can or should not be fulfilled in the same area (segregation), the other is to prioritise spatially or temporally interests over others (integration) (Benz et al. 2020). Within the framework of the multifunctionality of forests, other functions next to climate and biodiversity services may be promoted and equalised. The German Government, for instance, introduced a Forest Climate Fund to support the German Forestry which suffers from high amounts of damaged timber because of the climate-related forest crisis. The fund aims to preserve and expand the carbon storage potential of forests and wood and to adapt forests to climate change. In doing so, they explicitly adopted climate and biodiversity protection as an additional function next to already existing functions: "The contribution of forests and wood to climate protection shall be further expanded, taking into account all forest functions, including the preservation of biodiversity, within the framework of sustainable, proper forestry management" (BMEL 2021). Furthermore, sustainable forestry is considered as contributing positively to climate protection and the use of wood is seen as active climate protection as well (BMEL 2021; Bundesanzeiger 2021).

However, the concept of multifunctionality is lively debated, in particular since the ongoing climate and biodiversity crises bring protective forest functions further into the foreground. Questionable is, among others, if all forest functions can be equally maintained, how functions can be practically maintained, and what consequences for the forest ecosystem are. While the organisation of sustainable multifunctional forest management is in itself complicated, "climate change is (…) not making it any easier" (Benz et al. 2020, 12). A recent study of Simons et al. that investigated the multifunctionality of 150 forest plots in Germany showed that there is no single forest type that can provide all ecosystem services equally; hence forest multifunctionality is limited and there are trade-offs between different services (Simons et al. 2021). The computability of multifunctionality and intensive forestry is in general questioned respectively negated (Borchers 2010; Pohjanmies et al. 2021). Moreover, the subjective component of the concept of multifunctionality is criticised, as individual forest functions – except the utility function – can be rarely quantified and connected with clear targets, whereas ultimately the individual would define what is meant by it (Hanewinkel 2011). Similarly, forest scientist Michael Suda states: “The forest does not have any functions. Different interests exist in the forest. Forests can be functionalised by these interest groups” (Suda 2005).

A more concrete concept is seen in the definition of ecosystem services which enables a valuation of private and public goods (Hanewinkel 2011; Benz et al. 2020). Indeed, there are efforts to calculate and reward ecosystem services to forest owners. The German Bundestag adopted a corresponding motion (19/28789) for financial remuneration of ecosystem services on 22/04/2021 (Schmid 2021; for an approach to calculate ecosystem services see Hampicke and Schäfer 2021; for the economic and financial inclusion of nature and the value of biodiversity, see Dasgupta 2021). For Germany, a financial reward is also considered in the federal government’s forest strategy 2050 which is not published yet. Environmental protection organisations criticise the draft that rewards ecosystem services without linking them to minimum ecological standards (DNR 2021).

In Germany, the multifunctionality debate was fuelled by a decision of the Federal Constitutional Court on the Climate Protection Act (German Federal Constitutional Court, Order of 24/03/2021, 1 BvR 2656/18 et al.; on this also Ekardt 2021) and the actualised version of it. The law contains in Art. 3a of the German Climate Protection Law (KSG)[20] targets for the conservation and expansion of so-called natural sinks such as forests and peatlands which is sought to be achieved by, among other things, protecting and restoring the capabilities of forests to sequester carbon dioxide and store carbon. Interest groups, but also the Scientific Advisory Council for Forest Policy at the Federal Ministry of Food and Agriculture, criticised the preceding draft law for not taking into account the forests’ multifunctionality. They feared a set-aside of forest areas respectively massive restrictions or bans on the use of forestry and agricultural land that would lead to geographical shifting effects to other regions, and additionally argue that active forest management and wood use are active climate protection (DBV et al. 2021; DFWR 2021a, b; critically to non-use of forest and wood see WBW beim BMEL 2021). Similar concerns were expressed in advance to the post 2020 EU forest strategy (Sect. 5.2.1), among others by Swedish Forest Industries who appealed to “respect the multifunctionality of forests” (SFIF 2021; see also DFWR 2021c).

3.6.3 Ideas and Action by the Private Sector, Academics and Civil Society

Forest protection respectively deforestation is an issue beyond merely political concerns. Among political agents, companies, especially those who operate transnational, influence deforestation and forest degradation with being involved in global supply chains respectively being their initiators. Acknowledging this

[20] Bundes-Klimaschutzgesetz (KSG) from 12.12.2019 (BGBl. I S. 2513), amended by Article 1 of the Act from 18.08.2021 (BGBl. I S. 3905).

connection – also under pressure from civil society and consumers – initiatives by and with the private sector addressing forest protection in global supply chains were founded. As deforestation takes primarily place in agricultural expansion (see Sect. 4.1.2), primarily agricultural commodities supply chains have a potential to improve the state of the forests. For instance, Germany initiated private sector initiative like the Forum for Sustainable Palm Oil (FONAP) (FONAP 2021) or the Sustainable Cocoa Forum (GISCO 2021).

In addition to commitments of politics (see in detail Chap. 5) and the private sector, there is a strong interest in the fate of forests of civil society that concerns tropical as well as domestic forest. Nowadays, being aware of impacts of globalisation, the public interest in and civil society's efforts on forest protection exceed national boundaries. In case of the MERCOSUR trade agreement, an international alliance of 450 organisations mobilised protests against the free trade agreement because of deforestation concerns (Wiemann 2021). Moreover, academics increasingly involve in (forest) politics, e.g., through initiatives like Scientists for Future but also with reacting to policy plans and industry statements. In advance to the updated Renewable Energy Directive (Sect. 5.2.3), 772 scientists expressed their concerns about wood to be further regarded as renewable energy and called for an end of subsidising forest use as biomass in an open letter addressed to EU politicians regarding the updated (Beddington et al. 2018). In July 2021, as a response to critique on the new EU Forest Strategy (Sect. 5.2.1) by the Swedish Forestry Industry and others, 62 forest scientists expressed their support for the strategy, having assessed the critique on which they "fundamentally disagree" (Global Scientists 2021).

For Germany, the public interest in forest protection in modern times showed up first in the early eighties, when acid rain was suspected to cause a forest dieback that sparked protests among the German society which in turn led to new environmental policies and laws (Bork 2020, 84, 232 et seq.; see also Radkau 2003, 167 et seq.; Küster 2003, 229 et seq.). A renewed growing commitment to forest protection emerged in 2018, when the remaining Hambach Forest in Western Germany was to be cleared for open-cast lignite mining. A broad alliance of civil society organisations, forest occupiers and citizens on the ground as well as in the whole country protested to preserve the forest for months. Ultimately, the clearing of the forest was stopped by the courts and later on also politically agreed. Meanwhile, there was much criticism on political decisions to evict tree houses of occupiers, police harshness against environmental activists and a fatal accident of a journalist in the forest. The "Hambi", however, has since become a symbol for the energy transition (Bork 2020, 289 et seq.; see also Schneider and Morra 2018). Another forest occupation was less successful: in 2020, activists occupied the Dannenröder forest ("Danni"), which was being cleared for an autobahn (Kirsch 2020). Recently, also a monocultural forest ("Moni") was occupied to protect it from clearing in favour of the expansion of another autobahn. The activists know that the monoculture has a lower ecologic value, but state that "monoculture is still better than autoculture" and "in these times, we should have realised long ago that every tree counts" (Schipkowski 2021). The fear of wood shortage seems to have become a fear of forest shortage.

3.7 Interim Conclusion

Then and now, various motivational factors determine(d) human interaction with forests and impacted their dispersal, condition and composition. With land-use change, in particular permanent settlement, the use of forests steadily increased and led to forest degradation and pushbacks that were regularly overcome by declines in human population. With increasing forest and wood use there were times of constant forest overuse and for centuries people, e.g., in Central Europe lived with fears of timber shortage. This fear was closely connected to existential threats, and ambitions of people to overcome these shortages were diverse; they issued regulations, invented new methods and technologies, replaced factories and resources. Already then, shifting and rebound effects and also scapegoating occurred (as a typical human emotion referred to in Chap. 2). The shortage of wood and forests in combination with its existential importance led to aspirations to a sustainable use that guarantees a constant supply respectively production.

Overall, especially developments of human population and land use had great effects on forests. The changes that shape forests took place in different speed. Sometimes, forest ecosystems were not affected for thousands of years, e.g., during the time after the last ice age. Sometimes there were sudden and far-reaching changes in human culture leading to profound impacts on forests and their use, e.g., due to the Neolithic Revolution or the land reforms of the eighteenth century. In addition to time, also space is a relevant factor in forest history, as for instance the forest ordinances from the fifteenth century onwards led to a harmonisation of forest regulations and use and already prepared the preference of conifers. With globalisation and proliferation of technology, the human induced pressure on forests suddenly relieved, and the replacement of coal also took fears of wood shortage from the people. However, the indirect consequences of fossil fuels (construction of traffic routes, larger residential areas, and industrialisation) and animal husbandry have nevertheless caused forests to continue to shrink worldwide in recent decades. Phasing-out fossil fuels and reducing livestock farming could therefore increase the potential for a growing substantial use of wood instead of fossil-based products.

History emphasises the impact ideas on forest and societies can have, especially when they spread regionally or even globally. Today, ideas spread not only regional but global, and can change fast as well. This contrasts with the natural feature of forests to grow slow. While forest growth and regeneration take its time, forest destruction can happen fast. This again illustrates the origin of sustainability in forestry. But as forest history shows, the peak of clearing movements can also be their end, especially in combination with introducing a new land use system.

Until wood was replaced with coal, trade-offs in forest use were ubiquitous. For today, changing priorities in forest use and forestry seem necessary, meaning to focus on forest ecosystem services that mitigate climate change and biodiversity loss – which may in turn mean to align the sustainability approach of forestry to ecosystem maintenance, and limit the forests' multifunctionality at the expense of current wood use and production. Ultimately, the (preferred) use of forests is and will be guided by human ideas and interests that entail interventions, regulations – and ecological consequences.

The dependence of human existence and development on forests over the centuries seems to be a surprising finding on a first sight, but history shows that this dependence rather serves as a rule than illustrating an exception. Citing Radkau, "from the beginning until today, forest history cannot be understood from the forest alone, but has always been and is inextricably linked with the entire human history" (Radkau 2012, 30). The urgent need for intact ecosystems for climate, biodiversity and health protection shows that this is based on reciprocity: not only forest history is linked to human history, but human history linked to forest history as well.

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4 Potential and Limits of Forest Ecosystems on Climate and Biodiversity Protection and Implications for the Legislative Process

Abstract

Our analysis shows that the preservation of intact forest ecosystems is indispensable to protect climate and biodiversity in the long term, and the health and well-being of humanity. Despite this, the destruction of the last intact ecosystems (especially primary and old-growth forests) is increasing at rapid pace. This applies particularly to tropical forests but also to the last European primeval forests. The cause lies in humankind's gigantic hunger for resources, whether it be woody biomass or arable land to produce beef, feedstuffs such as soya, palm oil, rubber, etc. The transition to a post-fossil society and the partial replacement of fossil fuels with woody biomass is further pushing this development and therefore requires appropriate legal containment to finally achieve sustainable resource and forest management. Apart from that, demand-sight mitigation measures that steer consumption patterns (particularly but not only) in the western world, i.e. meat and biomass consumption, alongside frugality strategies are highly necessary.

At the same time, the book critically reviewed the potentials of afforestation and reforestation for climate mitigation, which is often presented as the new saviour to fulfil the commitments of the Paris Agreement and to reach climate neutrality in the future. It became clear that ultimately only biodiverse and thus resilient forests can function as a C sink in the long term (!). However, in the short term, the C storage capacity of newly planted forests is almost negligible and very small. In fact, due to necessary interventions in the soil, young forests are frequently a source of CO_2 and do not function as a sink. Potential trade-offs with regard to food security, biodiversity protection, e.g. of species-rich grasslands and wetlands, and the total amount of land available also come into play. In addition, existing forests worldwide are currently reducing their original sink

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capacity and release more CO_2 into the atmosphere. This is because of changing environmental conditions such as long dry seasons often coupled with unsustainable forest management. Overall, the expected future sink capacity of newly planted or existing forests is therefore often overestimated.

Nevertheless, monitoring and measuring GHG fluxes in forest ecosystems as accurately as possible is a necessary prerequisite for policy approaches (see Chap. 5). It became clear that this is very challenging. To date, it is hardly possible to achieve an accurate measurement of GHG fluxes in forest ecosystems and to monitor the development of forest ecosystems in a globally comprehensive and accurate manner. The problem of depicting is comparatively large in forest ecosystems as they are influenced by multiple factors. Efforts to reduce the problem of depicting as best as possible are therefore necessary. However, the problem will always remain to a certain extent which in turn has to be considered when developing policy instruments.

In this chapter, the importance of forests in the climate – and biodiversity – discourse is discussed on the basis of natural scientific data, which is essential for the development of effective policy instruments. Therefore, the forests' potential to function as a nature-based solution to mitigate the climate and biodiversity crises is investigated. Firstly, it is outlined why forest ecosystems are essential for the stability of the global climate and biological diversity in general, and which factors are driving their degradation and destruction. Secondly, their emission saving potential is pointed out in more detail taking into consideration afforestation and reforestation.

4.1 The Importance of and Risks for Existing Forest Ecosystems

This section explains firstly why forest ecosystems are important for the planet and humanity and how they can be categorised. Thereupon, it identifies risks, respectively drivers of forest loss and forest degradation.

4.1.1 Importance of the World's Forest Ecosystems

Today, forests cover approximately 31% of the world's terrestrial surface, whereby 49% are evaluated as relatively intact and 9% are fragmented, showing little or no connectivity (FAO and UNEP 2020, xvi). Forests provide manifold services to nature, humankind and the economy. First of all, they function as an essential basis of life on earth, providing numerous ecosystem services. Water and soil protection are important to name in this respect, next to the purification of air. They purify the air, prevent soil erosion, regulate water flows and serve as huge water storages, which they are also able to purify (Eikermann 2015; Brockerhoff et al. 2017). They can be distinguished from forest-free areas by higher humidity, lower temperature fluctuation and wind protection (Brockerhoff et al. 2017). Concerning the economy, forests deliver wood as a raw material, e.g., as fuelwood and for innumerable manufacturing processes (industrial wood, but also non-wood products such as bioplastics) and therefore play a major role in the transition to a post-fossil society. At the same time, their social functions: recreation and ecotourism, next to spiritual, cultural and heritage values, continue to play a significant role (Eikermann 2015, 15 et seq., 2018, 416). As they store about 45% of all terrestrial carbon (Bonan 2008; Zhao et al. 2019), forests are potential carbon sinks that help to mitigate the climate crisis. In addition, forests accommodate 80% of global biodiversity (IPBES 2019; European Commission 2019) and play a key role in protecting biological diversity. In the context of their importance for biodiversity, intact forest ecosystems are essential to prevent health risks such as pandemics whose major global driver is land-use change (IPBES 2020, 6; UNEP and ILRI 2020, 16 et seq.).

As nature-based solutions, forest ecosystems provide different values to biodiversity and climate protection depending on their state or type of re-growth (monocultural or species-rich, site-adapted, natural forests). This is why a further definition and possible classification of forest ecosystems appears valuable. According to the Food and Agriculture Organisation (FAO), forests are defined as an area of at least 0.5 hectares covered with trees that are higher than 5 meters or are able to reach this height in situ, and a canopy cover of more than 10% (FAO 2018, 4). The absence of other predominant land use such as agriculture or settlements is crucial. Fruit or oil palm plantations, olive chards or most agroforestry systems are thus not considered as forests according to the FAO definition. However, according to this definition nothing is said concerning the state and the provided ecosystem functions (FAO 2018, 4). Therefore, it is useful to classify forests further, e.g., into primary, secondary or old-growth forests. Primary forests have never been logged but might be used by indigenous communities that contribute to their diversity and protection (CBD 2006). They are characterised by their capacity to naturally regenerate, native tree species and functioning ecological processes without significant human influence. They account for 34% of the world's forests (FAO and UNEP 2020, xvi). Secondary forests have recovered either artificially or naturally after being logged (CBD 2006). Definitions of old-growth forests are ambiguous (Wirth et al. 2009). Here we follow the definition of the CBD according to which old-growth forests are old stands within either primary or secondary forests where old trees have accumulated in a way to form a different ecosystem than any younger class parts of the forest. Intact old-growth forests are – as primary forests – mainly characterised by their developed structures, which act as a distinct forest ecosystem. Plant, animal and microorganism communities and their abiotic environment form a functional unit (CBD 2006). This is why in particular primary and old growth forests are so-called biodiversity hotspots and deliver irreplaceable habitats for plants, animals and fungi (Watson et al. 2018; Di Marco et al. 2019; Hawes 2018; European Commission

2020, 5). Biodiversity hotspots contain at least 1500 endemic species found nowhere else on earth and have lost at least 70% of their primary native vegetation (CEPF 2021). In general, when the recruitment, growth and mortality of trees is balanced, their ecosystem is highly resilient and able to regenerate itself (European Commission 2020; McDowell et al. 2020). Thus, particularly intact forest ecosystems, provide additionally high resilience against natural disasters and minimise the risk of rapidly spreading pandemics (Wilkinson et al. 2018; Gómez-González et al. 2020; European Commission 2020, 2; UNEP and ILRI 2020). They therefore carry a significant value to all human life.

However, forest degradation and deforestation are progressing, particularly at the expense of primary forests as will be shown in the following Sect. 4.1.2. This can be observed in Latin America (e.g., Brazil, Nicaragua, see INPE Data 2020; Tyukavina et al. 2018; Tobar-López et al. 2019), Asia (e.g., Indonesia, see Tyukavina et al. 2018) and Sub-Saharan Africa (e.g., Congo, see Tyukavina et al. 2018) concerning the last remaining tropical rainforests. But also in Europe, the last primary forests are threatened, e.g., in Rumania and Poland (Niţă 2015; European Commission 2017, 38, 2020; Sabatini et al. 2018).

4.1.2 Drivers of Forest Loss and Forest Degradation

Understanding the drivers of forest degradation and deforestation that risk their potential to mitigate climate change and biodiversity loss is a prerequisite for successful forest governance. The European Commission defines deforestation as "the permanent destruction of forests and woodlands and conversion to non-forest uses" and forest degradation as "the loss of the forests' capacity to provide their essential goods and services" (European Commission 2021). In general, drivers of forest loss can be of natural or anthropogenic origin.

Today, the pressure on forests occurs due to diverse needs, which poses different risks to forests: While growing populations and poverty threaten forest conservation, the consumption patterns of more affluent populations drive deforestation (FAO and UNEP 2020, 82). Consumption patterns leading to deforestation and forest degradation (embodied deforestation) are linked to an increasing demand for agricultural and forest products that in turn is driven by global market pressures, dietary preferences and loss and waste along agricultural value chains (IPCC 2019b). In total, about 75–80% of today's global deforestation is caused by the expansion of agricultural land, followed by the extraction of timber, the expansion of infrastructure as well as mining activities and wildfires each accounting for about 7–10% (Kissinger et al. 2012; Curtis et al. 2018; ECOFYS et al. 2018a; European Commission 2019). The expansion of agricultural land is mostly linked to large-scale land acquisition and land-grabbing to establish agro-industrial plantations, commercial ranching and timber extraction or mining activities (Chen et al. 2019; Davis et al. 2020). In this context, also land speculation plays a strong local role (WWF 2021a, 7). Drivers of deforestation are therefore old and new; however, they are not static but their influence, and those of actors, changes over time as well as across regions which mainly depends on political and market shifts (WWF 2021a, 10, 28). The major role of livestock farming and fossil fuels in this respect have already been mentioned in the introduction of the present volume. A huge part of embodied deforestation is based on a demand and associated consumption patterns distant from the area of impact and outweighs local causes of deforestation, such as subsistence agriculture or small-scale timber extraction, e.g., for fire and fuelwood (Kissinger et al. 2012; European Commission 2019; Skutsch and Turnhout 2020). This becomes even more significant considering that the average rate of global net forest loss is declining Because in some countries forest loss was reduced and in others there were forest gains, the average rate of net forest loss declined by 40% between 1990–2000 and 2010–2020 (FAO 2020a). However, forest decline differs locally: While the forest area in Europe is increasing (Forest Europe 2020, 31), two thirds of global forest cover loss occurred in the tropics and sub-tropics from 2000 to 2018 (WWF 2021a, 20). An accelerating decrease concerns primary tropical forest with a loss of 12% from 2019 to 2020, whereas the loss in Brazil, that is linked to forest fires and clear-cutting, was particularly high with 25% (Weisse and Goldman 2021). In Latin America, most land-use changes at the expense of forests are connected to soybean and beef, next to palm oil cultivation (Henders et al. 2015; Vijay et al. 2016), while palm oil production is the major driver of deforestation in South-East Asia (Vijay et al. 2016). In total, mostly export related soy, beef, palm oil, coffee and cocoa cultivation are responsible for almost 80% of tropical deforestation (European Commission 2013; detailed overview: ECOFYS et al. 2018a, 177). This is why export-oriented agricultural policies can be identified as the main drivers of deforestation (Hautala 2018, 33). Apart from that, the production of bioethanol based on starchy (corn, maize) or sugar-containing plants (sugar beet, sugar cane) increases land-use pressures worldwide (Lapola et al. 2010; Hennig 2017; Smith et al. 2014, 872), along with investments in large-scale production of paper, rubber or shrimp from mangrove areas as well as mining projects (European Commission 2013, 2019; ECOFYS et al. 2018b). Unsecured land rights of small-scale farmers and/or indigenous peoples combined with insufficient or dismantled environmental policies in countries rich in tropical forests further encourage deforestation. However, it remains true that tropical deforestation is significantly supported by China and the EU (Rajão et al. 2020; European Commission 2013) as the major importers of goods such as beef, soy or minerals (Ferrante and Fearnside 2019; Kehoe et al. 2019; Rajão et al. 2020; Scheidel et al. 2020). A recent study by the WWF illustrates the impact of European consumption patterns on tropical deforestation; in 2017, 16% of deforestation associated with international trade can be linked to the EU, with Germany ranking first (WWF 2021b, 12 et seq.). The most consumed commodities from 2005 to 2017 were soy (31%), palm oil (24%), beef (10%), wood products (8%), coffee (5%), cocoa (6%) (WWF 2021b, 21).

Moreover, human-induced climate change is driving further loss and degradation of forests which is another compelling argument to combat climate change itself. Tree mortality is estimated to have doubled over the past four decades (Jofre et al. 2011; Craig et al. 2015; McDowell et al. 2020). Throughout Europe, increasing tree mortality leads to younger forests which negatively affects forest biodiversity and carbon storage potential (Senf et al. 2021). Driven by higher temperatures and long droughts, forest fires have reached a globally thus far unprecedented extent (Ryan et al. 2013; Michael and Tilman 2017; INPE Data 2020). In the future, tree mortality might further increase due to extreme weather events, such as extensive droughts and storms that further exacerbate wildfires or pest infestation (Ryan et al. 2013; Park Williams et al. 2013; Bugmann et al. 2019). Thus, natural causes of deforestation like wildfires or wind throw by storms and biotic attacks (insects, pathogen outbreaks) are exacerbated by human-induced climate change (Bond and Keeley 2005; Ryan et al. 2013; Park Williams et al. 2013; ECOFYS et al. 2018a, b; Bugmann et al. 2019; McDowell et al. 2020). However, the use of forests as a carbon sink is disputed, particularly when included in accounting rules, as will be shown in Sect. 4.2.2, sink capacity is linked to several uncertain factors. Indeed, with deteriorating forest conditions due to the advancing climate crisis, it is not certain if and how successful forest regeneration and forest preservation as such will be (on the emerging vulnerability of European forests due to climate change see Forzieri et al. 2021; see also Sect. 4.2.1). For forest biodiversity, "loss of habitats and species due to deforestation and forest degradation" (FAO and UNEP 2020, 82) is by far the greatest threat.

4.1.3 Interim Conclusion and Derivable Policy Implications

Today, not least due to the transition to a post-fossil society, forests worldwide are under unprecedented pressure of use and are exposed to changing climatic conditions, threatening the existence of the last primary forests in particular. Thus, in the future, policy instruments will need to be designed to interact in a way to halt the globally accelerating decline of forests and either strictly protect remaining primary, old growth and species-rich natural forests, following the principle of segregation, or ensure a sustainable and multifunctional forest use in clear favour of biodiverse forest ecosystems. Therefore, forest cover worldwide needs to be mapped and monitored more sufficiently (Luyssaert et al. 2008; Sabatini et al. 2020).

Considering the problem of embodied deforestation, it is important to highlight that the demand-side is neither locally nor globally fixed but is determined by consumption patterns which can (and have to be) changed by effective policy instruments. Thus, a strong focus needs to be set on demand-sight climate mitigation measures to minimise land-use pressures in favour of intact forests, tackling the livestock farming and the biomass sectors in particular (Smith et al. 2014; Hennig 2017; Ekardt 2019; Weishaupt et al. 2020). However, the implementation of policy instruments addressing the demand-sight and thus the drivers of forest loss are also– as we will show in the governance analysis in Chap. 5 in more detail – thus far widely missing so that direct and indirect land-use changes accelerate (ECOFYS et al. 2018a; European Commission 2013, 2019).

Concerning the use of biomass, not only the construction, textile or chemical sectors, but also the substitution of fossil-fuel based plastics might lead to a higher demand for timber in the future (Stubenrauch 2019; Verkerk et al. 2020). It is therefore prudent to foster the reuse of resources, enhanced recycling and the cascade utilisation of wood. Forest governance has to be integrated into a concept of circular economy, including efficiency, consistency and frugality strategies (Ted and Houten 1994; Claudia and Stern 2017; Ekardt 2019; Stubenrauch 2019; Köhl et al. 2020). The latter is even relevant when deadwood or agricultural waste is used for energy purposes. Coarse woody debris releases carbon more slowly and is more compliant with the natural carbon cycle than if energetically used (Smith et al. 2014, 871; Pfeifer et al. 2015) and agricultural wastes are important organic fertilisers that can contribute to the substitution of mineral fertilisers in the future (Smith et al. 2014; Stubenrauch 2019, 871; Garske 2020).

To guarantee the protection and the reconciliation of both climate and biodiversity, crucial is that conflicting goals are to be avoided and synergies be used. This is also essential for facilitating health provisions by forests, as reforestation and afforestation in form of plantations can, next to forest clearance, be responsible for outbreaks of infectious diseases (Morand and Lajaunie 2021). We have already seen so far that reducing land-use pressure caused by fossil fuels and animal husbandry could be a key element for this. Furthermore, reducing the usage of land-based biomass might therefore bear immense potential to reduce CO_2 emissions and decrease land use pressures at the same time (Smith et al. 2014, 872).

4.2 A Critical Review of Natural Scientific Data on Forests in the Climate Discourse and Implications for the Legislative Process

The carbon storage potential of forests is increasingly stressed within the climate mitigation debate. Thus, the following two sections seek to answer two main questions with major significance regarding the development of policy instruments: Firstly, which contribution to climate (and biodiversity) protection can be expected to be provided by the forest sector and particularly afforestation projects in the future, and secondly, can this contribution be reliably measured against a specific baseline?

4.2.1 Emission Saving Potential of Forests, Interlinkages with Biodiversity Protection and Depictability

Forest ecosystems contribute to approximately 50% of terrestrial net primary production and store approximately 45% of total terrestrial carbon and are therefore a crucial element in the global carbon cycle (Bonan 2008; Zhao et al. 2019). Forest biomass becomes a carbon sink as soon as the biological CO_2 uptake is higher than the total release of GHGs (e.g., through respiration, forest fire, profound disturbances; see Griffiths and Jarvis 2004). The net carbon balance of forest ecosystems is regularly positive and even old growth forests are not per se carbon neutral (Odum

1969; Lal 2005) and are able to further sequester carbon (Carey et al. 2001; Luyssaert et al. 2008; Jiang et al. 2020).

The carbon sequestration rate of forests depends on the type, age and density of trees, soil properties as well as latitude and connected climatic influences (e.g., temperature, precipitation, CO_2 concentration, nitrogen (N) deposition, and ozone (O_3) exposure) (Jandl et al. 2007; Luyssaert et al. 2008; Grüneberg et al. 2014; de Vries et al. 2017; Büntgen et al. 2019). With increasing latitude, the potential of forests to store carbon generally decreases due to a reduced net productivity (Erb et al. 2018). Tropical forests, that at the same time function as biodiversity hotspots, this have the largest potential to store carbon.

The total carbon storage in forest ecosystems consists of carbon sequestered in the forest biomass (including stem biomass, coarse woody debris, roots) and in the soil organic matter (SOM) (Lal 2005; Luyssaert et al. 2008; Grüneberg et al. 2014). Soils store most of the total carbon in forest ecosystems (Jandl et al. 2007; Luyssaert et al. 2008; Zhao et al. 2019; Terrer 2021). The amount of carbon sequestered in forest soils depends on their specific characteristics, which in turn are influenced by the upstanding trees and their productivity. Luyssaert et al. (2008) estimate for old-growth forests older than 200 years that they sequester 2.4 ± 0.8 tons of carbon per hectare and year (t C ha^{-1} $year^{-1}$) on average, thereof 0.4 ± 0.1 t C ha^{-1} $year^{-1}$ in the stem biomass, 0.7 ± 0.2 t C ha^{-1} $year^{-1}$ in the coarse woody debris (deadwood) and 1.3 ± 0.8 t C ha^{-1} $year^{-1}$ in the roots and the SOM. Coarse woody debris is often underestimated as a carbon reservoir and releases carbon more slowly and is more compliant with the natural carbon cycle than, for example, energetically used woody biomass does (Smith et al. 2014, 871; Pfeifer et al. 2015).

Degradation processes or unsustainable forest management might further harm the carbon stock of forest ecosystems. This is why the sink capacity of forests is regularly overestimated. According to Tubiello et al. (2021), the net contribution of worldwide forests for the period 2011–2020 was calculated to be less than −0.2 Gt CO_2 $year^{-1}$, when net forest conversion emissions (3.1 Gt CO_2 $year^{-1}$) were offset with net removals from forest land (−3.3 Gt CO_2 $year^{-1}$) (Tubiello et al. 2021). For the Amazon rainforest it was proven that forest degradation contributed three times more to the loss of aboveground biomass than deforestation (Qin et al. 2021). Apart from that, the exposure of the soil during silvicultural processes (logging or planting) can lead to a higher decomposition of SOM and thus to considerable carbon losses from belowground biomass (Jandl et al. 2007; Luyssaert et al. 2008). Moreover, the capacity of forest ecosystems to store carbon might be reduced under climate change conditions that do not enhance forest growth over the long term due to the expected accelerated life-cycles of forests and additionally lead to comparable high losses of carbon pools in the below ground biomass (Park Williams et al. 2013; Gatti et al. 2014; Büntgen et al. 2019; Yu et al. 2019; Nottingham et al. 2020; Varney et al. 2020):

- Firstly, photosynthetic activity of mature trees is not expected to be further enhanced due to higher atmospheric CO_2 concentrations (Carey et al. 2001; Jandl et al. 2007; Luyssaert et al. 2008; de Vries et al. 2017; Jiang et al. 2020) and even the stimulated growth of younger forests goes along with enhanced respiratory fluxes. Thus, large amounts of the additionally sequestered carbon are released through enhanced respiration (Jandl et al. 2007; Veldman et al. 2019; Jiang et al. 2020). Apart from that, a transition to a period dominated by vapor pressure deficits that significantly restrict tree growth, health and thus their longevity, is expected (McDowell et al. 2020). There are various indications that a higher stem productivity of trees in their early growth period leads to an earlier biomass turnover rate and thus a shorter carbon residence time (Bigler and Veblen 2009; Büntgen et al. 2019; Yu et al. 2019; McDowell et al. 2020).

- Secondly, extensive droughts already cause significant carbon losses in tropical forests which in regular (more wet) years function as carbon sinks, but due to missing precipitation seasonally turn into carbon sources (on the example of the Amazon Gatti et al. 2014). Generally, already small changes in precipitation can show significant effects on the carbon fluxes between forest ecosystems and the atmosphere (Naudts et al. 2016; Zhao et al. 2019).
- Thirdly, also in general, it is expected that soils release more carbon to the atmosphere due to a higher microbial activity. This has been proven for temperate latitudes as well as for the tropics, where carbon losses will be particularly high and (Nottingham et al. 2020; Varney et al. 2020) and are expected to increase by up to 55% due to further changing climate conditions (Nottingham et al. 2020).

It becomes clear that the sensitivity of forest ecosystems mainly influenced by any kind of soil disturbances, climate change and hereby induced weather phenomena, next to the expectable earlier tree mortality, means there are significant uncertainties in predicting the development of the carbon stock potential of forest ecosystems over time. All these factors would need to be considered in earth system model (ESM) projections, which is, however, hardly feasible due to the high intrinsic uncertainties (Luyssaert et al. 2008; Bigler and Veblen 2009; Steffen et al. 2018; Bugmann et al. 2019; Büntgen et al. 2019; Yu et al. 2019; Wieding et al. 2020). This is why, e.g., the shortened life span of trees is hardly considered in the modelling so far and also self-reinforcing processes regarding the loss of SOM are difficult to model accurately (Büntgen et al. 2019; Varney et al. 2020). This demonstrates how difficult it is to accurately depict increased or decreased sink capacities of forest ecosystems and therefore has far-reaching consequences for policy instruments based on them (see the REDD+ approach, Sect. 5.1.6 or the EU's LULUCF regulation, Sect. 5.2).

4.2.2 Afforestation and Reforestation – A Cheap and Feasible Solution to Combat the Climate Crisis? On False Hopes and the Problem of Depicting

Afforestation and reforestation are both associated with planting and/or deliberately seeding trees on land (FAO 2018, 6). However, in contrast to reforestation, afforestation implies land-use changes (FAO 2018, 7) as it includes planting forests on lands that did contain tree cover before (IPCC 2000). Afforestation should therefore be assessed differently from the reforestation of areas that are still classified as forest, e.g., due to a canopy density higher than 10% (FAO 2018, 6) meaning that forests are planted on land that had already contained forests before (IPCC 2000). The FAO, however, connects both with planting and/or deliberate seeding activities, only excluding natural forest regeneration processes (FAO 2018, 6). Terms such as "global tree restoration potential" (Bastin et al. 2019) therefore usually include both afforestation and reforestation as they equally refer to the planting and/or deliberate seeding of trees (Bastin et al. 2019; see, e.g., also Doelman et al. 2020). The boundaries between afforestation and reforestation become partially blurred in practice. Generally, planting trees as a climate change mitigation measure is regularly considered to be economically feasible already with CO_2 prices below USD 50/t CO_2 (see in detail Doelman et al. 2020). In the EU it is envisagedto plant at least 3 billion additional trees according to the EU's biodiversity strategy (critically Selva et al. 2020). The Bonn Challenge is aiming to globally restore 150 million hectares of deforested and degraded land by 2020 and 350 million hectares by 2030 based on the concept of forest-landscape restoration (IUCN 2020). Thus far, however, the challenge suffers from insufficient participation and requires better forest accounting on a national level (Bastin et al. 2019).

Modelling results regarding the potential to sequester carbon globally by the additional planting of trees until 2100 is, however, challenging and varies – due to contrary assumptions – considerably between 176 Gt CO_2 (Sathaye et al. 2006) and up to 800 Gt CO_2 (Humpenöder et al. 2014). Bastin et al. (2019) claim that globally the conversion of 1 billion hectares into forests with a canopy density higher than 10% could sequester approximately 205 Gt CO_2 under current climatic conditions (Bastin et al. 2019). Yet, they state that emission reductions might decline under changing climate conditions and that, in this regard, the model contains substantial uncertainties (Bastin et al. 2019). According to Veldman et al., the calculated climate effect is overestimated by at least the factor 5, as SOM gains are most probably lower, the albedo effect is inadequately considered and the afforestation is included in grasslands and savannas rich in biodiversity, where wildfires and omnivores naturally control the forest cover (Veldman et al. 2019). Therefore, afforestation can pose major threats to biodiversity-rich natural ecosystems (Bond and Keeley 2005; Veldman et al. 2019; Scurlock and Hall 1998; Selva et al. 2020) and can even increase the risk for spreading wildfires (de Rigo et al. 2017; Seidl et al. 2017). Concerning Europe, models of Strandberg and Kjellström reveal that afforestation of all unwooded areas in Europe could result in a cooling of 0.5–3 °C of seasonal mean temperatures, however, mostly with local and – again – hardly exactly predictable effects (Strandberg and Kjellström 2019) and without considering natural site conditions sufficiently.

In any case, modelling results and the potential contribution of afforestation and reforestation to climate change mitigation have to be reviewed critically due to the following:

- When estimating the climate effect, next to the challenging assessment of the potential carbon sequestration in forest biomass (see Sect. 4.2.1), surface albedo and evapotranspiration (the sum of evaporation and transpiration) have to be considered as interdependent biophysical climatic factors. Forested areas usually have a lower surface albedo compared to unforested areas and conceal the high albedo of snow. This causes a warming effect, which is particularly prevalent in lower latitudes, such as the boreal zone (Bonan 2008; Strandberg and Kjellström 2019; Kreidenweis et al. 2016; Hennig 2017; Fuss et al. 2021). In contrast, evapotranspiration of forest ecosystems interacts with clouds and influences precipitation, so that a cooling effect occurs (Bonan 2008; Strandberg and Kjellström 2019; Kreidenweis et al. 2016). The cooling effect due to enhanced evapotranspiration typically prevails but is particularly pronounced in the humid, tropical regions. The extent of these two contradicting effects is therefore determined by the amount of water in the ecosystems, positively influencing the evapotranspiration, and the latitude influencing the planar reflectivity together with the land-use changes, influencing the magnitude of the albedo effect (Henderson-Sellers and Meadows 1979). Therefore, afforestation and reforestation in tropical regions is estimated to be more effective than in more temperate regions with lower water availability but expectable greater changes in surface albedo (Strandberg and Kjellström 2019; Kreidenweis et al. 2016). In contrast, it is anticipated that afforestation in the boreal zone may even easily lead to adverse climate effects, meaning that it might contribute to global warming (Bathiany et al. 2010; Arora and Montenegro 2011; Gómez-González et al. 2020).
- Apart from that, there might be a limited or even an adverse climate effect of tree planting initiatives caused by reinforcing disturbances under changing climate conditions (Seidl et al. 2017; Bergkemper et al. 2016; Büntgen et al. 2019; Schwärzel et al. 2020; Hennig 2017; Fuss et al. 2021; Harris et al. 2021; Nabuurs et al. 2007). Firstly, increased tree growth requires sufficient water and nutrients such as nitrogen and phosphorus in order to take advantage of rising CO_2 content in the atmosphere, which however are limited (Norby et al. 2010; Terrer et al. 2019; McCarthy et al. 2010). Next to water shortage due to extended droughts this could be investigated concerning the plant available phosphorus that becomes further restricted under changing climate conditions, particularly but not exclusively in tropical environments (Touhami et al. 2020; Hou et al. 2018; Ellsworth et al. 2017). Thus, expectable enhancements in forest productivity might be considerably constrained by a shortage of essential nutrients such as phosphorus and might not occur in the expected manner. Secondly, with the increasing rising risk of droughts and as a result of the accelerated life cycle of trees, it is highly likely that tree mortality rates will continue to increase globally (see Sect. 4.1.2; McDowell et al. 2020). Thirdly, as a result of complex biogeochemical processes, the carbon budget of a forest is highly sensitive to any kind of disturbance. Soil disturbances regularly occur in the context of tree planting, converting young forests to conspicuous sources of CO_2 (Luyssaert et al. 2008, 213). Particularly severe and contradictory climate effects are to be expected when natural carbon reservoirs and biodiversity-rich wetlands or unmanaged grass-

lands are afforested (Scurlock and Hall 1998; Baldocchi and Penuelas 2019; Veldman et al. 2019; Ekardt et al. 2020). Besides a loss of SOM, natural vegetation gets lost, threatening biodiversity (Baldocchi and Penuelas 2019; Veldman et al. 2019).

- Furthermore, deforestation with successive afforestation might not maintain the same effects on warming and cooling as former old growth intact forest ecosystems might have done. Despite the fact that forested lands as part of the LULUCF sector in Europe (see Sect. 5.2.2) are still a strong sink in most of the EU Member States, a declining sink capacity has been recently measured due to increasing demand for timber and biomass for bioenergy as well as natural disturbances (EEA 2019, 30). According to the statistics of the FAO, the sink capacity of forested land in 2020 has already declined by nearly 50% compared to 2015 (FAO 2020b, 5). Naudts et al. (2016) claim in that respect that afforestation and forest management in Europe thus far did not contribute to the mitigation of climate change. Instead, not sustainably managed forests functioned as a net source of carbon (Naudts et al. 2016).
- All of this takes us to a more overarching point (see on the following Wieding et al. 2020 with regard to geoengineering and to the IPCC in general; Ekardt 2021). Discussions about figures and scenarios as such are far less binding for sustainability research than is often assumed. Rather, it is crucial to analyse the background assumptions of various calculations in detail. This is often difficult because sometimes assumptions are not openly revealed or are even completely opaque. In any case, scenarios on potentials are not norms, nor are they forecasts – they are merely projections.

Notwithstanding, assuming favourable natural constraints for tree cover and a sustainable forest management, successful tree planting projects that are evaluated after a longer time span of 50 or even better more than 100 or 200 years, might develop as a net carbon sink, especially if the interacting tree species reflect the natural, potential vegetation and are not regularly disturbed by logging (Erb et al. 2018; Naudts et al. 2016; Lawson and Michler 2014). Compared to the goal of reaching zero net emissions in less than two decades or even clearly before 2035, this is, however, a long time-span and will not substitute for mitigation measures with immediate effect such as phasing out fossil fuel based emissions (Ekardt et al. 2018b; Baldocchi and Penuelas 2019; Büntgen et al. 2019; Wieding et al. 2020).

Short-term carbon pool gains by afforestation might only be achievable if former agriculturally used and widely degraded land is managed sustainably and possibly afforested. This is because, especially under intensive arable land use, SOM content tends to decrease and soil disturbances are regularly higher than under a forest cover (Post 2002, 200; Lal 2005; Fließbach et al. 2007; Scotti et al. 2013; De Mastro et al. 2019; Fuss et al. 2021; Harris et al. 2021). This leads to another potential conflict associated with large-scale afforestation: food security. Particularly small-scale farmers could be (further) deprived of their land in the course of afforestation, potentially increasing dependency on food imports which might cause food prices to rise sharply (Kreidenweis et al. 2016; Griscom et al. 2017; Doelman et al. 2020).

Therefore, integrating trees into diversely managed agricultural systems seems to be more convincing than to afforest agricultural land on a large scale. This could generate urgently needed resilient food systems that locally contribute to reach food sovereignty, mitigate climate change and preserve biodiversity (Ausseil et al. 2014; IPBES 2019; Gómez-González et al. 2020). Agroforestry systems or sowing catch crops to diversify agricultural practices are first starting points here (Stubenrauch 2019; Gentsch et al. 2020; Gómez-González et al. 2020). Agroforestry binds carbon in vegetation and soil through the combination of trees or other woody plants and arable crops or animal husbandry and thus stores more carbon than agriculturally used land without trees (Nair et al. 2009; De Stefano and Jacobson 2018).

Keeping all this in mind, the idea of fighting climate change through planting trees alone must be generally questioned: The effects might be much lower than hoped for or even adverse, as the carbon-sink capacity of young forests and the availability of land are overestimated while land competition and potential trade-offs regarding food security as well as the need for biodiversity protection are underestimated (Black 2011, 150 et seq.; Hennig 2017; Ekardt 2019 Ch. 1.3; Palmer 2021). If reforestation and afforestation are considered as climate change mitigation measures by providing negative emission potentials, the manifold ecosystem functions of forest ecosystems and their resilience, next to site-specific natural and socio-economic conditions, require the utmost attention (Verkerk et al. 2020; Yousefpour et al. 2018; Seidl et al. 2017; Büntgen et al. 2019; Luyssaert et al. 2008; Forest Europe 2008; European Commission 2019). In other words: The climate mitigation potential of large-scale afforestation, partly overlapping with reforestation, varies widely in particular in the short term – and is regularly overrated (see also Table 4.1). Afforestation should only be considered if natural (and cultural) site-conditions are favourable and trade-offs regarding biodiversity and food security remain low. This is, however, regularly not taken sufficiently into consideration, contrasting human rights and the CBD. The IPCC therefore attributes only a medium confidence to the climate mitigating effect of afforestation and reforestation measures, in contrast to the high confidence regarding the potential of measures further listed in Table 4.1.

Table 4.1 Estimated global climate effect of different mitigation options according to assessments of the IPCC (2019a, b, c, 585, 586, 588)

Climate change mitigation option (selection)	Potential (Gt CO_{2e} year^{-1})	Confidence
Forest management	0.4–2.1	Medium
Reduced deforestation and forest degradation	0.4–5.8	**High**
Reforestation and forest restoration	1.5–10.1	Medium
Afforestation[a]	0.5–8.9	Medium
Increased soil organic carbon content	0.4–8.6	**High**
Dietary change	0.7–8.0	**High**
Reduced food waste	0.8–4.5	**High**

[a]Estimates are partly overlapping with reforestation

4.2.3 Interim Conclusion and Derivable Policy Implications

The natural scientific data highlights that preserving existing forests and halting not only deforestation, but essentially also the degradation of forest ecosystems as well as their restoration are more reasonable than large-scale tree planting at any cost. Like this, gains in ecosystem resilience, biological diversity and climate change mitigation as well as adaptation are achieved, and the latter become connected (Schoene and Bernier 2012; Elliot et al. 2013; European Commission 2019, 4; Verkerk et al. 2020). Thus, the protection of old-growth, intact forests ecosystems and stopping the accelerating forest degradation and its above-mentioned drivers should be given a high priority concerning policy interventions. Besides, policies will need to focus on the sustainable restoration of degraded forest ecosystems to support the natural capacity of forest ecosystems and re-instate ecological processes. In this way, not only biodiversity and climate come along together, but also a renewable resource pool to substitute fossil-fuel based materials is maintained in the long-term. To support this process, a "global system of dynamic monitoring" (Cook-Patton et al. 2021) that aggregates and controls restoration projects and uses advanced remote sensing methods is needed (Cook-Patton et al. 2021). Apart from that, the aforementioned can only be accomplished if drivers of deforestation and forest degradation are successfully addressed by policy interventions in the future (see Sect. 4.1.2).

The critical review of natural scientific data above showed that GHG bound in forest ecosystems are highly volatile and reversible and therefore much more difficult to capture than those of fossil-fuel emissions (Tubiello et al. 2021). The amount of additional carbon sequestered depends on a large number of mutually reinforcing or even opposing factors which impede exact measurement or prediction (Junfang et al. 2012, 2019). It can be concluded that both measurability and the prediction of the carbon storage capacity of forest ecosystems under future climatic conditions will be extremely challenging (Steffen et al. 2018; McDowell et al. 2020). When trying to depict the additional carbon storage potential, tree-specific and site-specific conditions have to be taken into account, which themselves are influenced by changing climatic conditions and further anthropogenic interventions (Naudts et al. 2016; Zhao et al. 2019). Site-specific soil conditions interact with vegetation and precipitation and are highly sensitive, so that forest ecosystems might even seasonally change from a carbon sink to a source. A large number of small actors, difficulties in verifying single emission sources as well as problems with the monitoring occur additionally.

All of this does not only demonstrate that forests are in serious danger of being overestimated regarding their climate protection capabilities. Moreover, the highly heterogeneous empirical findings indicate the same massive governance problem that we call the problem of depicting (see Chap. 2) and that have already played a major role in our earlier contributions on land use in general, on biodiversity and especially on peatlands (Ekardt and Hennig 2015; Hennig 2017; Ekardt et al. 2018a, 2020). This has to be considered when thinking about optimally designed policy instruments concerning forest governance since, for example, economic instruments need a governance unit, which is easy to grasp, in order to function well (Ekardt 2019; Weishaupt et al. 2020; Garske and Ekardt 2021). Insofar as drivers such as fossil fuels or animal husbandry are addressed, such a unit is available; however, insofar as additional specific rules for forests are to be formulated, this is lacking. Whether successful forest policies should rather be driven by economic or command-and-control instruments or a specific mix of both opens up a new research question that will be evaluated in the following. In any case, to reconcile different policy areas concerning biodiversity protection, climate protection and biomass use and to implement coherent policies in line with the targets of the PA and the CBD will be of paramount importance for successful policy interventions in a post-fossil world. One policy field can never be dealt with without the other. They all have to focus on the implementation of a sustainable, climate-smart and biodiversity conserving circular economy.

4.3 Interim Conclusion

In this chapter, it was shown that the preservation of intact forest ecosystems is indispensable to protect the climate and biodiversity in the long term, and not least the health and well-being of humanity as a whole.

Despite this, the destruction of the last intact ecosystems (especially primary and old-growth forests) is actually increasing at a rapid pace. This applies particularly to tropical forests but also to the last European primeval forests. The cause lies in humankind's insatiable hunger for resources, whether it be woody biomass or arable land for the production of beef and feedstuffs such as soya and palm oil, or materials such as rubber, etc. The transition to a post-fossil society and the partial replacement of fossil fuels with woody biomass is additionally driving this development and therefore requires appropriate legal containment in order to finally achieve sustainable resource and forest management. Apart from that, demand-sight mitigation measures that steer consumption patterns (particularly but not only) in the western world concerning meat and biomass consumption and to implement frugality are highly necessary.

At the same time, the chapter critically reviewed the potentials of afforestation and reforestation in climate mitigation, often presented as the new saviour concerning the aim to fulfil the commitments of the Paris Agreement and reach climate neutrality in the future. It became clear that ultimately only biodiverse and thus resilient forests can be a carbon sink in the long term. In the short term, however, the carbon storage capacity of newly planted forests is almost negligible. In contrast, due to necessary interventions in the soil, young forests are regularly initially a source of CO_2 and do not function as a sink. Potential trade-offs with regard to food security, biodiversity protection, e.g. of species-rich grasslands and wetlands, and the total amount of land available also come into play. In addition, existing forests worldwide are currently reducing their original sink capacity and releasing more CO_2 into the atmosphere. This is due to changing environmental conditions, such as long dry seasons, often coupled with unsustainable forest management. Overall, the expected future sink capacity of newly planted or existing forests is therefore often overestimated.

Nevertheless, monitoring and measuring GHG fluxes in forest ecosystems as accurately as possible is a necessary prerequisite for policy approaches based on this (see Chap. 5). In this context, it became clear that it is very challenging to accomplish this. To date, it is hardly possible to achieve an accurate measurement of GHG fluxes in forest ecosystems and to monitor the development of forest ecosystems in a globally comprehensive and accurate manner. The so-called problem of depicting is therefore large in the case of forest ecosystems, which are influenced by a wide range of factors. Efforts to reduce this problem of depicting as best as possible are therefore necessary. However, the problem of depicting will always remain to a certain extent, which in turn has to be considered in the choice of policy instruments.

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5 Governance Analysis – Existing Regulations and Their Effectiveness

Abstract

The international policy level on the protection of global forests is characterised by the various policy instruments, i.e. funding regimes and soft law. The REDD+ funding regime has so far fallen short of expectations and will require better coordination, monitoring and financing. In addition, the drivers of forest destruction cannot be effectively addressed by a selective funding regime alone. A review of EU law reveals that coherent legislation on forest protection does not yet exist. Instead, different regulations are in conflict with each other. The LULUCF Regulation and the RED II Directive offer a compelling example. The LULUCF Regulation aims to integrate the land use sector, including the forest sector, into the EU climate regime. However, it is necessary to close many of the existing loopholes in the future, as well as to reduce the existing broad leeway of the Member States in accounting for additional sink capacities or emissions and, last but not least, to raise the overall ambition level. Furthermore, the LULUCF Regulation does not support sustainable forest management which preserves or expands C-sinks of forests. Besides, the problem of depicting is present. The RED II Directive – counterproductively – promotes burning (i.e. energy utilisation) of woody biomass. In addition, the ILUC risk (shifting effect) is not sufficiently limited by the Directive but is in fact promoted by the insufficiently legally constrained promotion of agriculturally generated biomass. The sustainability criteria in their current form are not effective. Besides, existing funding for sustainable forest management and conservation in Europe which is so far mainly provided through the second pillar of the CAP, cannot compensate for these shortcomings and must be supplemented by further funding opportunities. Further regulations face substantial criticism, too.

J. Stubenrauch et al., *Forest Governance*, Environmental Humanities: Transformation, Governance, Ethics, Law,
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Given the background on methodology, history and the actual state of forests as well as the natural scientific review on forests in the climate debate, a governance analysis will be applied. Our focus in Chap. 5 lies on the status quo of governance. Afterwards, we will (try to) develop some core elements of optimised governance options in Chap. 6.

As a first step, we will show that there is currently no coherent forest policy in international law, assuming that any coherent and effective policy must be interwoven with a range of other policies (Sect. 5.1). By this standard, forest policy has so far been on the sidelines of other policy areas, which will be considered in this section. Forests, as a cross-cutting issue, are of interest to different international organisations. While all of their goals ultimately come down to forest management, forests are attributed different functions by different institutions. E.g., the focus of the UN Framework Convention on Climate Change (UNFCCC)[1] lies on the sink capacity of forested areas. Meanwhile the CBD considers forests as (parts of) ecosystems vital to preserve biological diversity (Savaresi 2013, 402 et seq.; Shivakoti et al. 2019).

In a second step, we will monitor EU policies (Sect. 5.2), complemented by some remarks regarding the German governance level. The legal assessment at the EU level addresses both: EU climate policy and its impact on forested ecosystems, as well as other EU policies that indirectly affect the forest sector, e.g., in the nature conservation legislation and agricultural law.

5.1 International Policy Level

The international policy level is characterised by legally binding multilateral environmental agreements (MEAs) on the one hand as well as non-legally binding legislation, initiatives and certification schemes (international soft law) on the other hand (Table 5.1). In the following their effectivity regarding forest conservation and restoration will be assessed in detail.

5.1.1 Legally Binding Multilateral Environmental Agreements

5.1.1.1 Convention on Biological Diversity

The CBD was founded as one of the pillars for environmental protection established at the UN Conference on Environment and Development in Rio in 1992. As mentioned earlier, the objectives relevant to forest management are the conservation of biological diversity and the sustainable use of the components of biological diversity, i.e., resources, etc. (Art. 1 CBD). Until 2020 these objectives were further specified in the Aichi Targets, implemented by states through National Biodiversity Strategies and Action Plans (NBSAPs, based on Art. 6 CBD) and the Expanded

[1] United Nations Framework Convention on Climate Change (UNFCCC), 09/05/1992, FCCC/INFORMAL/84 GE.05-62220 (E) 200705.

Table 5.1 Overview regarding important legal agreements of forest governance at the international level (own table)

International Forest Governance	
Multilateral Environmental Agreements (MEAs, legally binding)	Voluntary law, initiatives and certification schemes
• Convention on Biological Diversity (CBD) • UN Framework Convention on Climate Change (UNFCCC), Kyoto Protocol (KP), Paris Agreement (PA) • UN Convention to Combat Desertification (UNCCD) • Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES) • Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)	• Sustainable Development Goals (SDGs) • Payment for Ecosystem Services (Public Private Partnership) → *REDD+* • International Agreement on Forests (IAF) → *UN Forum on Forests (UNFF), UN Forest Instrument (UNFI)* • International Declarations to halt deforestation → *Bali Declaration, AFLEG Declaration, Bonn Challenge, New York Declaration on Forests, Amsterdam Declaration* • Certification schemes (private law) → *Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification Schemes (PEFC)*

Program of Work on Forest Biological Diversity[2] (POW, Decision VI/22, para. 10, annex). The concretisation of the CBD targets in the future will depend on the design of the post-2020 Global Biodiversity Framework and the related negotiations in Kunming, China in 2022 (with regard to first indications see also CBD 2019, 2021).

Thus far, as regards the level of instruments, in accordance with Art. 26, CBD states were to report on the success of their NBSAPs; the fifth reports, due in 2014, were submitted by 192 Parties, the sixth reports were due by the end of 2018,[3] however, only 98 reports have been submitted although there are currently 196 parties. This shows that compliance with reporting requirements varied and decreased over time. The POW contained three pillars which address structural needs for forest conservation, including addressing the drivers of degradation and capacity building with further goals each. This voluntary programme was designed for the acquisition of further funding and technology transfer among states, regions and private actors.

While the CBD itself mentions a number of measures suitable to cover sustainable forest management and to conserve forests with all their beneficial ecosystem functions, there are no concrete and obligatory measures at this level. Furthermore,

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[2] Decision VI/22 of COP 6 to the CBD on forest biological diversity, para. 10, annex, 04/2002, the Hague, Netherlands.

[3] Decision VIII/27 of COP 8 to the CBD on alien species that threaten ecosystems, habitats or species (Article 8 (h)): further consideration of gaps and inconsistencies in the international regulatory framework UNEP/CBD/COP/DEC/VIII/27, 15/06/2006, Curitiba, Brazil.

the CBD provides no system of implementation and no enforcement capacities. Therefore, the CBD, the Aichi Targets and the post-2020 Global Biodiversity Framework remain primarily relevant as a system of targets (Sect. 2.1).

5.1.1.2 United Nations Framework Convention on Climate Change, Kyoto Protocol and Paris Agreement

International climate law also provides instrumental aspects besides the already mentioned level of targets (Sect. 2.1). The UNFCCC[4] as an international regime was founded in 1994 following the Rio Convention, like the CBD. It is a legally binding treaty under international law. Its objective is the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change (…)" (Art. 2 UNFCCC). This includes sustainable management, and promote cooperation in the conservation and enhancement of GHG sinks and reservoirs including, among others, forests (Art. 4 lit. d). Sinks, in the UNFCCC definition, include all processes, activities and mechanisms that absorb GHG from the atmosphere (Art. 1.8 UNFCCC). This specifically includes land use, land-use change and forestry (LULUCF). Therefore, forests are covered both in terms of their GHG storage capacities and as valuable ecosystems which are to be protected from climate change. They are covered by the monitoring and reporting requirements of Art. 12 UNFCCC.

The Kyoto Protocol[5] of 11.12.1997, specifying UNFCCC targets, commits contracting parties to reduce GHG in industrialised countries and contains flexible mechanisms (emissions trading, Joint Implementation (JI) and Clean Development Mechanism (CDM)), which also enable emissions to be reduced abroad – specifically in developing countries and countries in transition –, for example through forest conservation or reforestation (on CDM and JI see Ekardt and Exner 2012; Exner 2016; Garske and Ekardt 2014). The Kyoto Protocol had two commitment periods, from 2008 to 2012 and 2013 to 2020.

Besides reporting obligations, sinks were long left aside in climate negotiations. Only since 2011, the agriculture sector is covered through a general consultation process by the Subsidiary Body for Scientific and Technological Advice (SBSTA) under the UNFCCC.

The Paris Agreement passed in 2015 (and came into effect in 2015) obliges parties to define their own nationally determined contributions (NDCs) to limit the rise in temperatures to well below 2 °C and at best 1.5 °C (Art. 2 para. 1 PA). Through Art. 4 PA the LULUCF sector is fully covered by the PA, including forests and the connected protection and enhancement of sink capacities. Most of the parties – such as the EU and many developing countries – have thus included the LULUCF sector into their NDCs (more than 100 parties in total (Romppanen 2020). Considering the

[4] United Nations Framework on Climate Change (UNFCCC) by the United Nations, 06/1992, Rio de Janeiro, Brazil, FCCC/INFORMAL/84.

[5] Kyoto Protocol to the UNFCCC by the United Nations, 11/12/1997, Kyoto, Japan.

role of sinks in complying with Art. 2 para. 1 PA raises the importance of increasing the sink capacity of forest ecosystems in the future even further. It becomes clear that achieving the objectives of the PA is not possible without including forests in international climate protection policy which acknowledges their importance in climate protection both politically and legally. Art. 6 PA aims at the further configuration of instruments for inter-state cooperation which might also affect forestry. However, there are indications of substantial decisions in the near future.

The obligations of the contracting parties with regard to the reporting and accounting rules concerning the LULUCF sector vary according to the respective treaty. The UNFCCC only defines rules on reporting for all parties. For industrialised countries (Annex-I countries), the LULUCF sector is included in the National Greenhouse Gas Inventory. Reporting guidelines for the LULUCF sector were last updated in 2013 by Decision 24/CP.19,[6] alongside the 2006 IPCC Guidelines which apply as the reporting standard. They specifically include information on accounting for harvested wood products. Developing countries (Non-Annex-I countries) on the other hand, submit biennial update reports on the national communications of the matter. Decision 17/CP.8[7] of 2011 provides the guidelines. Developing countries use the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. This leads to differently estimated climate impacts within the same sector, indicating controversy on the matter which is more apparent in the context of REDD+ (see below).

In contrast, the Kyoto Protocol obliges developed nations to report and account for national emissions and removals occurring from the LULUCF sector following the Decision 529/2013/EU[8] until the end of 2020. The Paris Agreement that takes effect from January 2021 for all contracted parties lays down strengthened reporting rules aiming at enhanced transparency (Art. 13 PA, Annex to Decision 18/CMA.1). In the national inventory, reporting the tracking of the development of emissions by sources and removals by sinks needs to be possible (Art. 13 para. 7 PA). However, the agreement does not make harmonised, binding and detailed accounting rules available to the parties (Romppanen 2020, 269). Art. 4 para. 13 PA only defines overarching guidelines concerning the NDC accounting: “Parties shall promote environmental integrity, transparency, accuracy, completeness, comparability and consistency, and ensure the avoidance of double counting.” The responsibility to establish a legal framework with detailed accounting rules for the LULUCF sector is thus the responsibility of the parties (Savaresi). The EU’s accounting regulations for the LULUCF sector from 2021 on and their impact on the protection and

[6] Decision 24/CP.19 of COP19 to the UNFCCC on the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention, 11/2013, Warsaw, Poland.

[7] Decision 17/CP.8 of COP8 to the UNFCCC on Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention, 10/2002, New Delhi, India.

[8] Decision 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities, OJ L 165, 18/6/2013.

development of forests will be further assessed in Sect. 5.2. All this is especially challenging given the already mentioned problem of depicting (Sect. 4.2.2). Furthermore, the PA – just like the CBD – contains only a (insufficient) framework for reporting and accounting but no detailed policy instruments on forestry.

5.1.1.3 Convention to Combat Desertification (UNCCD)

The UNCCD[9] was established in 1994 and is thus far the only legally binding international treaty addressing sustainable land management. The focus of the Convention is on the avoidance of ecosystem degradation and drought effects in drylands, including arid, semi-arid and dry sub-humid areas. According to the UNCCD 2018–2030 Strategic Framework, the Convention aims at "a future that avoids, minimizes, and reverses desertification/land degradation and mitigates the effects of drought in affected areas at all levels [...] to achieve a land degradation-neutral world consistent with the 2030 Agenda for Sustainable Development" (UNCCD 2017, 3). To date, 197 parties have signed up to the convention and a bottom-up approach is pursued that encourages the participation of local communities (UNCCD 2021).

According to Strategic Goal 1, the status of affected ecosystems should be improved by increasing their resilience and land degradation/desertification should be combated, in particular through sustainable land management (UNCCD 2017). This includes forested areas and thus also demands sustainable forest management in dry lands. Forests and trees are even considered to be "at the heart of land degradation neutrality" (UNCCD 2019, 1), defined as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (UNCCD 2016a, 9). Thus, the goals of the UNCCD are strongly aligned with both the SDG 15.3, aiming to achieve land degradation neutrality by 2030 and the sustainable management of forests, as by managing forests sustainably or by their restoration, manifold social and environmental benefits can be achieved (UNCCD 2021).

However, thus far the Convention has shown little impact in combatting desertification. Particularly quantitative targets that allow the measurement of progress over time are lacking and need to be (a) established in the contracting parties and (b) underpinned with concrete measures and policies guiding them in the desired direction (UNCCD 2016b; Chasek et al. 2019). Future efforts in reaching land neutrality in dry regions and thus protecting and managing respective forest sustainably will therefore depend on the political initiatives to overcome implementation challenges regarding land degradation neutrality (see in detail also Chasek et al. 2019).

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[9] United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa by the United Nations, 17/06/1994, Paris, France.

5.1.1.4 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The international CITES Convention[10] came into force on 01.07.1975 and aims to regulate international trade concerning wild flora and fauna. It legally restricts the joining parties in their trade regarding wild species so that they are not threatened in their survival. Appendix I includes all species already threatened by extinction and calls for strict domestic regulation through the parties for these. Appendix II lists species that may become threatened by extinction in the future and whose trade should therefore be "brought under effective control" (Art. 2 No. 2 CITES) to ensure their survival. Lastly, Appendix III includes species that parties individually define as needing to be regulated and controlled concerning their trade. According to Art. 2 No. 4 CITES trade is not allowed with the listed species except in accordance with the CITES Convention.

The regulation also covers trees and thus timber gained from tree species that are or might be in danger of extinction, such as the African rosewood (Pterocarpus erinaceus), one of the most traded tropical hardwood that entered the IUCN Red List of Threatened Species in 2018 (Dumenu 2019; IUCN 2021). It is therefore also a legal instrument at the international level to fight illegal logging, particularly concerning primary and old-growth forests in the tropics which contain manifold endangered species. However, the effectiveness of CITES as a framework for further legislative measures concerning the protection of forests largely depends on the successful implementation by the parties – that oftentimes lack strict domestic and regional regulations (on the example of Indonesia, see Siriwat and Nijman 2018; on the example of Ghana where illegal logging and trade has even increased by 120% since CITES was implemented, see Dumenu 2019). Besides structural drivers of illegal logging or the far-reaching exclusion from indigenous and rural people from political decision-making processes (Hagen 2019), the successful monitoring of endangered tree species is an indispensable precondition to restrict or ban the trade of endangered tree species (Ugochukwu et al. 2018; Dumenu 2019). Thus far, regular and reliable identification by the responsible authorities cannot be guaranteed but might be improved through the use of new technologies in the future (Ugochukwu et al. 2018; Hasyim et al. 2020; Olschofsky and Köhl 2020). This is why the CITES Convention, even though implemented more than four decades ago, still cannot effectively restrict illegal logging.

On the example of the relevant EU legislation, the effectiveness of CITES will be further assessed in Sect. 5.3.2 concerning the EU Timber Regulation and Sect. 5.3.3 concerning the EU's biodiversity and nature conservation law.

[10] Convention on International Trade in Endangered Species of Wild Fauna and Flora Washington, 03/03/1973, D.C., United States.

5.1.1.5 Ramsar Convention on Wetlands

The Ramsar Convention[11] is an international treaty for the conservation and sustainable utilisation of wetlands. It was adopted in 1971 and came into force in 1975. The Convention recognises the fundamental ecological function of wetlands and their economic, cultural, scientific and recreational values. It focusses on the protection of mainland, coastal and anthropogenic wetlands, both forested and non-forested.

Art. 2 of the Convention names hydrology as one criterion besides ecology, botany, zoology and limnology for inclusion on the List of Wetlands of International Importance. Thus, linkages between wetlands and the surrounding forests are implied (Blumenfeld et al. 2019, 33). Art. 3 calls for contracting parties to implement their planning so as to promote the conservation of the wetlands included in the list, and as far as possible, responsible use of wetlands in their territory. This is why sustainable management and conservation of wetlands must include the surrounding forested areas, "given their interdependence and the impacts that management of one area may have on the other" (Blumenfeld et al. 2019, 33).

In the Ramsar classification of wetland types, developed to support the designation of Wetland of International Importance (Ramsar sites), three types of forested wetland are recognised:

- Intertidal forested wetlands: including mangrove swamps, nipah swamps and tidal freshwater swamp forests (type I);
- Freshwater, tree-dominated wetlands: including freshwater swamp forests, seasonally flooded forests, and wooded swamps on inorganic soils (type Xf); and
- Forested peatlands: including peatswamp forests (type Xp).

Therefore, the Convention has many references to the CBD and is implemented in a comprehensive way, following a joint working plan (5th Joint Working Plan 2011–2020). However, to date, country declarations of adherence to the Ramsar Convention have not led to an overall improvement in the protection of wetlands, including forested peatlands, worldwide. In fact, an accelerated loss can be observed globally (Ramsar Convention on Wetlands 2018; Geijzendorffer et al. 2019). Effective monitoring is still not provided at most sites, and capacity building, e.g., in terms of remote sensing tools, remains necessary (Navarro et al. 2017). Apart from that, as with the CBD and most multilateral environmental agreements, the Ramsar Convention does not constitute concrete instrumental and enforceable measures and lacks effective implementing mechanisms that are capable of permanently restraining the drivers of (forested) wetland destruction (Gaget et al. 2020).

[11] Convention on Wetlands of International Importance especially as Waterfowl Habitat, 02/02/1971, Ramsar, Iran.

5.1.2 Results-Based Payments to Protect Forests – The Example of REDD+

5.1.2.1 Development of REDD+ and General Functionality

The groundwork of forest protection under the UNFCCC was laid down with the Kyoto Protocol in 1997, where according to Art. 3.33 afforestation, reforestation and deforestation activities have to be monitored and reported. Furthermore, Art. 10.b.i Kyoto Protocol calls for the establishment of suitable programmes for climate mitigation, among others for the forestry sector. This led to concepts of Avoided Deforestation (AD); this concept still plays a major role in voluntary carbon markets (Streck 2020). Furthermore, it led to Reducing Emissions from Deforestation in Development Countries (RED), an innovative legislative proposal set up by Costa Rica and Papua New Guinea in 2005 (Arts et al. 2019). At the Bali conference in 2007 RED was complimented by Forest Degradation (REDD) and implemented under the framework of the UNFCCC. It functioned as a comparably simple financial instrument to prevent deforestation mainly caused by industrialised agriculture projects, mining, and infrastructure development and to reward forest protection measures in developing countries. Finally, in 2013, forest management and reforestation were additionally included in the approach leading to REDD+ under the Warsaw Framework at the 19th conference of the parties under the UNFCCC (COP 19) (Warsaw Framework for REDD-Plus). Thus, via a number of alterations, the REDD+ approach has evolved towards a broader programme to establish low-carbon pathways (Bastos Lima et al. 2017). A compilation of all key decisions with relevance to the REDD+ framework under the international climate regime can be found here (UNFCCC 2016).

The current basis for the implementation of REDD+ into the international climate regime can be found in Art. 5 PA which highlights the role of land-use related emissions and sinks, including forest ecosystems.[12] As already mentioned briefly in Sect. 5.1.1, it says:

Art. 5 para. 1 PA: Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of GHGs as referred to in Art. 4, para. 1 lit. d, of the Convention, including forests.

Art. 5 para. 2 PA: Parties are encouraged to take action to implement and support, including via results-based payments, the existing framework as set out in related guidance and decisions already agreed to under the Convention for: policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+); and alternative policy approaches, such as joint mitigation and adaptation approaches for the integral and sustainable manage-

[12] Decision 1/CP.21 of COP 21 to the UNFCCC on the Adoption of the Paris Agreement, Art 54, 29/01/2016, FCCC/CP/2015/10/Add.1.

ment of forests, while reaffirming the importance of incentivising, as appropriate, non-carbon benefits associated with such approaches.

REDD+ provides the basis for efforts to monetize the forest sector, because not only destruction can be punished, but also conservation rewarded. It aims to commodify forested land by accrediting certificates per ton of CO_2 stored and therefore enables the commercialisation of forest functions, especially the carbon storage potential and its integration into a market economy (Kemfert and Tol 2002; DeShazo et al. 2016; critical already Ekardt et al. 2018a). The idea is that by allocating monetary value to forests, they receive more attention in future policy decisions, thus increasing forest preservation in developing countries. Emitters can purchase emission reduction units to offset their carbon footprint and developing countries and forest owners can use the money to protect the forests (e.g., from deforestation), creating a win-win situation (DeShazo et al. 2016).

REDD+ has the potential to be an attractive instrument for states, as – direct action concerning forest management on their part is not necessarily required, or that needs to be supported by strong partnerships (Brown 2013, 4) – basically, states can be paid to do nothing to their forests and to simply avoid deforestation. However, the aim is that the developing countries additionally establish policies and incentives addressing the drivers of deforestation and aim to protect the rights of indigenous peoples as well as vulnerable communities, to alleviate poverty and to improve tenure rights for the rural population (Andersson et al. 2018; Streck 2020). Along with the involvement of a broad set of private and state actors as well as international institutions, REDD+ is therefore meant to be able to address several issues associated with forest preservation, i.e. enhancing sink capacities, biological diversity, socio-economic aspects, and development aid (Brown 2013). Thus, the approach has been transformed from the "world's largest experiment in Payments for Ecosystem Services" (Corbera 2012), to a "results-based aid" (Angelsen 2017; Arts et al. 2019).

5.1.2.2 Design and Financing of the REDD+ Framework

There is general agreement on three necessary steps to implement REDD+:

(1) Creating Readiness for REDD, which includes national action and strategy plans, capacity building, fundraising and establishing partnerships and setting up a scheme for monitoring, reporting and verifying (MRV) the effects on sink capacities and other relevant parameters.
(2) Implementation of said action and strategy plans and development of further measures, as well as establishing results-based demonstration activities and technology development and transfer.
(3) Measuring, reporting and verifying the results-based activities, "allowing countries to seek and obtain results-based payments" (UNFCCC 2020).

The first two phases are mainly supported by the UN-REDD program, a joint initiative of the UN Food and Agriculture Organisation (FAO), the UN Development

Program (UNDP) and the UN Environment Program (UNEP). While FAO is mainly involved in the development of MRV standards and procedures, UNEP and UNDP are concerned with the planning and implementation of activities (UNFCCC 2020). Developed countries like Norway, Germany, the UK, Australia, and the US aimed to reach Readiness for REDD between 2007 and 2015 (Arts et al. 2019). Until today 634 projects and programs are listed in the international database on REDD+ of which 416 are active (REDD Projects Database (Simonet et al. 2021). However, in order to contribute effectively to achieving climate (and possibly biodiversity) targets, MRV stands at the core of any REDD+ project (UNFCCC 2013a). Due to the complexity of monitoring and measuring GHG fluxes in forest ecosystems, further aggravated by the setting of projects in developing countries with weaker infrastructure and little finances to do so (Global Forest Coalition 2013), this remains a weak spot in the framework as will be further discussed in the following.

The financial basis for REDD+ is ensured either by public funding through governments, by multilateral funds managed by (1) the World Bank (Forest Carbon Partnership Facility (FCPF)[13] and the BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL), (2) the Global Environment Facility (GEF), (3) the Green Climate Fund and (4) the UN-REDD program itself (Atmadja), or the private sector, e.g., companies. Since 2010 almost 4.7 billion USD have been pledged by governments as the financial basis for REDD+ projects, while Germany (REDD Early Movers Program), Norway (Norway's International Climate and Forest Initiative, concerning Indonesia and Brazil), United Kingdom, United States and Australia account for the largest share (Brown 2013, 6; NYDF Assessment Update 2019; Streck 2020). Nevertheless, there are uncertainties regarding the long-term financing of the programme (Olesen et al. 2018). The necessity to increase the involvement of the private sector is regularly highlighted, not least because a secure long-term financial basis must be generated as long as support for forest protection is confronted with ever higher opportunity costs of forest use (Henderson et al. 2014; Angelsen 2017; Atmadja et al. 2018), see also Art. 77 of Decision 16.1.[14]

Also, the specific design of the REDD+ framework is still very controversial in its details: there are several options on the table (e.g., inclusion in the emissions trading, financing mainly by funds such as the UN's Green Climate Fund, development of entirely new instruments), without any indication of finding a consensual solution or institutional or state leadership to push forward with the matter (Brown 2013; Savaresi 2013; DeShazo et al. 2016). The difficulties resulting from this are discussed further in Sect. 5.1.3.5.

[13] As an exception the FCPF explicitly requires the generation of tradable units from the generated emission reduction and removals (Streck 2020).

[14] Decision 16.1 of COP 16 to the UNFCCC on the Cancun Agreements: Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention 15/03/2011, FCCC/CP/2010/7/Add.1.

5.1.2.3 Calculation of Emission Reductions and Removals by Sinks Against a Forest Reference Level

Emission reductions and removals by sinks (including the enhancement of carbon stocks and forest areas) are calculated against a forest reference emission level and/or forest reference level (FRL). The FRL is a forward-looking projection of the future development of carbon stock changes/GHG fluxes in a specific forest area and functions as a baseline, assuming a business-as-usual scenario[15] (Decision 13/CP.19). Thus, already the FRL itself is based on a modelling process that includes inter alia historical data, estimated harvesting intensities, but also future changes in forest management due to domestic policies (Decision 13/CP.19). Against this "counterfactual emission scenario" (Streck 2020, 5), emission reductions and removals that have been monitored according to the most recent IPCC guidance and guidelines (para. 2, Decision 11/CP.19) are accounted for. Hence, beneficiaries have to develop their own methodology to establish the FRL. The process is their responsibility, is highly complex and leaves a lot of room to manoeuvre (Chagas et al. 2011). Only general rules are set, particularly that the accounting should be "transparent, complete, consistent and accurate, including methodological information, description of data sets, approaches, methods, models" (Decision 13/CP.19, Annex No. 2c) and, in accordance with Art. 4 para. 13 PA, should not lead to any double counting. Apart from that, the FRL is supposed to be consistent with the national GHG inventories, provide information about the historical data used and whether "assumptions about future changes to domestic policies have been included in the construction" (Decision 13/CP.19, Annex No. 2h). The REDD+ approach thus allows the inclusion of higher than expected harvesting intensities due to domestic policy changes (see in detail to criticism concerning accounting against a FRL Sect. 5.2.2). This is why emission reductions can be easily achieved if the real harvesting intensity is less than the (in the worst case generously) predicted harvesting in the FRL. Even though this weakens the general intentions of the REDD+ approach, this procedure is expressly intended. Although any submission of an FRL by a developing country will be assessed by technical experts from the UNFCCC secretariat, including representatives from developed and developing countries (Decision 13/CP.19, Annex No. 5–9), it is stated in Decision 13/CP.19 that "the assessment team shall refrain from making any judgments on domestic policies taken into account in the construction of forest reference emission levels and/or forest reference levels" (Decision 13/CP.19, Annex No. 5). Thus, although in reality the sink capacity of a specific forest might not increase and may even decline due to increased harvesting, it is possible to generate tradable emission accountings (carbon rights) as long as they are covered by domestic policies. This high flexibility concerning the calculation of FRL is also a reason why in general, accounted emission reductions and removals are hardly the same between different beneficiaries. The emission savings accounted for therefore lack comparability (Streck 2020) and emission leakage as

[15] Decision 13/CP.19 of COP 19 to the UNFCCC on Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels, 22/11/2013, FCCC/CP/2013/10/Add.1.

an "ubiquitous phenomenon in climate mitigation" (Streck 2021) cannot be ruled out.

Due to a lack of historical data, e.g., for a long time, Indonesia has not included peat fires in their calculation of the FRL (Mongabay 2020). Thus, emission savings could be generated although large areas of wetlands and their forests were burning, destroying biodiversity, carbon sinks and livelihoods. Indonesia is among one of the countries with the highest rates of forest degradation and deforestation globally (Enrici and Hubacek 2016). Yet, Indonesia received extremely large amounts of financial support based on REDD+ (Hayasaka et al. 2020). Looking to the future, the danger increases that the rates of GHG emissions due to large-scale fires in ecosystems dominated by peatlands will now be included in the calculation for the new FRL. Then once again, considerably high payments could be generated, although the trend towards forest destruction continues, only somewhat reduced compared to the negative values in the recent past. This is just one example of how payments can be generated even if – apart from single positive forest protection initiatives – the general trend towards deforestation continues.

One positive exemption is Costa Rica that managed to restore forest cover from 21% in the 1980s to currently 52% and also included indigenous people in the engagement of the REDD+ scheme (Stubenrauch 2019, 152). However, the success of the REDD+ scheme in Costa Rica can also be attributed to a very strict command-and-control regulation concerning forest protection, which even foresees punishing illegal deforestation with prison sentences (Wallbott and Florian-Rivero 2018; Stubenrauch 2019). The establishment of a wide net of protected forest areas at the same time have led to success in steadily increasing forest cover since the 1980s. The key for effective forest protection might therefore lie in a clever mix of command-and-control regulations and incentives through funding regimes such as REDD+. However, Costa Rica, a small country that relies on (eco)tourism as an important economic pillar, also faced huge transitions in the agricultural sector in favour of large-scale plantations, e.g., of pineapple or banana; not at the cost of forests but at the cost of small-scale farmers that now hardly exist. This problem, of unsustainable agriculture with high usage of pesticides and mineral fertilisers is still to be solved in this showcase country that can demonstrate major successes in reforestation and forest protection (Stubenrauch et al. 2018; Stubenrauch 2019).

5.1.2.4 Carbon Credits – Tradability and Competitiveness Between Private REDD+ Credits and Results-Based Payments to States

Another question is how tradable carbon credits can be generated from the calculated emission reductions under REDD+ and who has the right to trade and benefit from them (carbon rights). To qualify for "legally defined certificates", emission reductions need to meet specific carbon-market standards and follow additional criteria (Streck 2020, 4). The intricate challenge is that private or public carbon market standards and funding regulations next to domestic REDD+ regulations can differ, as well as those who profit and receive payments which could be private actors such as forest owners or states. Due to the previously described differing standards regarding the establishment of FRL as well as "competing measurement and accounting systems" (Streck 2020, 5), it becomes clear that overlaps and double counting of carbon rights in this potpourri of possibilities are difficult to rule out (Streck 2020, 5).

The Warsaw Framework of COP 19 does not explicitly formulate rules for a carbon market but proposes that REDD+ could be linked to market-based or other cooperation mechanisms and refers to Art. 6.2 and 6.4 of the Paris Agreement (UNFCCC 2013a, para. 15; Streck 2020). The latter, together with Decision 1/CP.21, provides for the following market rules and flexible mechanisms:

- Cooperative Approaches among UNFCCC Parties that can transfer credits amongst each other to achieve their NDCs;
- Mitigation and Sustainable Development Mechanisms (MSDM), similarly but not equally to JI and CDM (i.e., usable by all parties and not only developed countries);
- non-market approaches (Tänzler et al. 2018, 49).

As states have firstly not fully agreed on the specifications of the flexible mechanisms and secondly, as an international carbon market for the post-2020 period is yet to be fully developed, it remains to be determined whether REDD+ certificates will be creditable in international emission trading schemes that thus far compete with national or transnational emission trading systems (Tänzler et al. 2018, 49; UNFCCC 2020). In the case of cooperative approaches and bilateral transfers, the rules of accounting for NDC set by the UNFCCC have to be followed. The transferring country can subtract internationally transferred mitigation outcomes (ITMOs) (e.g., based on REDD+ activities) from their NDCs, while the acquiring country has to add them to their NDCs to avoid double counting (Decision 1/CP.21, para. 36).

Additionally, domestic REDD+ legislation, in which REDD+ projects can be nested in, competes with private standards which function independently of the Warsaw Framework, following different rules and assumptions. This voluntarily offsetting of credits is characterised by a "vibrant market" (Streck 2020, 4). Examples of market-based approaches are the Verra's Verified Carbon Standard (VCS) (Verra 2021) or the new ART/Trees standard (ART 2021). Apart from that, REDD+ offsets can also be linked to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which came into force in 2021 and aims to offset all emissions above a certain baseline to reach so-called carbon-neutral growth (ICAO 2017; Tänzler et al. 2018, 52). The risk of double-counting between the different approaches thus further increases (REDD-Monitor 2020a, b). This is even more true as carbon rights still lack clear legal definition and taxonomy (Streck 2020). Again, comparability is hardly achievable as far as "the definition of carbon rights and the legal nature of carbon credits depend on local law and differ between countries" (Streck 2020).

Thus, assessed credits gained under voluntary markets also can contribute to the NDCs under the Paris Agreement and once on the market, certificates remain tradable (DeShazo et al. 2016; UNFCCC 2016). In case a cap-and-trade system (such as the EU ETS) allows the offsetting of credits, e.g., under the CDM, emission reductions and removals become a licence to pollute. In contrast to the current EU ETS thus far only the New Zealand emission trading system (NZ ETS) covers the land use sector as well (Government of New Zealand 2008; critical Ekardt et al. 2018a, 2020).

5.1.2.5 Discussion and Critical Assessment of the Effectiveness of REDD+ Concerning Forest Protection

In general, the goal to stop devastating deforestation and preserve particularly primary and old-growth forests could thus far not be reached by REDD+. Despite the US$ 230 million paid under the Green Climate Fund alone for REDD+ to Brazil, Ecuador, Chile, and Paraguay, deforestation has increased in each of the countries (Farand 2020). Likewise, Indonesia has had accelerating and the worldwide highest deforestation rates over the last two decades, despite the introduction of REDD+ in 2007 (Enrici and Hubacek 2016). The main causes are the expansion of large-scale agricultural systems, such as palm oil plantations. It becomes clear, that the real drivers of deforestation cannot be addressed sufficiently by REDD+, as it focusses rather on local communities instead of the bigger drivers, i.e., intensified fodder and biomass production (Skutsch and Turnhout 2020). Thus, REDD+ has little impact on deforestation and GHG emissions globally, and cannot stem the tide of ongoing and accelerating deforestation. Governments in fact get paid without confronting the drivers of deforestation sufficiently. Therefore also demand-sight standards in importing countries need to be tackled (Streck 2021). Here, economic policy instruments can generally be well suited to address global environmental issues and usually allow for a cost-effective volume control of the polluter being regulated. This is all the more remarkable because economic instruments for drivers such as livestock products or fossil fuels would not suffer from the identified problem of depicting, because they provide an easily measurable governance unit (Hennig 2017; Ekardt et al. 2020; Weishaupt et al. 2020; Garske and Ekardt 2021).

The addressing of indigenous rights and community participation is a further crucial issue (Savaresi 2013; Kronenberg et al. 2015; Streck 2021) that seems to rather overload the scheme than to be able to be fulfilled by it and needs to be better addressed in the future (Dupuits and Cronkleton 2020; Löw 2020). The FAO has developed Guidelines for Seeking the Free, Prior and Informed Consent to create a procedure to safeguard human rights (FAO 2016). However, these are voluntary standards that the World Bank adopted for REDD+, while changing the word consent to consultation. This is just one vivid example of the ambiguities that still exist (Brown 2013; Global Forest Coalition 2013; DeShazo et al. 2016; Savaresi 2016). Additionally, when local communities have to decide how to allocate financial benefits (Streck 2020), it was proven, that oftentimes only certain kinds of privileged groups received most of the payments, and the so-called elite-capture takes place (Andersson et al. 2018). Combined with the fact that the FRL's calculation provides a generous balancing leeway in terms of generating emission reductions not necessarily reflected in reality, it is questionable whether or to what extent this instrument can contribute to forest protection. In the worst case, the relatively easy way to generate carbon credits by REDD+ might additionally hinder necessary mitigation measures in industrialised countries, as the opportunity to simply compensate for inadequate measures is provided.

Thus, setting aside individual successes in smaller countries like Costa Rica, the REDD+ scheme faces a general lack of political leadership and of agreement in defining key parameters, benchmarks and procedures, and there is a practical standstill in the large-scale implementation of the framework (Brown 2013; Savaresi 2013; DeShazo et al. 2016). The "dearth of definitions" (Streck 2020) leads to several ambiguities, especially, since there are a number of institutions and stakeholders involved. This regards, for example, the definition of sustainable forestry, even when the quality standard for forests is quite low, allowing even rather monocultural plantations to be creditable under REDD+ (Soedomo 2018). This is why intensified livestock farming might be compensated through monocultural afforestation at the expense of biodiversity-rich grassland or wetland ecosystems (Verschuuren 2017). REDD+ is therefore, in its current configuration, not a ground-breaking instrument to slow the general trend of deforestation, especially in the Global South (Brown 2013; Global Forest Coalition 2013; Ekardt 2019). This is not only due to insufficient legislation that tries to leave more leeway than desirable, measured against what we learned about human motivation (in Chap. 2). Beyond that, it represents the problems of baselines and of depicting which is difficult to solve in land use and in forestry in particular (Sect. 4.2; Ekardt et al. 2018a, 2020) and which is already well-known from the long debate on the Clean Development Mechanism (CDM) (Ekardt and Exner 2012; Exner 2016).

In the future, REDD+ credits could possibly either become part of an existing international market (which effectively does not currently exist, as the above-mentioned criteria are not met), or be tradable only within a possible LULUCF-emissions system. The absence of both is one of the reasons REDD+ still has considerable financing problems and mainly relies on international funds. Either the amount of CO_2 or CO_2-equivalents as in the case of REDD+, or the forested area could be the reference unit for a respective market. Creating a closed market that many parties and all sectors belong to is imperative to prevent loopholes, surplus allowances and double-counting of reduction activities (Ekardt and Wieding 2017; Ekardt et al. 2018a; Ekardt 2019). In contrast, allowing for credits from external mechanisms opens the market up for additional emission allowances, diminishing the emission reduction incentives. This has been clearly demonstrated by credits from the CDM (Larson et al. 2011; Savaresi 2013; Horstmann and Hein 2017; Köhl et al. 2020).

5.1.3 Non-legally Binding International Law

The international arena knows some more voluntary initiatives besides REDD+. In past years, many international initiatives emerged with the goal of restoring forests or stopping degradation, usually also including non-forest areas. These operate on a wide range of international and national as well as, state and private actors. Usually however, a stringent set of policies or other instruments to achieve the set targets is missing, as we will see in the following.

5.1.3.1 Sustainable Development Goals

Aside from the main treaties in international environmental law, the Sustainable Development Goals (SDGs) are at the forefront of several soft-law approaches and political programs. These indicate general environmental targets as guidelines for action. SDGs have the potential to foster global awareness, public pressure, political accountability, and provide a basis for global debates (Bastos Lima et al. 2017; on contradictions, vaguenesses and the non-binding character of the SDGs see Ekardt et al. 2021). All of the 17 SDGs with their specific sub-targets are connected more or less strongly to forests and the people depending on them (Katila et al. 2019) Indirect connections are found in most of the 17 goals:

- SDG 1: no poverty – tenure security and building resilience on forests (Lawlor et al. 2019);
- SDG 2: zero hunger and SDG 12: responsible consumption and production – run on land due to large-scale agriculture projects (Sunderland et al. 2019) and reduced land take due to shifted consumption patterns and reduced food-waste (Hedenus et al. 2014; Tilman and Clark 2014; Mader 2019; Schröder et al. 2019; Garske et al. 2020);
- SDG 3: good health and wellbeing – co-benefits of forests for people's health (Ohm et al. 2017; McFarlane et al. 2019; UNEP and ILRI 2020);
- SDG 4: quality education – in relation to forests and their value or concerning their management see Kanowski et al. 2019;
- SDG 5: gender equality and SDG 10: reduced inequality – stronger dependency of women on land (Savaresi 2013, 2016) and question of environmental justice related to forests (Basnett et al. 2019);
- SDG 6: clean water and sanitation – forest-water interactions and the preservation of water reservoirs for clean drinking water (Amezaga et al. 2019);
- SDG 7: affordable and clean energy – energy transition and biomass production from forests (Hennig 2017; Jagger et al. 2019);
- SDG 8: adequate work and economic growth and SDG 9: industry, innovation and infrastructure – trade-offs concerning expanding agriculture, mining, energy and other industrial projects at the expense of forests vs. synergies from, e.g., ecotourism or payments for ecosystem services (de Jong et al. 2019; Stoian et al. 2019; Tomaselli et al. 2019);
- SDG 11: sustainable cities and communities – resource consumption in cities, inclusion of forests in urban planning processes, urban-rural linkages and people-nature connections (Devisscher et al. 2019);
- SDG 13: climate action – preservation and enhancement of natural sink capacities (Carey et al. 2001; Luyssaert et al. 2008; Grassi et al. 2017; Louman et al. 2019);
- SDG 14: life below water – preservation of mangroves (Thompson et al. 2017; Friess et al. 2019);

- SDG 16: peace, justice and strong institutions – implementation of forest legislation, prevention of illegal logging, fair world trade between the Global North and South (Humphreys 2016; Leipold et al. 2016; McDermott et al. 2019);
- SDG 17: partnership for goals – international cooperation in forest conservation and restoration (Humphreys et al. 2019).

Apart from the manifold indirect connections it is SDG 15 (life on land) which directly addresses forests in terms of protection, restoration and sustainable management in order to halt and reverse land degradation and biodiversity loss by2030. The main challenge is to integrate this target successfully into the other SDGs and thus to search for cross-sectoral solutions to achieve the targets concerning forests in accordance with the other SDGs (Sayer et al. 2019), which is particularly challenging concerning the SDG 9 (industry, innovation and infrastructure) that needs to be developed in a sustainable manner and therefore oftentimes requires fundamental transformation processes (de Jong et al. 2019).

The 2030 Agenda was adopted by the UN General Assembly as a resolution within the meaning of Art. 10 of the UN Charter, so that the 2030 Agenda is not binding soft law under international law (on the following Ekardt et al. 2021). This is because the General Assembly has no competence under any legal norm to set binding law (Biermann et al. 2017; Pavoni and Piselli 2016; Pogge and Sengupta 2015; Nowrot 2020; Dulume 2019). In particular, the SDGs are neither a treaty under international law within the meaning of the declaratory enumeration of the various sources of international law in Art. 38 para. 1 lit. a ICJ Statute, nor a general principle of law within the meaning of Art. 38 para. 1 lit. c ICJ Statute (Huck and Kurkin 2018; Ekardt and Hyla 2017; Ekardt 2019). For the qualification of the SDGs as customary international law within the meaning of Art. 38 para. 1 lit. b ICJ Statute, there is for the time being still a lack of ongoing legal practice with regard to the implementation of the SDGs. Consequently, although UN resolutions could certainly be suitable as a medium for this, the SDGs do not in any case declaratively reflect customary international law.

5.1.3.2 International Agreements on Forest Protection and Global Forest Goals

In 2019, the UN Forum on Forests (UNFF) provided the draft for the first United Nations Strategic Plan for Forests (UN SPF) 2017–2030 which is contained in the ECOSOC Resolution 2017/4 (E/RES/2017/4) and defines six global forest goals (Fig. 5.1) and 26 associated targets (UN 2017). It aims to reinforce the Aichi Targets, the targets of the Paris Agreement and the SDGs all in one. Specifically, it sets the target to reverse the loss of forest cover worldwide, increase global forest area by 3% and maintain or enhance global forest carbon stocks by 2030. The resolution has declarative character and is – like the SDGs – not legally binding. The UNFF was founded in 2000 and was installed to further debate the objectives and the content of an alternative international forest convention, after the initiation of a Global Forest Convention 1992 in Rio never came to pass. In 1992 the Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forests (so-called Forest

Fig. 5.1 Global forest goals according to the United Nations Strategic Plan for Forests. (Own figure based on UN 2017, 6–9)

Principles) and the Chap. 11 of Agenda 21 on Combating Deforestation were established. As a follow-up, in 2007, so-called non-legally binding instruments in all types of forests were adopted by the UN General Assembly and renamed as the United Nations Forest Instrument (UNFI) in 2015. Four global objectives on forests were set: (1) to halt deforestation, (2) to enhance economic, social and environmental benefits, (3) to increase the area of protected and sustainably managed forests worldwide and (4) to strengthen official development assistance and financing (UN Forum on Forests Secretariat 2018). Those principles have now been integrated in the six global forest goals, shown in Fig. 5.1.

While the debate on international legally binding rules regarding forests is ongoing, it has not succeeded in proposing a passable forest convention. Lines of disagreement are mostly between developing countries with tropical forests that fear intrusion by industrialised countries. One concern is, for example, for the livelihoods of indigenous and local communities. Another argument concerns interference with their national sovereignty, assuming that industrialised countries conveniently use tropical forests as sinks to compensate for emissions and degradation at home (Sotirov et al. 2020). Therefore, even in the absence of a Global Forest Convention, existing conflicts of objectives – which are also reflected within the various and often contradictory SDGs – remain, and cross-sectoral solutions have to be found between the global North and South, also involving marginalised population groups on equal terms (de Jong et al. 2019; Winkel et al. 2019).

5.1.3.3 International Declarations to Halt Deforestation

Governance initiatives based on “ministerial-level political processes” (Worldbank 2013) can be found in different world regions and aim at creating awareness for the existing problems of forest degradation and deforestation and to stimulate political processes and improve forest legislation and their enforcement. Examples are:

- The Bali Declaration, focussing on forest law enforcement and governance in East Asia which was endorsed in 2001 at the East Asia Ministerial Conference.
- The Africa Forest Law Enforcement and Governance (AFLEG) Ministerial Conference in Cameroon, that adopted the AFLEG Declaration and Action Plan in 2003.
- The New York Declaration on Forests is a recent international declaration, established at the UN Climate Summit 2014. It unites national and regional governments, companies, indigenous representatives and non-governmental organisations in their aim to halt global deforestation (Forest Declaration 2021).
- The Glasgow Leaders' Declaration on Forests and Land Use, established at the UN Climate Change Conference 2021. The leaders inter alia committed to work collectively to halt and reverse forest loss and land degradation by 2030 (UK COP 26 2021).

All these declarations have in common that they are voluntary and non-binding, trying to incentivise efforts to strengthen national or international policies and their implementation to counteract accelerating global deforestation. However, it has not yet been possible to achieve sweeping successes in reversing the global trend, even if it may be that individual successes have been achieved with regard to improved legislation on forest protection in certain regions/countries. The problem that, above all, the drivers of deforestation need to be addressed by effective legal instruments is once again evident here.

In contrast to this, the Bonn Challenge was set up by in 2011 as an initiative of the International Union for Conservation of Nature (IUCN) and is aiming to bring 150 million hectares of deforested and degraded land into restoration by 2020 and 350 million hectares by 2030 based on the concept of forest landscape restoration (IUCN 2020). Here, concretely degraded areas are supposed to be reforested and their ecological functionality restored. Guidelines that regulate how afforestation should take place in order to be sustainable and that tackle the manifold trade-offs connected with afforestation (see Sect. 4.2.2) therefore exist. Up to now there are 62 commitments concerning 172.35 million hectares. However, the progress of the actual restoration process is not entirely documented and the Bonn challenge suffers from insufficient participation and requires better country-level forest accounting (since 2011 there are just 62 commitments) (Bastin et al. 2019). Not least, once again, deforestation drivers cannot be addressed appropriately by such a voluntary initiative.

5.1.3.4 Forest Certification Schemes

The Forest Stewardship Council (FSC) is a transnational standard or certification scheme, aiming at the promotion of "environmentally appropriate, socially beneficial, and economically viable management of the world's forests" (FSC 2018) to avoid deforestation etc. To reach a certification status organisations have inter alia to comply with applicable laws (which however might be non-existing or legally weak), to respect workers' rights and employment conditions as well as indigenous peoples rights, to contribute to community relations, to avoid, repair or mitigate negative environmental impacts, to provide a management plan for the forest and monitor the management activities, and to apply a precautionary approach to enhance or maintain a high conservation value (FSC 2018). In 2016, a forest area of 195 million hectares across 80 countries was certificated by the FSC standard (Rafael et al. 2018).

However, scientific research demonstrates that the scheme suffers from diverse shortcomings. Firstly, the FSC does not provide a clear set of biodiversity protection criteria. Secondly, particularly in tropical countries, more technical guidance is needed to overcome the barriers of the certification process (Rafael et al. 2018; Bhattarai et al. 2019), so that more companies are willing to join the scheme. Guidance is sometimes also needed to be able to comply with certain aspects of FSC (Rafael et al. 2018). Thirdly, concerning the effectiveness of the FSC certification scheme, the influence and subjectivity of local certification bodies should be considered. It was proven for Brazil that the latter can widely influence the granting of the domestic FSC standards (Piketty and Drigo 2018). Also, it was shown that despite non-conformance with the standards, companies might be re-recertified. However, improved management practices cannot always be guaranteed. The possibility of interpreting domestic standards broadly within the scope of discretionary powers further impedes effective control as was also shown in the example of Brazil (Piketty and Drigo 2018). In general, the successful involvement of the government of the countries concerned with the FSC process is decisive for the potential success of the – again only voluntary scheme – as can be shown in the example of a comparative study between Belarus and Poland (Niedziałkowski and Shkaruba 2018).

The Programme for the Endorsement of Forest Certification Schemes (PEFC) is, next to the FSC standard, the worldwide leading forest certification scheme (Lopatin et al. 2016). Approximately 75% of all certified forests are covered by the scheme. In total, 330 million hectares of forests worldwide are managed according to the internationally accepted PEFC Sustainability Benchmarks (PEFC 2021). However, the example of Sweden shows that next to the FSC scheme standards of the PEFC certification also need to be tightened to show significant effects on forest nature conservation (Nordén et al. 2016). Apart from that, it was proven for Finland that control and field-audits are demanding due to the rapid increase in certified areas and scattered logging sites and require further improvement, for example, through geographic information systems (GIS) application. To date, it is mainly the auditors' varying expertise in sustainable forest management that influences the assessment of the certification bodies, which is moreover based on individual samples and thus needs to be questioned frequently (Lopatin et al. 2016).

5.1.4 Interim Conclusion on International Forest Policy

The international policy level concerning the protection of global forests is characterised by the following policy instruments:

- Multilateral environmental agreements (MEAs), in particular the CBD, the Paris Agreement, the UNCCD, CITES and the Ramsar Convention on Wetlands that provide legally binding targets to their parties concerning the protection of the climate, the conservation of biodiversity, the preservation of soils in drylands, and the preservation of wetlands and endangered species. All of them entail manifold references to global forest protection. However, the MEAs do not usually provide concrete governance instruments but only targets and overall provisions. Furthermore, although legally binding, there is oftentimes a lack of effective enforcement provisions in case of a non-compliance by the contracting parties and thus they cannot reach the desired effect.
- Funding regimes such as REDD+ that aim at incentivising forest protection provide at least some kind of instrumental approach and not only targets. However, they represent various shortcomings of forest governance in terms of (1) the weak accounting rules for saved emissions, (2) the generation of carbon rights and their tradability in different (private or public) carbon markets, so that double counting cannot be ruled out, (3) a problem of long-term funding and (4) the thus far not equally involved marginalised groups in the scheme and an elite capture of the generated payments, while not effectively tackling the drivers of deforestation. All in all, such approaches have not taken the problem of depicting sufficiently into account so far. In the same way, there is no clear framework for establishing, for example, economic instruments for the drivers of deforestation on an international level. This is why the approach so far cannot reverse global deforestation practices.
- There is at least some soft law, e.g., provided by the SDGs with all of the 17 SDGs connected to the protection of forests and their sustainable management, while some may even be counterproductive for successful protection and restoration of global forests. Apart from that, international and also non-legally binding declarations try to tackle deforestation in certain world-regions, albeit again without the ability to address the main drivers of deforestation effectively and thus restricted concerning their effectivity. The same is true for voluntary international certification schemes, like the FSC and the PEFC approach that aim for the sustainable management of forests and their protection, but either lack participation, particularly in tropical countries, and/or strict biodiversity criteria and strict implementation of the goals set.

Therefore, it can be stated that international obligations concerning forest protection are widely fragmented and no overarching and coherent forest policy on an international level exists. However, the legally binding MEAs clearly require involved parties to take action to firstly preserve their national forests and secondly, to minimise their impact on deforestation and forest degradation apart from their national borders. This has to be done through an adequate domestic or supranational (such as at the EU level) climate, biodiversity and forest policy that is also intertwined with the development of sustainable trade agreements in the future. The soft law provisions as well as specific funding schemes for forest protection point in the same direction and underpin the legally binding MEAs. Thus, although an international forest convention does not exist (that would most probably have the same problems concerning their implementation and enforcement as other MEAs), an obligation to protect forest ecosystems and to halt global deforestation can be derived by the existing policies – especially from the overarching and legally binding targets in PA and CBD (Sects. 5.1.1.1, 5.1.1.2 and 2.1).

5.2 Supranational Policy Level – Further EU Legislation on Forests and Their Management

Since there is no European common forest policy, forestry policy is a national competence. Nevertheless, forests are indirectly affected by many EU policies and initiatives including the biodiversity, agricultural and climate sector (European Parliament 2021a). These policies are analysed in the following chapters: After an overview regarding non-legally binding strategies tackling the forest sector (Sect. 5.2.1) the EU climate framework including the LULUCF Regulation and the Renewable Energy Directive and their impact on forest ecosystems is assessed (Sects. 5.2.2 and 5.2.3). Apart from that, the EU Timber Regulation as a transnational standard on sustainable forest management (Sect. 5.2.4), the EU Biodiversity and Nature Conservation legislation (Sect. 5.2.5), the Common Agricultural Policy (Sect. 5.2.6) as well as further directives that indirectly influence the forest sector (Sect. 5.2.7) are evaluated.

5.2.1 EU Strategies Related to Forests and Their Management

During the last several years, more and more strategies of the EU recognise forests as important components to achieve various environmental and sustainability targets. The respective strategies are briefly presented in the following. Within the framework of the European Green Deal (European Commission 2019e), the Commission points out the need to improve the quality and quantity of forested area to reach climate neutrality and a healthy environment (European Commission 2019e, 13). To this end, the Commission will, inter alia, take measures to promote imported products and value chains that do not contribute to deforestation and forest degradation (European Commission 2019e, 14), which is also in line with the Communication on Stepping up EU Action to Protect and Restore the World's Forests (European Commission 2019a) and the Farm to Fork Strategy (European Commission 2020a).

Next to the Farm to Fork Strategy (see below), a core element of the Green Deal, is the EU Biodiversity Strategy for 2030 (European Commission 2020c) aiming at putting biodiversity on the path to recovery by 2030 through protecting and restoring nature in the EU (European Commission 2020c, 3). Primary and old-growth forests are one main focus of the strategy because they are biodiversity-rich ecosystems with high climate value (European Commission 2020c, 3). In line with the CBD, the Biodiversity Strategy intends to ensure a contribution to reverse biodiversity loss (European Commission 2020c, 2 et seq.), which does not only call for the strict protection of remaining forests but also for the restoration of degraded forests as well as re-/afforestation according to specific criteria.

Rather than aiming at strict protection, restoration and re-/afforestation, the EU Forest Strategy from 2013 focusses on sustainable forest management, which is defined as “using forest and forest land in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems” (European Commission 2013b; based on Forest Europe 1993, 1). However, despite this overall definition of sustainable forest management in the Helsinki Declaration elaborated by Forests Europe, particular interpretation of what sustainable forest management is about varies within the EU Member States and is rather “linked to factors such as the economic importance of the forest sector, forest policy priorities, and the forest ownership structure” (Sotirov et al. 2021, 69).

To promote sustainable forest management in Europe and globally, the 2013 EU Forest Strategy already emphasises the funding of forestry measures, e.g., by the European Agricultural Fund for Rural Development (EAFRD) (see Sect. 5.2.6), the EU’s Environment and Climate Action Programme LIFE 2014–2020, the Cohesion Fund and the Solidarity Fund (in the case of major natural disasters such as storms and forest fires), REDD+ and the EU Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan as well as by the research fund Horizon 2020 (European Commission 2013b, 16; European Parliament 2021a). Nevertheless, the strategy lacks specific objectives, such as the level of funding or a timeframe for the implementation of sustainable forest management practices. Besides, the strategy considers forests above all as valuable contributors to the bio-based economy. This is also true for the accompanying blueprint for the EU forest-based industries (European Commission 2013b, 14–16) which aims at stimulating growth and increasing the competitiveness of wood-based and related products and services (European Commission 2013c, 28 et seq.; European Commission 2013b, 6 et seq.).

Currently, the Commission has released a new EU forest strategy building on the 2030 Biodiversity Strategy, that “recognises the central and multi-functional role of forests” (European Commission 2021h, 1). The key objectives of the new forest strategy include effective afforestation, forest preservation and restoration in Europe to increase the absorption of CO_2, reducing forest fires, promoting bio-economy and biodiversity as well as optimising the use of wood in line with the cascading principle – thus to first produce durable wood products, to extend their service life, to re-use them, to recycle them, use them for bioenergy production and only in the last step to dispose of them (European Commission 2021c, 4). Therefore, a revision of the legislation on forest reproductive material shall also take place by 2022. The carbon farming initiative additionally seeks to establish a regulatory framework for certification of carbon removals from tree planting, forest restoration, improved forest management practices and forest biomass production for long-lasting products, including forest managers and owners (European Commission 2021l). A respective carbon removal certification should be adopted by the end of 2021.

To enhance the quantity, quality and resilience of forests, the new Forest Strategy includes a roadmap for planting at least three billion additional trees in the EU by 2030 to achieve biodiversity targets and climate neutrality (European Commission 2021h, 15; European Commission 2021i). If trees are planted, careful planning with regard to the aim, a multiyear timeframe, the monitoring, the area, the selection of mixed-species, resilient, (native) trees and the stakeholder involvement is required (Holl and Brancalion 2020, 581). The latter is partly included in the new Forest Strategy, e.g., by allowing only native tree species to be planted, unless they are no longer adapted to projected climatic and pedo-hydrological conditions (European Commission 2021i, 21).

Afforestation, reforestation and particularly tree planting are to be promoted by the CAP Strategic Plans (see Sect. 5.3.4), the Cohesion Policy funds, LIFE programme, Horizon Europe research and innovation funding programmes, the aforementioned carbon farming initiative, as well as further state aid and private sector funding (European Commission 2021h, 22 et seq.). In this way, payments for ecosystem services and carbon farming (synonymous with carbon sequestration) practices will be rewarded. However, tree planting neither enhances the quality and the resilience of existing forests automatically nor avoids forest dieback. It can even have only minor or even adverse effects on carbon sequestration and biodiversity, if valuable, biodiverse treeless ecosystems such as historic grasslands are threatened (see Chap. 4). It therefore remains to be seen to what extent the voluntary guidelines and criteria set out in the tree planting pledge can successfully prevent potential adverse effects (Gómez-González et al. 2020, 1439; Holl and Brancalion 2020, 580; Selva et al. 2020). Biodiversity-friendly afforestation and reforestation are envisaged to take place according to voluntary guidelines to be established within the closer-to-nature forest management certification scheme (European Commission 2021h, 18) by 2023. However, to enhance ecological effects, the EU's focus should be even more on reducing forest degradation through tree harvesting and further disturbances such as road constructions through forests. Besides, the natural restoration processes of forests, which have hitherto been disregarded, should be supported (Holl and Brancalion 2020, 581; Selva et al. 2020, 1439). In that respect, the EU Commission will propose a legally binding instrument specifying the conditions for ecosystem restoration, focussing on forest ecosystems with a high carbon-storage potential as listed in Annex I of Habitats Directive,[16] by the end of 2021. Apart from that, the definition of primary and old-growth forests should be sharpened in favour of their mapping, monitoring and foreseen strict protection even by this date. Additionally, until 2023 "thresholds or ranges for sustainable forest

[16] Council Directive 92/43/EEC of 21/05/1992 on the conservation of natural habitats and of wild fauna and flora, 22.07.1992, OJ L 206/7.

management" (European Commission 2021h, 18) are intended to be established. However, once again, initially on a voluntary basis together with the closer-to-nature forest management certification scheme (European Commission 2021h, 14, 18).

In addition, the Farm to Fork Strategy covers forests at various points. Firstly, the strategy recognises the interdependence of the increasing frequency of forest fires, new pests, extreme weather and food security (European Commission 2020a, 3, 11). Secondly, the strategy emphasises the objective to reduce the EU's contribution to global deforestation and forest degradation, which is why the Commission will present a legislative proposal and other measures to avoid or minimise the placing of products associated with deforestation or forest degradation on the EU market in 2021 (European Commission 2020a, 17, see Sect. 5.2.7). At the same time, the strategy points out the need to reduce the dependency on critical feed material such as soya grown on deforested land, for example, by a transition towards more sustainable livestock farming and promotion of EU-grown plant protein and alternative feed materials (European Commission 2020a, 8). Thirdly, the strategy underlines the importance of eco-schemes within the framework of the new CAP to fund agroforestry and supports a minimum budget for eco-schemes (European Commission 2020a, 10). And fourthly, the strategy proposes green business models such as rewarding carbon sequestration measures undertaken by farmers and foresters by public or private carbon markets or via the Common Agricultural Policy (European Commission 2020a, 6). Finally, the Farm to Fork Strategy draws attention to the issue of critical long-haul transportation for primary agricultural, fishery and also forestry products. A limitation of transportation would enhance the resilience of regional and local food systems and reduce transportation emissions (European Commission 2020a, 13).Taken together, the strategy recognises the manifold important forest-related aspects, yet these also need to be implemented effectively.

The same is true for the EU Climate Strategy (European long-term vision for a prosperous, modern, competitive and climate neutral economy Strategy) (European Commission 2018c) aiming at net-zero GHG emissions by 2050, far exceeding the estimated time-frame required anyway (European Commission 2018c, 3). In the strategy, the need for legislation to maintain and enhance EU forests sinks is pointed out. At the same time, forests are considered to be suppliers of biomass for material and energy usage (European Commission 2018c, 5, 13 et seq.). Before this background, the strategy highlights the need to foster both roles, e.g., by promoting agroforestry. However, at the same time, it calls for "sustainable intensification of forestry" (and agriculture) (European Commission 2018c, 19) which is questionable, especially since a reference to the necessity to strictly protect primary and old growth forests is missing (for more details on this topic see Sect. 5.2.3).

Additionally, various other EU Strategies are not only linked to the aforementioned strategies, but also touch upon forests, e.g., the EU Bioeconomy Strategy (European Commission 2018b) and the EU Circular Economy Action Plan (European Commission 2020b). In line with the above-mentioned Climate Strategy, the Bioeconomy Strategy calls for a more sustainable management of forests, as they are important suppliers of biomass. Furthermore, both strategies draw attention to enhanced carbon removal by forests, supported, e.g., by voluntary carbon sequestration projects for forest owners funded by LIFE and by forest protection, afforestation and sustainable forest management (European Commission 2018b, 2020b, 16). However, all these strategies are not legally binding and compliance with them cannot be sanctioned. Nevertheless, they do provide important starting points for the design of binding regulatory instruments. As regards instrumental measures, the most relevant of the above-mentioned regulations will be analysed in more detail in the following.

5.2.2 The LULUCF Regulation as One Pillar of the EU Climate and Energy Framework

The EU recently revised its climate and energy framework within the Fit for 55 package (European Commission 2021f) to halt global warming optimally at 1.5 °C. According to the EU's Green Deal, climate-neutrality should be reached within the EU by 2050. As an intermediate goal, net GHG emissions shall be reduced by at least 55% by 2030 compared to 1990 levels. These goals are now legally binding, enshrined in the European Climate Law.[17] The target includes enhanced sink capacities from forests and soils, which reduces the necessary GHG emission cut to only 52.8% (DNR 2021a; European Commission 2016b). In contrast, the EU Parliament voted in October 2020 to raise the 2030 climate target from 40% to 60% and not (only) 55%, irrespective of further enhancement of sink capacities, that anyhow remains necessary to fulfil the Paris Agreement (European Parliament 2020a). In that respect, the aim of achieving carbon neutrality in the European Union by 2050 will probably be already too late to limit global warming in conformity with Art. 2 para. 1 PA (Ekardt et al. 2018b; Wieding et al. 2020; WMO et al. 2020). This is particularly true, if an overshoot of the temperature goal, difficult to reverse, is not taken into account and a higher probability of achievement than in the IPCC projections is assumed (IPCC 2019a; Randers and Goluke 2020).

As a consequence of the new EU climate target of 2030, the resulting sub-targets for the different sectors also require further adaptation. The first legal proposals in this regard were presented by the EU Commission on 15th of July 2021. They will be evaluated in comparison with the actual legal status quo in the following. Thus far, all sectors comprised by the EU emissions trading system (ETS) have to cut emissions by 43% (envisaged to be enhanced to 61%) and non-ETS sectors that fall under the Effort Sharing Regulation (ESR)[18] are obliged to cut emissions by 29%[19]

[17] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999, OJ L 243/1 of 09/07/2021.

[18] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013, OJ L 156 of 19/06/2018.

[19] The original target of 30% was adjusted to 29% when the UK left the EU.

(to be enhanced to 40%) compared to the baseline of 2005.[20] The EU ETS is planned to be extended to the maritime sector and implement CORSIA, a carbon offsetting scheme for international aviation and additionally a new ETS that covers fossil fuel emissions from buildings and road transport should be established (European Commission 2021d). According to the Energy Efficiency Directive,[21] energy efficiency is to be improved by at least 32.5% by 2030. The LULUCF sector itself, under the current status quo of the LULUCF Regulation,[22] has thus far (only) to follow a no-debit rule. It is proposed to increase the targets set in the Renewable Energy Directive (share of energy from renewable sources of 32% by 2030) to 40%, directly affecting the forestry sector (European Commission 2021j) (see Sect. 5.2.3) (Fig. 5.2).

The EU ETS in its current version (only) covers CO_2 emissions from power and heat generation, energy-intensive industry sectors, including the production of mineral fertilisers. The EU ETS as possible instrument for a fast phasing-out of fossil fuels and an ambitious reduction of livestock products – as drivers of deforestation – will be discussed later (in Chap. 6). Non-ETS emissions occurring from industrial energy supply (heating) and product use as well as from the transport, building, waste and agricultural sector (European Council 2020) are currently subject to the ESR, which therefore also includes non-CO_2 emissions, e.g., nitrous oxide (N_2O) from the application of fertilisers on crop- or grassland or methane (CH_4) from ruminant enteric fermentation or rice pads, which are converted into CO_2 equivalents (CO_{2equ}) for the accounting requirements. The ESR divides the 29% target among Member States according to their Gross Domestic Products for the period from 2021 to 2030 (Decision 406/2009/EC). The July 2021 proposals aim to tighten the reduction targets for ETS and ESR and to make fossil fuels (including buildings and transport) more subject to the ETS overall. This is to be combined with social compensation and a border adjustment. All in all, this goes in a similar direction as we will propose later (in Chap. 6) in a more ambitious way. However, at present it is still completely unclear how the discussion on the EU Commission's proposals will develop.

The LULUCF regulation is the third pillar of EU climate policy, in which is the focus of the present section. The regulation applies from January 2021 on, and was adopted in 2018 as a "major step forward in establishing a holistic climate policy for Europe" (Romppanen 2020) and is "rife with complexity" (Romppanen 2020). It includes the emissions of CO_2, CH_4 and N_2O as well as their removals through land

[20] Concerning earlier legally binding targets under the Effort Sharing Decision until 2020 see Decisions No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, 05/06/2009, OJ L 140/136.

[21] Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency, OJ L 328 of 21/12/2018.

[22] Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU, 19/06/2018, OJ L 156/1.

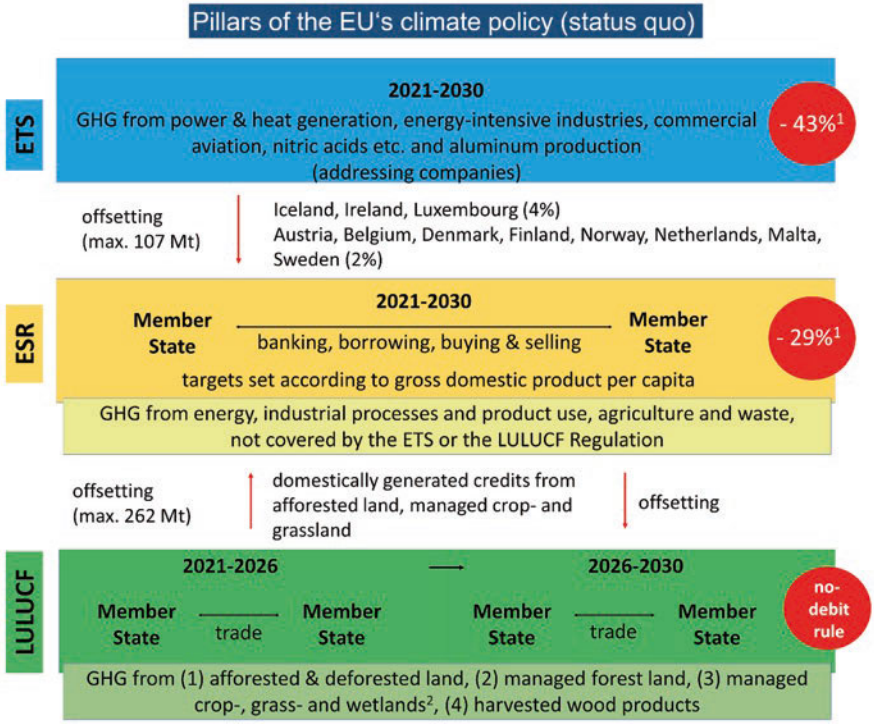

Fig. 5.2 Pillars of the EU's climate policy including targets and flexibilities – status quo after United Kingdom left the EU. (Own figure)
[1]GHG emissions reductions compared to the baseline 2005
[2]GHG emissions of wetlands are to be included mandatorily in the second accounting period from 2026 to 2030

management, forests and biomass, with forestry being of particular relevance. For the first time, emissions from forest-based bioenergy are included in the carbon accounting alongside all other forest-related emissions. The heart of the regulation is the *no debit rule*, requiring net-zero emissions from the sector (Art. 4), meaning that all emissions originated in the LULUCF sector have to be fully offset by the removal of GHG emissions in sinks. From 2021 to 2025 no less than -225 Mt CO_{2equ} of annual net removals shall be generated by the sector. Notabene, LULUCF according to its actual status quo does not cover all land-use-based emissions, but excludes major factors, especially most aspects of livestock farming and land-use-related fossil fuel use, that are partly covered by the ESR (see also Chap. 1; in detail Ekardt et al. 2018a).

5.2.2.1 Accounting Rules Concerning Different Land-Use Categories

While in accordance with the Paris Agreement, reporting about emissions and removals in national GHG inventories is mandatory every year, accounting of GHG fluxes of the LULUCF sector is considered separately as a specificity of the sector (Iversen et al. 2014; Grassi et al. 2018). As legally binding accounting rules are not provided by the Paris Agreement (see Sect. 5.1.2), parties have to define their own accounting rules (Art. 13.7 PA), aligned to the IPCC guidelines (IPCC 2006; UNFCCC 2013b; IPCC 2019b). The recent refinement of methods by the IPCC inter alia aims to provide methods to separate natural disturbances like wild fires (IPCC 2019b). However, further research is required in this regard and countries will need to agree to change reporting methods to the UNFCCC, which will not be feasible in the short term (Ogle and Kurz 2021). The EU's LULUCF Regulation can therefore be seen as an endeavour to establish a first legally binding approach to account for emissions and removals from the LULUCF sector in the Member States of the EU, however in the current status quo widely influenced by the accounting rules under the Kyoto Protocol (Iversen et al. 2014; Savaresi and Perugini 2019; Savaresi et al. 2020).

According to the LULUCF Regulation, the accounting for the sector is divided into two compliance periods from 2021 to 2026 and from 2026 to 2030 (Art. 2) and is based on a land-based and not solely activity-based, piecemeal approach as under the Kyoto Protocol[23] (Schlamadinger et al. 2007; Iversen et al. 2014, 18; Hannes Böttcher et al. 2019; Savaresi et al. 2020). Thus, not only selected human-induced forestry activities on land are accounted towards their influence on the carbon cycle, but changes in carbon stocks and land-use changes are measured as well. In this way, the injustice towards developing countries participating in REDD+, that already had to prove reliable emissions reductions following a land-based approach should be (finally) overcome (CAN International 2012). However, in the general context of the no-debit rule it is questionable, whether the accounting rules of the LULUCF regulation are precise enough. Art. 5 of the LULUCF Regulation states that the accounting should be "accurate, complete, consistent, comparable and transparent".

The LULUCF Regulation divides the accounting into the following categories:

- afforested and deforested land (Art. 6);
- managed cropland, grassland and wetland (Art. 7);
- managed forest land (Art. 8);
- harvested wood products (Art. 9); and
- natural disturbances (Art. 10).

Natural disturbances can be excluded from the accounting concerning afforested, deforested and managed forest land, as far as the accounted emissions lie above a certain statistical background level. In fact, they have to exceed the average

[23] The Decision 529/2013/EU69 implementing the Kyoto Protocol's reporting and accounting obligations remained in force until January 2021, then the LULUCF Regulation will apply.

emissions from the accountings in the period from 2001 to 2020 to be excluded (Art. 10). However, Member States are expected to "develop sustainable and innovative practices and technologies, including agroecology and agroforestry" to "strengthen the productivity and resilience of that sector" (Recital 8, LULUCF Regulation), so that the risks associated with natural disturbances are reduced (Forsell et al. 2018, 18).

Managed wetlands are only included for the period 2021–2025 for Member States that notified a respective intention (chosen by just two Member States). Art. 2 foresees an obligatory inclusion in the second period to reach compliance with the reporting under the UNFCCC framework. However, depending on the feedback from the Member States, it was expected that the EU Commission might postpone the inclusion of managed wetlands for another five years due to the particularly challenging emission accounting (Hannes Böttcher et al. 2019; Ekardt et al. 2020). Due to the proposed transition to the Common Reporting Format under the UNFCCC reporting guidelines from 2026 on, that inter alia already include peatlands and peat-extraction under the reporting category wetlands, a respective discussion is obsolete (see Sect. 5.2.2.6).

As the accounting methodology varies significantly between the different land-use categories a detailed assessment is required. In the following, this is examined with a special focus on managed forest land next to the other named land-use categories.

5.2.2.2 Accounting Rules – Other Than Managed Forests Land

Harvested wood products (HWP) are accounted as a separate carbon pool either in afforested or in managed forest land in accordance with the Kyoto Protocol. The accounting rules laid down in Art. 9 are further specified in Annex V. To prevent double-counting, a production approach is followed that does not consider imported HWP (Forsell et al. 2018, 18).

To promote long life cycles of wood products, the accounting considers the average time that the carbon remains stored in various products, compared with an instantaneous oxidation. The latter assumes the total release of the entire carbon stored in HWP into the atmosphere at the time of harvest (Art. 3 No. 10 LULUCF-Regulation). This methodology only has to be applied concerning HWP for energy purposes. For other HWP, their life-values have to be estimated. Annex V specifies 2 years for paper, 25 years for wood panels and 35 years for sawn wood. However, it is possible for the Member States to further specify the wood-based material products and to use country specific methodologies and half-live values for the accounting, as long as they are "determined on the basis of transparent and verifiable data" and as the "methodologies used are at least as detailed and accurate as those specified in this Annex". If HWP are exported, the country-specific data of the importing country has to be considered.

Savaresi and Perugini (Savaresi and Perugini 2019, 161) emphasise that this accounting approach underlines the "positive contribution of wood, especially as a building material, with the twofold advantage of storing carbon, while replacing more emission intensive materials, such as iron and concrete". The staggered crediting of emissions, depending on the utilisation period of the wood, can therefore be seen as a positive stimulus with regard to the necessary cascade use of wood in a post-fossil and circular economy.

The accounting follows the net-net accounting approach. That means that the annual level of net emissions (or removals) in the period from 2021 to 2025 and 2026 to 2030 is directly compared with the average emissions in the historical reference period from 2005 to 2009. It is assumed that the management of crop-, grass- and wetlands either does not change or easily improves due to an adapted climate performance that fosters the sink capacity of managed crop- and grasslands and in the second accounting period probably also of wetlands (Romppanen 2020, 273). Long-term climate trends – that could however steer in the opposite direction –tend to be cancelled out in this accounting mechanism, while short-time influences due to several management practices should be accounted for (Schlamadinger et al. 2007). Climate-friendly land management compared to the reference period is thus rewarded and vice versa. However, the problem of the relatively difficult exact depictability of GHG fluxes remains also for this land use category.

To measure and reward GHG fluxes from deforestation, afforesting or reforesting activities the gross-net accounting approach is followed. In contrast to the net-net accounting approach, total emissions from sources and/or removals from sinks occurring in each year of the reference period are considered, without comparing them to a reference level (Forsell et al. 2018). Thus, if deforestation has led to emissions this must be fully added to the accounting within the LULUCF sector and vice versa, emission savings by afforestation activities can be directly subtracted. However, according to Art. 6 No. 2, cropland, grassland, wetlands (next to settlements or other land) can be accounted for as afforested land only 30 years after the date of their conversion and if duly justified according to the IPCC guidelines. The characteristics that define a forest area (size of the area, percentage of tree crown cover and necessary tree height) is specified for every Member State in Annex II of the Regulation.

5.2.2.3 Accounting Rules – Managed Forest Land

The accounting approach regarding managed forest land can be seen as "a compromise solution between gross-net and net-net accounting" (Romppanen 2020, 273). Emission and removals in the two accounting periods are compared to a specific Forest Reference Level (FRL). The FRL is based on the assumed continuation of sustainable forest management practices with a constant ratio of solid and energy use of above-ground biomass as documented for the period from 2000 to 2009, using the best available data and considering dynamic age-related forest characteristics (Art. 8 No. 5, Annex IV No. A e). The difference between the FRL, based on how a forest would develop if no changes in policies and forest management practices occurred (continuity), and the reported net emissions from managed forest land are accounted for. As already in the second commitment period of the Kyoto Protocol, the FRL functions as a forward-looking baseline, that – in contrast to historical baselines – requires a projection of future GHG fluxes and is therefore the result of a modelling process that inherits potential uncertainties itself next to the problem of depicting of the development of sink capacities (Krug 2018; Romppanen 2020). To minimise the risk accompanying the modelling process, all relevant historical data are to be included, based "on transparent, complete, consistent, comparable and accurate information" (Annex IV A lit. h LULUCF Regulation). As an indicator of its functional efficiency, the model should be able to reproduce historical data from the National Greenhouse Gas Inventory (European Commission 2019b, 16). Compared with the measurement of GHG flows, changes in carbon stocks are measured, as it is considered to be more accurate in the land-use sector. Art. 3 No. 4 defines carbon stocks as "the mass of carbon stored in a pool". According to Annex 1.B. six carbon pools are determined: (1) above ground biomass, (2) dead wood, (3) harvested wood products, (4) below ground biomass, (5) litter, (6) soil organic carbon. The pools No. 4–6 may be excluded from the accounting within the managed forest land category (as for the other land use categories), provided that they are not a source of emissions (Art. 5 No. 4). However, natural science findings prove, that already due to changing climate conditions (Varney et al. 2020), it can hardly be ruled out that the carbon stocks in soils and below ground biomass change over time (see also Sect. 4.2.1). At the least, however, when the soil is vigorously stirred up by the felling or planting of trees, the resulting losses should be included in the calculation, as these are then directly attributable to human-induced management. This will probably be the most common case in managed forest land.

The FRL is based on a business as usual (BAU) scenario, which considers changes in natural country-specific forestry dynamics (growth effects) and indirect human-induced effects on the GHG fluxes, while policies and forest management practices are not included and accounted for. Natural growth effects should be factored out from direct and additionally human-induced impacts that can lead to credits or debits in carbon accounting (Grassi and Pilli 2017; Krug 2018). Also, natural disturbances through fire, storms, pest infestation etc beyond certain thresholds should be ruled out (Savaresi et al. 2020). Under the second commitment period of the Kyoto Protocol (2013 to 2020), assumed policy implementation are still allowed to be included into the FRL, as it is also the case under the REDD+ approach (Decision 13/CP.19) (Schlamadinger et al. 2007). Thus, increased harvest intensities covered by a certain new policy did not lead to accountable emissions. In this way, credits could be gained although forest management did not improve, because the real amount of harvest was lower than assumed in the "unverifiable counterfactual scenarios" (Grassi et al. 2017) (see Sect. 5.1.2). By excluding policy and management changes from the FRL in the LULUCF regulation an obvious loophole in the accounting under the Kyoto Protocol is circumvented and the lack of comparability to other sectors is overcome (Grassi and Pilli 2017; Krug 2018).

Now, the selected reference period, 2000 – 2009, which already covers increasing demand for biomass, plays a significant role with regard to the projected harvest intensity. Therefore, a critical examination of the projected harvesting ratio in the BAU is still indispensable, at best on the basis of strict regulations that define how sustainable forest management should look in (best) practice. However, those are not provided by the LULUCF regulation. Rather, concerning legally binding provisions on sustainable forest management, an EU-wide regulatory gap exists (whether the upcoming EU taxonomy is good to close this gap will be discussed in Sect. 6.3). Art. 8 No. 5 LULUCF Regulation only defines forest management intensity as a core element of sustainable forest management practices, however, without further specifications except the general provision, that long-term carbon sinks should be maintained or strengthened. In Annex IV No. f it is additionally mentioned that the FRL should be consistent with the objective of contributing to the conservation of biodiversity and the sustainable use of natural resources. The usage of the word 'should' instead of 'shall' indicates that these requirements are not yet given the same substantial weight as other parameters (i.e., the exclusion of the mere presence of carbon stocks in the accounting in contrast to their enhancement or depletion).

Generally, to reflect the different "national circumstances" (Krug 2018, 2) inherent to the forestry sector, "ample room for manoeuvre" (Romppanen 2020, 263) is conceded to the Member States on how to develop the FRL. The overarching provisions in Art. 8 combined with Annex IV of the LULUCF regulation, are rather "loosely defined", referring to (a) continuity, (b) forest management practices, (c) sustainability and (d) dynamic age-related forest characteristics, using the best available data (Romppanen 2020, 274). Further technical guidance on how to develop the FRL in accordance with the LULUCF Regulation is provided by Forsell et al. (2018) and by Grassi and Pilli (2017) concerning the continuation of forest management.

The LULUCF regulation obliged Member States to submit a National Forestry Accounting Plan (NFAP) including the proposed FRL by 31.12.2018 for the first accounting period from 2021 to 2026 (Art. 8 No. 3). The Commission published an assessment of the latter in June 2019 (European Commission 2019b). 26 Member States, including Germany, needed to revise their NFAP and the FRL based on the given technical assessment and recommendations of the EU Commission (European Commission 2019b). Finally, in late 2020 the Commission adopted a delegated act laying down the FRL for the first accounting period: The Commission Delegated Regulation (EU) of 28.10.2020 amending Annex IV to Regulation (EU) 2018/841 of the European Parliament and of the Council as regards the forest reference levels is to be applied by the Member States for the period 2021–2025.

According to the difference between the now for every Member State set FRL and the reported net GHG emissions or savings in the future, either offsettable credits in case of enhancing the sink capacity are generated or debits which have to be offset. The generated debits or credits from managed forests can be assimilated by the debits or credits derived from the other sectors covered by the ESR, following the same accounting scheme, i.e., in the agricultural sector. However, the total accountable net removals from managed forests are limited by a cap of 3.5% compared to the base year or base period according to Annex III LULUCF Regulation multiplied by the factor 5, to compensate for any weaknesses in the calculation. This automatically restricts further incentives to additionally strengthen sink capacities of the managed forest land. The reported net emissions or removals as a whole are additionally registered in the LULUCF inventory under UNFCCC.

5.2.2.4 Flexible Mechanisms

Besides possible loopholes due to imprecise counting of emissions, certain flexible mechanisms might undermine the no-debit rule and thus the overall effectivity of the LULUCF Regulation. With flexible mechanisms the varying economic capacities of the Member States should be taken into account and cost-effectiveness, fairness and solidarity as main principles of the EU's climate policy should be created (Romppanen 2020). Apart from that, the flexibilities should not weaken the overall (however, as shown, not stringent enough) ambition level of the GHG reduction targets (Recital 21).

As an intra-regulatory flexibility, the ESR is connected with the LULUCF regulation. Emission savings according to the ESR can offset emissions from the LULUCF Regulation (Art. 12 (1) LULUCF Regulation) and vice versa (Fig. 2.1). Offsettable net removals from the LULUCF sector are limited and can – after UK has left the EU – only compensate emissions occurring under the ESR up to 262 Mt CO_{2equ} (Art. 7 ESR; recalculated from 280 Mt CO_{2equ} after the UK has left the EU). A regular criticism concerning the intra-regulatory mechanism is the possible offsetting of fossil fuel emissions or emissions from the agricultural sector to a limited but nonetheless extensive extent by negative emission counting's from the LULUCF sector. As a consequence, necessary mitigation practices to effectively reduce emissions in other sectors, i.e., energy intensive industries or reduced livestock farming in agriculture, might not take place (Ekardt et al. 2018a; Fyson and Jeffery 2019; Aho 2020; Romppanen 2020). However, in the (not so distant) future, net zero emissions across all economic sectors have to be achieved, meaning all remaining emissions have to be offset by sinks, particularly from the LULUCF/forestry sector. Therefore, this flexible mechanism is absolutely necessary and has to include the ETS sector in the future as well. At the same time, it will be of paramount importance to extend the no-debit rule equally and to include all pillars of the EU's climate policy (ETS, ESR and LULUCF) under it. The LULUCF sector then needs to function as a sink and stringent emission reduction targets must be set separately hereafter for every Member State (Grassi et al. 2017; Meyer-Ohlendorf 2020; H. Böttcher et al. 2021, 25). To lay down a no-debit rule only for this sector is therefore already outdated and does not reflect the necessity to reach carbon neutrality or in other words net zero emissions across all sectors.

In addition, the LULUCF Regulation itself contains internal flexibilities. Firstly, Member States might buy and sell net emissions savings among each other without limit (Art. 12 No. 2). Secondly, Member States might transfer net removals from the first accounting period to the second period (banking, Art. 12 No. 3). Thirdly, emissions from one land-use category can be balanced with removals from another land category in a Member State, considering national preferences (recital 21). However, fourthly, managed forest lands are subject to further and more specific flexibility regulations: On the one hand, calculated net removals from managed forests can only be used until they reach a cap, as mentioned earlier (Art. 8 No. 2). Therefore, the uncertainties in the calculations should be considered. On the other hand, if net emissions compared to the FRL from managed forests are calculated, they might be compensated up to a maximum amount that is Member State specific. The latter flexibility can only be applied by a Member State, if (1) total emissions accounted for in the LULUCF sector do not exceed total removals and (2) if measures to enhance or conserve forest sinks are (at least) planned or ongoing (Art. 13 in conjunction with Annex IV). Increased harvest intensity (lowering the originally calculated sink capacity of a forest within the FRL) is therefore possible. In this respect it is often criticised that the permission of the forest industry to increase their emissions undermines the no-debit-rule for the sector and that neither sustainable forest management nor the protection of old-growth forests are encouraged strongly enough by the current regulation (Aho 2020; Romppanen 2020). All these problems repeatedly indicate the deficits in terms of proper baselines that are already well-known from the debates on CDM (Ekardt and Exner 2012; Exner 2016). In other words, the problem of depicting is not solved here but used as a way of watering down climate ambition. Furthermore, all of this is a reminder that trading components in climate policy is pointless as long as there is no ambitious cap without loopholes (Ekardt 2019). Unfortunately, this point is often misunderstood as a valid criticism against cap-and-trade approaches (on these approaches in an ambitious shape see Chap. 6).

This criticism becomes even reinforced when considering the – often pointed out – need to convert the whole LULUCF sector into a sink in the future. Nonetheless, this flexibility is also useful in principle as the transformation to a post-fossil society is associated with increased reliance on alternative sources of energy and raw materials, particularly from the forest sector. It must therefore be possible to cushion higher short-term demand, i.e., for wood, through flexible mechanisms. However again, this only applies to the extent that the European Climate Law defines the necessary framework conditions and is strictly adapted to the Paris Agreement. This, as has already been pointed out, is not yet the case.

5.2.2.5 Interim Conclusion on the Status Quo of the LULUCF Regulation

In general, the inclusion of the LULUCF sector in the climate regime of the EU and the attempt to establish binding accounting rules for a sector whose GHG emissions are very complex to measure is clearly necessary. The complexity of depicting GHG emission fluxes and changes in carbon stocks makes it also reasonable to not integrate LULUCF easily as a whole in an ETS. This would be possible for livestock products and of course for all fossil fuels (Ekardt et al. 2018a; Weishaupt et al. 2020; Garske and Ekardt 2021), but not for land use in general due to the problems already discussed in terms of heterogeneity, baselines and depicting (Hennig 2017; Ekardt et al. 2018a; Ekardt 2019). However, precisely these challenges have not been sufficiently addressed in the LULUCF Regulation either:

With regard to the accounting of emissions from the LULUCF sector or the increase in sink capacity, the accounting rules for managed forest land are of particularly interest. Not surprisingly, the accounting system based on the comparison with a FRL is highly complex, which already enhances “the possibility of abuse” as formulated by the German Advisory Council on Global Change 20 years ago (WGBU 1998) and is currently still in use – even if, compared to the accounting under the Kyoto Protocol and the accounting rules under REDD+, several loopholes (e.g., concerning the inclusion of policy changes) could be closed. Like this, comparability of gained credits with other sectors under the Paris Agreement is reached, even if the comparability of the different land-use categories defined by the LULUCF regulation due to differing accounting rules is not always given and even though it is reasonable to differentiate between the accounting of, for example, afforested land and managed forest land. More severely, however, due to differences in the accounting methodologies used to measure emission reductions in individual Member States, there is no general comparability between the emission allowances achieved in the LULUCF sector. However, trading of emission allowances generated from the LULUCF sector between Member States is a granted flexibility – and this is precisely a way of establishing a kind of quasi-emissions trading through the back door, followed by all the incompatibilities that arise when emissions trading and land use encounter. This can lead to large scale distortions and discourage some Member States from the necessary protection of forests because others can very easily generate emission reductions beyond their own needs.

Considering that the overall goal in line with the Paris Agreement needs to be the achievement of net-zero emissions by 2035 or earlier across all sectors, the no-debit rule needs to be extended to all three pillars of the EU climate regime in the future. However, according to the actual legal status quo, no incentives are given to enhance sink capacity of the LULUCF sector further above the no-debit rule, particularly through the limited possibility of offsetting generated emission reductions with the ESR. On the other hand, unlimited offsetting under the ESR is allowed and increased harvest intensities do not necessarily lead to accountable emissions under the LULUCF Regulation (Art. 8 No. 2) watering down the no-debit rule for the LULUCF sector itself. As a consequence, the LULUCF Regulation still does not sufficiently promote the protection of existing forests and their sustainable management. In total, a low level of ambition is reached. This is particularly serious in light of the asymmetry that appears to exist between positive emissions emitted into the atmosphere and negative emissions, e.g., removed by forest ecosystems. Zickfeld et al. concluded in their study that the same amount of CO_2 emissions is more effective than if an equivalent is removed from the atmosphere, so that in order to achieve net zero emissions, the amount of stored carbon must be even higher (Zickfeld et al. 2021).

Overcoming the weaknesses of the current LULUCF Regulation also requires in the first step a better monitoring of the existing sink capacity (that is already triggered by the current regulation) and secondly, an assessment of their potential future expansion as well as finally, the establishment of effective instruments concerning preservation and enhancement of sinks concerning forests, in line with the PA, supported by the CBD target that also calls for a different kind of forestry.

5.2.2.6 Legal Proposal to Amend the LULUCF Regulation

According to the new legislative proposal of July 2021,[24] only minor, non-substantive, changes (legislative proposal, p. 2) are foreseen in the first compliance period until 2025. However, in the second accounting phase from 2026 to 2030 the net removal target shall be increased from the current -268 Mt CO_{2equ} annually to -310 Mt CO_{2equ} as a legally binding EU-wide target. Complex accounting rules as laid down in Sects. 5.2.2.1, 5.2.2.2, 5.2.2.3 and 5.2.2.4 will no longer be applied, but shall be simplified by relying more on geographical data and remote sensing and be based on emissions and removals according to the national GHG inventories (European Commission 2021e). Pursuant to the Regulation 2018/1999[25] reporting categories of the Common Reporting Format under the UNFCCC reporting guidelines for monitoring and reporting GHG emissions and removals are to be directly adopted. This is why. in addition, the land accounting categories as set out in the first compliance period are intended to be abolished from 2026 onwards. This renunciation, especially of the much-criticised FRLs, is a welcome step to decrease the complexity of the regulation and – assuming the baseline is determined correctly – to close existing loopholes and account for total emissions, e.g., from timber harvesting and bioenergy production. Like this, the comparability of emission reductions between specific land use categories and Member States can also be expected to be improved. The common reporting guidelines already include wetlands as one category and consider natural disturbances, which makes Art. 10 on natural disturbances and Art. 13 on the managed forest land flexibility of the current LULUCF regulation redundant as well. The aim of the new proposal is to ensure consistency with Directive 2003/87/EC[26] and Regulation 2018/842[27] and in this way to reliably contribute to the 55% net zero emission target by 2030.

[24] Proposal for a Regulation of the European Parliament on of the Council amending Regulations (EU) 2018/841 as regards the scope, simplifying the compliance rules, setting out the targets of the Member States for 2030 and committing to the collective achievement of climate neutrality by 2035 in the land use, forestry and agriculture sector, and (EU) 2018/1999 as regards improvement in monitoring, reporting, tracking of progress and review, COM(2021) 554 final.

[25] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council, OJ L 328 of 21/12/2018.

[26] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, OJ L 275 of 25/10/2003 as amended by Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814, OJ L 76 of 19/03/2018.

[27] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013, OJ L 156 of 19 /06/2018.

The latter shall be also achieved by defining new categories of carbon storage products in addition to harvested wood products in line with the cascading principle and by the support of carbon farming incentives and the certification of carbon removals as already mentioned in the New Forest Strategy (proposed Art. 9 LULUCF Regulation). Improved monitoring of land use units with high-carbon stock, land use units under protection, land use units that are subject to restoration or are of a high climate risk (proposed Part 3 of Annex V LULUCF Regulation) shall close the existing monitoring gap as a huge step forwards and might also help to avoid carbon farming at the expense of biodiverse forest ecosystems and not at least contribute to a more comprehensive reporting of Member States. In the compliance report according the new proposed Art. 14 of LULUCF Regulation, Member States also have to assess (a) policies and measures regarding trade-offs, (b) synergies between climate mitigation and adaptation and (c) synergies between mitigation and biodiversity. However, despite all of these planned measures, clear and legally binding specifications on how forestry practice is to be changed or forest restoration needs to take place to be in line with biodiversity targets are not expected to be established. Furthermore, our analysis of the problem of depicting (Sect. 4.2) has shown that a governance approach that primarily depends on a precise accountability of emissions will probably not work in terms of land use in general and of forestry in particular.

Finally, the flexibility regulations are planned to be adapted: It will no longer be possible to bank surplus removals at the end of the first compliance period in 2025. Instead, they will be part of the new flexibility mechanism for land use (proposed Art. 13b), which allows Member States to still achieve their overall LULUCF targets by requesting an additional share if all other flexibility options under Art. 12 have already been exhausted and the overall EU removals target of -310 Mt CO_{2equ} is met. The other flexibility mechanism under the proposed Art. 12 still allow (1) the purchasing of credits from carbon removals from other Member States that have exceeded their targets, (2) to use certificates gained under the ESR to meet the targets under the LULUCF Regulation, (3) to offset emissions in the ESR with carbon credits from the LULUCF sector – though up to a certain limit, divided equally between the two compliance periods, without the ability to transfer unused carbon credits, (4) to use a legally defined share of the general flexibility mechanism up to a certain limit, provided the overall EU removal target of -310 Mt CO_{2equ} is met.

From 2031 onwards, all non-CO_2 emissions of the agricultural sector are to be combined with the LULUCF sector, so that the whole land sector including agriculture, forestry and other land use (AFOLU) could be brought together for the first time under only one legal instrument. It remains an open question how this could work given the major differences regarding accountability of emissions of livestock farming on the one hand and forestry, peatland and other land-use sectors on the other hand (Sects. 2.7 and 4.2). Furthermore, it is criticised that ambitious, legally binding emission reduction targets particularly for the agricultural sector up to 2030 and beyond for the EU and each Member State are still lacking (EEB 2021). Instead, compensation by the forestry sector is relied on without exhausting the full emission reduction potential of other sectors and here particularly the agricultural sector

(EEB 2021). However, the combined sectors are meant to achieve climate neutrality at the latest by 2035 and shall generate negative emissions to balance remaining emissions in other sectors thereafter (Legislative Proposal, 10 et seq.). In this way, an increasing combination of the land-use sector with other economic sectors that should have exhausted their emission reduction potential is intended and thus, finally, the no debit rule will be extended over all pillars of the EU climate regime as previously requested.

Uncertainties as to the extent to which sink capacities can be increased in the LULUCF sector further aggravate the situation. The sink capacity of forests and peatlands may stagnate or even fall below zero by 2030 due to aggravating climate change and despite the planned additional efforts (see Sect. 4.2). A guarantee mechanism that automatically tightens the reduction target in the other sectors in this case until 2030 is therefore called for (Germanwatch e.V. 2021). However, decisive steps to reduce emission levels across all sectors and separate instruments for livestock farming are essential in order to lower residual emissions. Even if only 10% of residual emissions from agriculture, industry and aviation compared to the 1990s level remained in 2030 (which we are far from), more than -500 Mt CO_{2equ} would have to be compensated annually by negative emissions to achieve net-zero emissions across all economic sectors (European Commission 2018c, 28). This is not reflected by the EU-wide target of -300 Mt CO_{2equ} by 2030. Therefore, the strategy should be more focussed on consistently reducing emissions across all other sectors and generating resilient, biodiverse forests as long-term carbon sinks only to compensate for residual emissions that remain even in a fossil-free and drastically livestock-reduced Europe. Particularly, the restoration of resilient, biodiverse forests including wetlands should neither be endangered by rather blind and narrowly-focused carbon farming initiatives nor by enhanced harvesting for energetical purposes as it is still regulated under the Renewable Energy Directive (see Sect. 5.2.3.4). So far, the Fit for 55 package lacks the corresponding legislative proposals in this respect.

According to the new proposal, Member States are required to update their integrated national climate and energy plans by June 2024 and submit them in accordance with Art. 14 of Regulation 2018/1999. On this basis, the EU Commission seeks to propose the legally binding individual Member State and EU-wide targets for the combined land use sector from 2031 onwards. To this end, the legally binding national reduction targets concerning the LULUCF sector from 2026 to 2030 and the commitment of climate neutrality of the combined AFOLU sector in 2035 are foreseen to be enshrined in Art. 4 of the Regulation 2018/1999.

5.2.3 Renewable Energy Directive II – Impact on Forest Ecosystems

5.2.3.1 Status Quo

The overall aim of the amended Renewable Energy Directive II (RED II)[28] from 2018 for the period 2021 until 2030 is the promotion of the use of energy from renewable resources as one goal of the EU's energy framework that (thus far) envisages increasing the share of energy from renewable sources to at least 32% compared to the baseline of 2005. The current directive covers all potential sources of renewable energy and consequently includes also renewable energy from agricultural and forest grown biomass. According to Art. 2 para. 24 RED II, biomass is defined as "the biodegradable fraction of products, waste and residues of biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin."

Thus, next to direct land use changes due to enhanced logging activities in forests, indirect land use change (ILUC, as an important example for shifting effects as a typical governance problem) might be fostered, if biomass production for energetic purposes is not sufficiently legally constrained, which is examined in the following.

First of all, the classification of woody biomass as renewable energy can be questioned in general. The classification creates public subsidies that counteract subsidies paid under approaches such as the CAP (or, at the international level, the REDD+ system) that aim to prevent forest degradation through increased harvesting or clear cutting (see Sects. 5.2.6 and 5.1.2). In this respect, the directive assumes climate neutrality of the energetic usage of woody biomass if the sustainability criteria, that "apply irrespective of the geographical origin of the biomass" (Art. 29 para. 1) are met. Whereas the previous directive from 2009[29] did not specify any restrictions or sustainability criteria for biomass derived from forests, the new directive tries to close this loophole. In the following, the sustainability criteria laid down for agricultural and forest grown biomass used for the production of biofuels, bioliquids and biomass fuels will be critically assessed (see in detail Hennig 2017; Ekardt and von Bredow 2012, 49 et seq.).

- If the biomass fuels are gained from agricultural land, firstly the biomass shall not be taken from land with a high biodiverse value which includes (a) primary forests and other wooded land which is characterised by native species and functioning ecological processes (b) species rich and not degraded highly biodiverse forests and other wooded land (according to the assessment in 2008), (c) highly

[28] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, OJ L 328, 21/12/2018, p. 82-209.

[29] Directive (EU) 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 05/06/2009, p. 16-62.

biodiverse grasslands and (d) nature and wildlife protection areas according to domestic or international law (Art. 29 para. 3). The latter also includes multilateral agreements and lists drawn up by NGOs such as the International Union for the Conservation of Nature (IUCN). However, an exception clause is made concerning highly biodiverse forests, weakening the criteria: The biomass fuels can be produced if evidence is provided that their production did not affect the nature conservation purposes (Art. 29 para. 3 lit. b). Secondly, Art. 29 para. 4 excludes the usage of biomass from land with high-carbon stocks, including wetlands, continuously forested areas and lands of more than one-hectare size with trees higher than 5 meter and a canopy cover between 10% and 30%. For the latter, again an exemption clause is set: evidence can be provided that the carbon stock is not negatively affected by the usage of biomass (Art. 29 para. 4 no. 4 lit. c). Thirdly, raw materials for biofuel productions should not be obtained from peatlands, unless (once again) evidence is provided that "the cultivation and harvesting (…) does not involve drainage of previously undrained soil" (Art. 29 para. 5). Finally, in case of the usage of agricultural waste and residues for biofuel production, management plans need to address the impact of agricultural production on soil quality and soil carbon (Art. 29 para. 2).

- If the biofuel production is based on forest biomass, firstly national or subnational laws in the country of harvesting shall ensure legal and long-term sustainable harvesting, forest regeneration by not exceeding the growth rate of forests, the protection of nature conservation areas and the monitoring of forest areas as well as the enforcement of the legislation have to be implemented (Art. 29 para. 6 lit. a). However, if respective evidence by legal requirements cannot provided (which is the case in most of the world's countries, including the EU), forest management systems need to ensure the latter (Art. 29 para. 6 lit. b). Secondly, the country needs to be party to the Paris Agreement, has to have submitted the NDCs and established national legislation in accordance with Art. 5 PA focussing on the strengthening of sinks (Art. 29 para. 7 lit. a). Again, if respective national legislation to strengthen sinks is missing, its absence can be compensated by management systems, ensuring that "carbon stocks and sinks levels in the forest are maintained, or strengthened over the long term" (Art. 29 para. 7 lit. b).

By late 2021, operational guidance to demonstrate compliance with the criteria should be given by the EU Commission (European Commission 2021a) and by the end of 2026 an assessment of the effectivity of the criteria shall be carried out, leading to potential further amendment of the regulation after 2030 (Art. 29 para. 8, 9). The sustainability criteria described above are further combined in Art. 29 para. 10 with mandatory GHG emissions savings for the use of biofuels, bioliquids and biomass fuels. Depending on the time the installation started to operate concerning biofuels and biogas in the transport sector, they shall gradually rise from at least 50% for installations that started to operate before 05.10.2015 up to 60% after 05.10.2015, up to 65% after 01.01.2021, and 70% for electricity, heating and cooling after 01.01.2021 and 80% after 01.01.2026. The highly complex calculation follows Art. 31 para. 1 in combination with Annex VI.

5.2.3.2 Critical Assessment of the Sustainability Criteria

An important point of criticism is, that the sustainability criteria to avoid indirect land-use changes (ILUC) and regarding highly biodiverse forests only apply to biomass sourced from agricultural land, and not to biomass sourced from forests (on all following points see Hennig 2017; Ekardt and von Bredow 2012). Thus, woody biomass gained from primary and highly biodiverse forests can be harvested and sold officially if the new sustainability criteria explicitly for forests are met. Those are, however, still very weak and vague, particularly concerning the not sufficiently specified sustainable management systems and, above all, lack strict biodiversity-protecting regulations (Hennenberg et al. 2018). Apart from that, "to minimise the administrative burden", (Recital 104) Art. 29.1 stipulates that the sustainability criteria for both agricultural and forest sourced biomass only apply to electricity and heating from biomass fuels produced in installations with a total rated thermal input equal to or exceeding 20 MW (solid biomass fuels), and with a total rated thermal input equal to or exceeding 2 MW (gaseous biomass fuels). Member States are however free to extend the criteria to smaller installations, however there is no obligation to do so. This is why in these cases, non-complying biomass can simply be sold to smaller plants and the already weak sustainability tend to be further undermined (Hennenberg et al. 2018).

Moreover, it is highly questionable whether the ILUC-risk due to agriculturally sourced biomass can be sufficiently limited by the sustainability criteria of Art. 29 combined with the regulations in Art. 26 of the RED II Directive. Art. 26 lays down specific rules for bioliquids and biomass fuels produced from food and feed crops, such as palm oil, soybeans, maize, sugar cane or rapeseed and sunflower. The share of fuels produced from food and feed crops in the final consumption of energy in a Member State is restricted to a maximum of 7% (Art. 26 para. 1). Member States, however, are free to set a lower limit or caps distinguishing the different sources of biomass production and considering the ILUC-risk of feedstuffs. If a Member State decides to set a lower limit, also the minimum share of 14% for the use of renewable energy in the transport sector according to Art. 25 para. 1 can be lowered accordingly, but by a maximum of 7%. Additionally, Art. 26 para. 2 restricts the share of biofuels gained from high ILUC-risk biomass production, that would lead to the extension of agricultural land into areas with high carbon stocks, such as forests, wetland and peatlands (Recital 81), that however needs to be considered as significant (see for the determination of a significant expansion European Commission 2019c, 12 et seq.). Low ILUC-risk crops are defined by yield increases through improved agricultural practices and, in general, productivity promoting schemes as well as by their cultivation on land not previously used for the cultivation of crops (Recital 82). For the years 2020 until 2023 the share of biofuels and bioliquids gained from the cultivation of crops with a high ILUC-risk shall not increase the level from 2019 and then, from the beginning of 2023 until the end of 2030, gradually decrease to a level of 0%. However, the decision to simply allow biomass to be harvested for energy use from further areas with a proven high ILUC-risk is absolutely irresponsible in view of the urgent climate and biodiversity crisis. A phase out only in 2030 is much too late.

Furthermore, impending shifting effects from one crop to the other are not sufficiently considered. This becomes clear taking into account the Delegated Regulation 2019/807 of 13.03.2019 that supplements the RED II Directive in this respect. According to the Annex of the Regulation 2019/807, palm oil is considered as the only crop with a high ILUC-risk, with a share of 45% of expansion into continuously forested and wooded area according to Art. 29 para. 4 lit. b and c of RED II and a share of 23% into wetlands according to Art. 29 para. 4 lit. a of RED II. In contrast, soybean is only attributed a share of 8% concerning its potential expansion in forested and wooded areas. However, in reality it is estimated that additional soy production could take place mainly in Latin America covering 2.4 up to 4.2 million hectares of additional cropland and thus "vast evidence about deforestation and land use change linked to the cultivation of soy" (Transport & Environment 2020, 1) exists (Malins 2020). Apart from that, the criteria for low ILUC-risk laid down in the Delegated Act are not strict enough and may lead to a high risk of ILUC "through the back door" (Dusser 2019, 5). In contrast, advanced biofuels as listed in Part A of Annex IX (inter alia algae cultivated in ponds or photobioreactors, different kind of (bio)wastes, used cooking oil etc.) are introduced only very hesitantly. Art. 25 para. 1 RED II foresees a contribution of advanced biofuels and biogas as a share of final consumption energy in the transport sector with at least 0.2% in 2022, 1% in 2025 and 3.5% in 2030 and their energy content may be considered twice in the accounting (Annex IX).

There are some overall aspects of bioenergy that underline how problematic the perspective of RED II is (Hennig 2017; Ekardt and von Bredow 2012). Ideally, bioenergy, like other renewable energies, is climate-neutral; in reality, however, it generates GHGs itself due to processing (and sometimes through its origin, e.g., in rainforest areas). Moreover, biomass provides relatively little energy per plant. It also reinforces the existing problems of conventional agriculture regarding biodiversity loss, soil degradation, water pollution or disturbed nitrogen cycles (Ekardt 2019, Sect. 4.9). In addition, imports from developing countries exacerbate problems with food security. Furthermore, bioenergy for the North, cultivated on high-yield tropical soils, competes with traditional biomass use in the countries of the Global South, for example as building material. Nevertheless, bioenergy appears to be attractive since it is always available, unlike wind and solar energy. But this will gradually change (Ekardt 2019, Sect. 4.10) via options such as new power lines, storage facilities and power-to-X; furthermore, wind and solar energy are much cheaper options. The current attempt to promote only the kind of bioenergy in the EU which meets certain criteria, i.e., bioenergy not produced in the rainforest does not promise a truly radical solution, given the above-mentioned governance problems. Firstly, it is almost impossible to verify these EU criteria anywhere in the world when it comes to administrative implementation (enforcement problem). Secondly, there are shifting problems: The Brazilian bioenergy producer can simply place its bioenergy plants on non-rainforest fields in response to a ban of this kind, and instead create other production areas, such as feed for Western meat consumption, all the more in rainforest areas. Thirdly, the many challenges of bioenergy cannot be depicted as criteria on which the admissibility of bioenergy could depend: How does one intend to determine, for example, whether the individual bioenergy plant has endangered the world food situation or not? Fourthly, there is a lack of ambitious criteria, given that bioenergy is far from climate neutral – and that biomass is only renewable to a limited extend: Considering biomass from forests, it can be stated that burning wood cannot – or only in a few exceptions – be seen as a carbon neutral process (Booth 2018; Norton et al. 2019). The carbon from the forest stock is transmitted to the atmosphere within minutes and stays there for a long time. To recover the carbon originally saved in the harvested and burned wood will need decades or centuries or might even never be achieved at all. Thus, considering this slow-in-fast-out principle, it becomes clear that the assumed climate neutrality – despite the however insufficient sustainability criteria – is not justified. A different assessment results only in the case that forest biomass from waste and residues is used for energetic purposes. This is why, in the future only residues from traditional forestry management (i.e., leftovers after use for timber, board, paper etc.) or naturally fast-decaying wood as a result of forest dieback from diseases or fire with very low payback periods should be fostered as advanced under RED III (Norton et al. 2019; Howes et al. 2016; Stephenson and McKay 2014; Sterman et al. 2018; Ter-Mikaelian et al. 2015).

In contrast to that, it was calculated that more than 100% of Europe's annual harvest of wood would be needed to supply just one third of the RED II Directive's renewable energy target (Beddington et al. 2018). This is why under the current directive even further increases in forest biomass harvesting can be expected in Europe. The rising demand for wood from the bioeconomy has already led to a 69% higher biomass loss between 2016 and 2018 compared to the period between 2011 and 2015 and thus also to a significant reduction in carbon sink capacities of Europe's forest ecosystems (Ceccherini et al. 2020; Ceccherini et al. 2021). This is why, besides this, a sharp increase in the demand for soy causing further deforestation in Latin America is expected as well (Malins 2020). A further complicating circumstance is that particularly woody biomass (biomass pellets) contains less energy than fossil fuels like coal and that the energy used for felling, transportation, drying and pelleting has to be accounted for as well (McKechnie et al. 2011; McKechnie et al. 2014; Norton et al. 2019). Already in 1850, EU forests were almost cut down to zero for to energy purposes (Beddington et al. 2018) until fossil fuels had substituted forest biomass, that now needs to be substituted.– However, in doing so, lessons should be learned from history and the same mistakes should not be repeated. It therefore seems appropriate to redirect more renewable energy production towards solar and wind power (Marimuthu and Kirubakaran 2013; Hennig 2017; Ekardt 2019; Grant and Hicks 2020) and to strictly limit, but by no means continue to promote, any further use of woody biomass that is not based on the recycling of waste at the end of the life cycle of a product. However, as far as alternatives like wind and solar power are also resource-intensive and not always free of negative side-effects (Hennig 2017; Avila 2018; Parker et al. 2018; Ekardt 2019;

Subtil Lacerda and van den Bergh 2020), the implementation of frugality also concerning energy purposes needs to be pursued in parallel. This applies not least to the transport sector, where the simple replacement of combustion engines with electric motors cannot be a solution, but instead completely new transport concepts must be developed, in a renunciation of the overemphasis on individual transport (Salazar et al. 2018; Smith et al. 2018; for actual research needs see Tirachini and Cats 2020).

5.2.3.3 Interim Conclusion on the RED II Directive

To sum up: Even though RED II sets binding sustainability criteria to avoid direct and indirect land use effects and changes related to biofuels consumed in the EU, and defines a cap for the use of biofuels gained from food and feed crops, the risk of deforestation cannot be sufficiently reduced. In contrast, the risk for further deforestation and forest degradation, through enhanced harvesting of forest biomass and accelerating ILUC might even be enhanced through the regulation. The current regulation is thus far "achieving the reverse of that intended" (Norton et al. 2019, 1258) and does not contribute to solving the climate crisis by saving high carbon reservoirs like forest ecosystem but exacerbates the destruction of forests due to direct and indirect land use changes.

In combination with the accounting rules for land use change under the Paris Climate Agreement, which refer to the most up-to-date IPCC guidelines (IPCC 2019b), this effect will be even more severe. The assumption is that the loss of forest biomass is already accounted for in the LULUCF sector of the country of origin. However, this is not necessarily the case due to weak accounting rules especially if, for example, policy changes can be incorporated in a business-as-usual scenario. This means that the imported forest biomass used in a plant is accounted for as zero emissions in the importing country. In this way, the importation of biomass use for energy production is stimulated, while the responsibility for reporting is shifted to the export countries, which mostly lack effective monitoring and enforcement capacities (McKechnie et al. 2014; Norton et al. 2019).

5.2.3.4 Legal Proposal to Amend the Renewable Energy Directive (RED III)

As with the amendment plans for the LULUCF Regulation, expectations were high that RED III would close existing loopholes in favour of the restoration and protection of forest ecosystems with high biodiversity and carbon value. In particular, there were frequent calls to abandon or at least restrict the promotion of burning biomass generated from forestry and agriculture (European Commission 2021g, 75–80). These expectations cannot be met by the actual legal proposal (RED III proposal[30]), that first of all envisages enhancing the share of energy from renewable

[30] Proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 of 14 July 2021, COM(2021) 557 final.

resources in 2030 to at least 40% (Art. 3 No. 1 RED III proposal). This is convincing as such – although not ambitious enough with regard to Art. 2 para. 1 PA -, but needs supplementary rules that focus on the renewables of wind and solar energy. The absence of such rules brings about the danger of further increasing the demand for bioenergy from forestry- and agriculturally-derived biomass in Europe, a demand that already today cannot be met from agricultural production and timber harvesting in the EU (see Sect. 5.2.3.2). At the same time, an earlier phasing out of fuels from palm or soy oil is not intended and ILUC risks where not reassessed – again at the expense of global forest cover.

The most important further changes envisaged in the RED III proposal can be summarised and evaluated as follows: No subsidies will be granted for the use of saw logs, veneer logs, stumps and roots to produce energy and from 31.12.2026 onwards there will be no financial support for electricity from forest biomass produced in electricity-only installations (Art. 3 lit. a, b RED III proposal). However, the industry already burns mainly wood with low financial but potentially high carbon and biodiversity value in power plants that mostly combine electricity and heat generation, or even in old coal-fired power plants that – following an already ongoing trend in the EU – could in the future be completely converted to burning forest biomass instead of coal, with as yet uncertain, but probably enormous detrimental consequences for global forest conservation (Bethge 2021; Endt 2016; Kohan 2021; Sheffield 2021; Baraniuk 2018). Additionally, if a region is "identified in a territorial just transition plan" (Art. 3 lit. b ii RED III proposal) this requirement does not apply and support can still be gained even if the power plant produces only electricity, which fosters the potentially disastrous substitution of coal by woody biomass in coal-dependent regions further.

Thus, neither a general phasing-out of the promotion of the energetic use of woody biomass is envisaged according to the RED III proposal, nor a concentration on the exclusive use of residual materials, e.g., from sawmills or the collection of fine woody debris up to a certain locally defined limit, as also recently proposed by the European Commission's Joint Research Centre (JRC) (Jonsson et al. 2021, 8). Instead, a delegated act on how to apply the cascading principle is to be adopted one year at the latest after the amended regulation comes into force (with hitherto uncertain provisions, Art. 3 RED III proposal) and the sustainability criteria of Art. 29 will be further adjusted as follows: First of all, the sustainability criteria of Art. 29 should apply to all installations producing electricity, heating or cooling related to a thermal input to or exceeding 5 MW and no longer 20 MW, which means that more installations will have to follow the sustainability criteria. Secondly, a ban on the procurement of biomass for energy production from primary forests, peatlands and wetlands is proposed, so that the existing RED II no-go areas for agricultural biomass production according to Art. 29 No. 3–5 will finally also apply to forests. This is, first of all, to be welcomed in order to preserve the last primary forests and peat- and wetland with enormous significance for climate protection. In this way, woody biomass from plantations established on former natural forest land shall be excluded from any potential support by RED III and the conversion of biodiverse natural forests into fast growing plantations be prevented in the future (see for this suggestion also Camia et al. 2021, p. 162). However, considering that primary forests are very rare in Europe and – like peatlands and wetlands – should be protected anyway (and partly already are), the criteria still remain insufficient, as all other carbon-rich forest types can still be used for energy without restrictions that go beyond the only slightly adjusted sustainability criteria. As has already been pointed out, to prevent problems such as sufficient control in the global value chain, there should be a clear rejection of the promotion of energy recovery from woody biomass that is not based on residual or waste materials that cannot be further recycled anyway. It remains to be seen how the final version of RED III and the Delegated Act on the cascading principle will ultimately be designed.

5.2.4 EU Timber Regulation & FLEGT

The EU Timber Regulation (EUTR) No 995/2010[31] is a product-related regulation which refers to a more sustainable forest management and acknowledges that the elimination of illegal logging and related trade cannot be achieved by EU Member States individually. Rather, the regulation recognises that the EU is an importer of commodities associated with significant deforestation, including crop, feedstuff and livestock products, which makes a policy aiming at stopping deforestation and illegal harvesting, not only in the EU but also abroad, important (European Parliament 2019, 3 et seq.).

The Regulation is a key component of the EU Forest Law Enforcement, Governance and Trade Action Plan (FLEGT) (European Commission 2003; see also European Commission 2018a) and obliges operators who place timber and timber products on the market to minimise the risk of importing illegally harvested timber by due diligence (European Commission 2019a, 4). The due diligence system comprises information, risk assessment and risk mitigation. This means, the operator must have access to information about the timber and timber products including the country/region of harvest, species, quantity, details of the supplier and information on compliance with national legislation. Besides that, an assessment on the risk of illegal timber in the supply chain of the operator and measures to mitigate this risk, e.g., by additional information and verification from the supplier, are required (Art. 5 and 6 EUTR).

The EUTR applies to imported as well as domestically produced timber and timber products to be placed on the internal market. The EUTR complements and strengthens the FLEGT Voluntary Partnership Agreements (VPA) between the EU and timber-producing countries. These FLEGT VPA create legally binding obligations for the parties to implement a licensing scheme and to regulate trade in timber and timber products (recitals 7 and 8 EUTR). The licensing scheme for imports of

[31] Regulation (EU) No 995/2010 of the European Parliament and the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market, 12/11/2010, OJ L 295/2.

timber into the internal market is established in Regulation (EC) No 2173/2005,[32] which lists timber products to which the licensing scheme applies in Annexes II and III and partner countries in Annex I. Building on FLEGT, Art. 3 para. 1, EUTR considers timber embedded in timber products listed in Annexes II and III to the Regulation (EC) No 2173/2005 which originate in partner countries listed in Annex I and which comply with Regulation No 2173/2005, as legally harvested. The same is true for timber of species listed in Annex A, B or C to Regulation (EC) No 338/97 which implements CITES (Art. 3 para. 2 EUTR) (see Sects. 5.1.4.3 and 5.3.3 on CITES).

Member States are obliged to lay down rules on penalties for infringements of the provisions of the Regulation including fines, seizure of the timber and timber products or immediate suspension of authorisation to trade (Art. 19 EUTR). Illegally harvested timber and timber products should not necessarily be destroyed. Instead, it may be used for purposes of public interest (recital 27 EUTR). However, the implementation of these penalties in the Member States varies. Sanctions range from administrative sanctions to criminal prosecution (European Commission 2016a, 4). Altogether, the EUTR lacks a cohesive understanding, application and enforcement throughout the Member States which narrows its effectiveness (European Commission 2016a, 8 et seq.).

Furthermore, the EUTR does not establish sustainably forest rules itself but aims at procedural standards and improving supply chain transparency. Although recital 2 of the EUTR recognises the deficiencies of the institutional and governance framework in a number of timber-producing countries with regard to combating illegal logging and the associated trade, the EUTR fails to address this issue: To be exported to EU-countries, the wood has to be harvested legally, which means, according to Art. 2 (f) "harvested in accordance with the applicable legislation in the country of harvest", no matter whether the host states harvesting rules are sustainable or not (Ituarte-Lima et al. 2019, 255 et seq.). As a consequence, the EUTR suffers from a weak governance effect in timber-producing countries without strict forest legislation (Ituarte-Lima et al. 2019, 255 et seq.). It rather manifests the status quo in these countries. The implementation of a definition on legally harvested and/or sustainable forest practices independent of the host countries' legislation into the EUTR would have a stronger governance effect. One approach is to incorporate the CBD principles and targets in the EUTR (Ituarte-Lima et al. 2019, 263 et seq.). However, the EU has not yet made any efforts in this regard. Additionally, it remains to be seen how the envisaged regulation on due diligence throughout the value chain (see Sect. 5.2.7) relates to the EUTR and to what extend binding standards will be implemented and enforced to ensure more sustainable forestry practices. It also remains open to what extend key drivers of deforestation such as the production of animal food will be addressed.

Thus far, the EU fitness check on the EUTR and FLEGT Regulation (European Commission 2021k) revealed that the steering effect of both regulations remains

[32] Council Regulation (EC) No 173/2005 of 20 December 2005 on the establishment of a FLEGT licensing scheme for imports of timber into the European Community, 30/12/2005, OJ L 347/1.

comparatively low. The impact of the EUTR on the volume of timber imports from high-risk sources was considered not to be significant and the interpretation of 'negligible risk' according to Art. 6 para. 2 lit. c was proven to be subjective, while the stringency of enforcement measures generally varies widely. Thus, illegally logged timber could at best be kept out of the EU market but not halted globally (European Commission 2021k, 3). Apart from that, FLEGT mainly suffered from a very slow implementation process and involved a limited number of countries. Only 3% of timber product imports into the EU were covered by FLEGT licences in 2018 (European Commission 2021k, 3). Finally, the lack of political will, the absence of a robust administration, and corruption were named as factors that generally hinder implementation processes (European Commission 2021k, 4).

5.2.5 Biodiversity and Nature Conservation Law

The cornerstones of the EU biodiversity policy are the Birds Directive[33] and the Habitats Directive.[34] Both directives, by means of command-and-control law and planning law, create a network of protected sites, which is known as Natura 2000 network, making up one fifth of the EU's land area (European Commission 2015b). While the Birds Directive relates exclusively to the protection, management and control of naturally occurring birds in the wild state (Art. 1 Directive Birds Directive), the Habitats Directive refers directly to forests. According to Annex 1 Habitats Directive, many forest types are considered as natural habitat types of Community interest whose protection requires the designation of special areas of conservation. Forests account for half of the Natura 2000 territory. However, there are significant differences between Member States and biogeographical regions (European Commission 2021b; European Commission 2013a, 34).

The aim of the Habitats Directive is to contribute towards ensuring biodiversity by taking measures to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora (Art. 2 para. 2 Habitats Directive). According to Art. 6 Habitats Directive, Member States are obliged to take necessary conservation measures for sites defined as special areas of conservation, to avoid deterioration of respective habitats and to introduce assessment procedures of plans or projects that may have a significant negative impact on Natura 2000 sites. Necessary conservation measures may include appropriate (forest) management plans and statutory, administrative or contractual measures (Art. 6 para. 1 Habitats Directive) co-financed by Member States and EU funds such as EAFRD or LIFE (Art. 8 Habitats Directive). These measures may also involve agri-environment-climate measures within the framework of the CAP (see Sect. 5.2.6 European Commission 2013a). Furthermore, Art. 10 Habitats Directive emphasises the

[33] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds, 26/01/2010, OJ L 20/7.

[34] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, 22/07/1992, OJ L 206/7.

necessity of ecological coherence of the Natura 2000 network to enhance migration, dispersal and genetic exchange of wild species. To this end, Member States shall endeavour to ensure linear and continuous structures and stepping stones for protected habitats, including small forests.

Overall, the EU legal framework on the conservation of nature, habitats and species is insufficient due to incomplete and small-scale regulations and a lack of enforcement (European Commission 2020c, 3; European Commission 2015a, 19; European Commission 2016c, 5). This is also true for Germany, where the EU Commission recently stepped up the already ongoing infringement procedure against Germany. The Commission considers that there is a general and persistent practice of not setting sufficiently detailed and quantified conservation objectives and that the objectives are additionally not sufficiently quantified, measurable and reportable. Apart from that, a significant number of areas have still not been designated as Special Areas of Conversation (SACs) (European Commission 2021c; INFR(2019)2145). This is why the new EU Biodiversity Strategy for 2030 aims at widening the network of protected areas and developing an ambitious EU Nature Restoration plan by the end of 2021 (European Commission 2020c, 3). The envisaged larger and more coherent EU-wide network of protected areas will build on existing Natura 2000 areas and strictly conserve areas of very high biodiversity and climate value. This is where primary and old-growth forests come into play (European Commission 2020c, 4). One element of the objective to extend the area of *strictly* protected land from 3% to 10% is to define, map, monitor and protect *all* the EU's remaining primary and old-growth forests and to advocate for those forests globally (European Commission 2020c, 4). However, Member States are responsible for implementing measures to achieve this goal, which could make successful implementation more difficult. These enforcement deficits are illustrated, for example, by the infringement proceedings against Poland for increased logging in the Białowieża Forest which is a protected Natura 2000 site (see IP/17/1948). Besides that, it is estimated that primary forests account for only 0.7% of the total forest area in Europe of which only 46% are legally protected today (Selva et al. 2020, 1439; Sabatini et al. 2018, 1432 et seq.). Further measures for areas not classified as primary and old-growth forests are required so that they contribute to achieving biodiversity protection and carbon removal and storage. This approach would also be in line with the key commitment of the 2030 Biodiversity Strategy to legally protect a minimum of 30% of the EU's land area and to integrate ecological corridors (European Commission 2020c, 5).

Besides, within the envisaged EU Nature Restoration Plan, the health of existing and newly protected areas should be improved by ensuring the sustainable use of ecosystems and reducing pressures on habitats and species. To this end, binding targets and timelines, clear definitions or criteria on restoration and sustainable use as well as stronger implementation support, including sufficient funding, and enforcement are necessary, which are lacking today (European Commission 2016c, 41 et seq., 89, 2020c, 6). Above all, the legally binding EU nature restoration targets planned for 2021 should include forests with a high potential to capture and store carbon and of great value for biodiversity (European Commission 2020c, 6).

Besides Natura 2000 legislation, the EU Wildlife Trade Regulations implement CITES (see Sect. 5.1.1.4) in Community law. These regulations include the Basic Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein[35] (Council of the European Union 1997), the Implementing Regulation (EC) No 865/2006 laying down detailed rules concerning the implementation of Council Regulation (EC) No 338/97[36] (amended regularly) (Commission of the European Communities 2006), and the Permit Regulation (EU) No 792/2012 laying down rules for the design of permits, certificates and other documents[37] (European Commission 2012), and a Suspension Regulation[38] (European Commission 2019d) to suspend the introduction into the EU of particular species from certain countries (European Commission 2021c).

The Basic Regulation lists the species from Appendix I, II and III of CITES and some non-CITES species, especially those non-CITES species of the Habitats Directive and the Birds Directive. As mentioned above, these species include endangered tree species. Timber products from these species need an export permit from the country of origin and an EU import permit to be imported into the EU. The export permit is only issued if the timber is harvested legally in the country of origin while the import permit is only granted if detrimental effects of the import permission on the conservation status of the tree species or on the extent of the territory occupied by it can be excluded (Art. 4 and 5 Council Regulation (EC) No 338/97).

However, even if CITES is an overall gain for species conservation, it depends on how the exporting states interpret CITES and what they consider to be legal and whether and how illegal logging is pursued. At the same time, EU Member States have different interpretations of the Wildlife Trade Regulations which implement CITES. Besides that, given the Wildlife Trade Regulations are complex and apply to non-routines cases, Member State authorities face difficulties in deciding how to treat a species. Thus, complexity and divergent interpretations weaken the effectiveness of the regulations (Ó Críodáin 2017).

[35] Council Regulation (EC) No 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein, 03/03/1997, OJ L 61/1.

[36] Commission Regulation (EC) No 865/2006 of 4 May 2006 laying down detailed rules concerning the implementation of Council Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein, 19/06/2006, OJ L 166/1.

[37] Commission Implementing Regulation (EU) No 792/2012 of 23 August 2012 laying down rules for the design of permits, certificates and other documents provided for in Council Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein and amending Commission Regulation (EC) No 865/2006, 07/09/2012, OJ L 242/13.

[38] Commission Implementing Regulation (EU) 2019/1587 of 24 September 2019 prohibiting the introduction into the Union of specimens of certain species of wild fauna and flora in accordance with Council Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein 27/09/2019, OJ L 248/5 (most recent version).

5.2.6 Common Agricultural Policy

The Common Agricultural Policy (CAP) is the main source of EU funds for forests (for an overall critical view on the CAP see Heyl et al. 2021). The CAP consists of two pillars, of which the first pillar mainly comprises direct payments to farmers and the second pillar covers rural development programs. Around 90% of EU funding for forestry measures come from the European Agricultural Fund for Rural Development (EAFRD) which is co-financed by Member States (European Commission 2015c, 18), i.e., Pillar II (governed by Regulation (EU) No 1305/2013 (European Parliament and Council of the European Union 2013). Art. 21 et seq. of the Regulation (EU) No 1305/2013 lays down forest-related measures for investments in forest area development and improvement to the viability of forests. Support under this measure is granted for afforestation and the creation of woodland (Art. 22), the establishment of agroforestry systems (Art. 23) as well as for the prevention and restoration of damage to forests and from forest fires, natural disasters and catastrophic events such as pest and disease outbreaks, and climate related threats (Art. 24). Furthermore, investments improving the resilience and environmental value of forest ecosystems including ecosystem services of forests such as climate change mitigation (Art. 25) are supported. The same applies to investments in forestry technology and in the processing, the mobilising and the marketing of forest products including soil- and resource-friendly harvesting machinery and practices (Art. 26). In addition, Art. 34 Regulation (EU) No 1305/2013 includes payments to forest-environmental and climate services and for forest conservation commitments which go beyond the relevant mandatory requirements in relevant national legislation. Besides, agri-environment-climate payments may also be granted for forest-related commitments on a voluntary basis (Art. 28). Apart from this, payments for Nature 2000 and the Water Framework Directive (Art. 30) can be provided to forest holders in order to compensate for additional costs for measures taken to implement the Natura 2000-Directives (see Sect. 5.2.5) and the Water Framework Directive. Other measures may also include forest-related commitments, e.g., support for cooperation measures, which may be granted for cooperative drawing up of forest management plans or equivalent instruments, too (Art. 35 para. 2 lit. j Regulation (EU) No 1305/2013).

Within the framework of the CAP beyond 2020, according to the European Green Deal, Member States are required to emphasise forest issues more strongly when designing their national strategic plans and thus incentivising more sustainable forest management and avoiding forest degradation (European Commission 2019e, 14). To this end and in accordance with the objectives of the new Biodiversity Strategy and the Farm to Fork Strategy, Member States shall provide an adequate budget for sustainable practices such as agroforestry, for forest restoration and re-/afforestation and for bringing back at least 10% of agricultural areas with high-diversity landscape features such as non-productive trees (European Commission 2020c, 7–9).

However, at present and in the future, the design of the rural development programmes depends on the Member States and so does the decision on the budget to be provided for measures aiming at more sustainable forest-related practices (European Parliament 2021a). At the same time, administrative burdens hinder the implementation of such measures (European Commission 2015c, 18–19). Moreover, only a small part of the total CAP budget is earmarked for the second pillar (24.4%), i.e., rural development, including agri-environment-climate commitments – and even less for forestry measures. The second pillar thus suffers from chronic underfunding, although it contributes to climate and biodiversity protection. The first pillar instead receives 75.6% of the CAP budget – despite criticism towards its direct payments for their detrimental environmental effects (European Parliament 2021b; critically pars pro toto Heyl et al. 2021; Pe'er et al. 2014, 1090–1092; Pe'er et al. 2017). Furthermore, the CAP does not prevent the large demand for feedstuff for animal husbandry, which triggers deforestation not only in the EU but also in third countries, which export feed (on the challenges of livestock farming see Chap. 1 and Sect. 4.2.2). This, and in particular the weak financing of the second pillar does not appear likely to change in the future CAP (for the reform proposals see COM(2018) 392 final, 393 final and 394 final; for a critical review see Heyl et al. 2021). Indeed, on 23th of November 2021 the EU Parliament approved the amendments of the CAP compromise package after the super-trilogue on 24 to 25 June 2021. Hence, the new CAP regulation[39] is expected to come into force from 1 January 2023 (European Parliament 2021c).

5.2.7 Further Directives, Legal Proposals on Due Diligence and Forest Information System for Europe

EU legislation contains further references to forests-related issues in Council Directive 1999/105/EC[40] on the marketing of forest reproductive material, since the restocking of forests and new afforestation require high quality, genetically diverse and site-adapted reproductive material (recitals 2 and 3 Directive 1999/105/EC). Besides that, Council Directive 2000/29/EC[41] establishes protective measures against the introduction of organisms which are harmful to plants or plant products into the Member States from other Member States or third countries and

[39] Regulation (EU) 2021/… of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council. 2018/0216 (COD). LEX 2131.

[40] Council Directive 999/105/EC of the Council of the European Union of 22 December 1999 on the marketing of forest reproductive material, 15/01/2000, OJ L 11/17.

[41] Council Directive of the Council of the European Union of on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community, 10/07/2000, OJ L 169/1.

furthermore aims to prevent harmful organisms spreading to forests (European Parliament 2021a).

In addition, Member States' criminal laws and other legislation such as legal acts regarding stolen goods may be applicable in some cases of illegal logging, which may enable the criminal prosecution of operators dealing with illegally harvested timber in Member States. Besides that, Member States may apply the measures established in the OECD Action Statement on Combating Bribery (such as the refusal to grant credit), since illegal logging operators are often involved in bribery and corruption (European Commission 2003, 20 et seq.).

Apart from that, deforestation-free supply chains may be encouraged through various measures. While public funds should only be granted if they do not conflict with sustainability objectives, private investments can also be linked more closely to sustainability criteria. For instance, investors can demand increased transparency along the investment chain from companies. Such measures are supported by the Shareholder Rights Directive (EU) 2017/828 which amends Directive 2007/36/EC.[42] Transparency measures would also be in line with the Commission's proposal for a regulation on disclosures relating to sustainable investments and sustainability risks and amending Directive (EU) 2016/2341.[43] In fact, the Non-Financial Reporting Directive[44] already requires large companies to enhance transparency and to disclose non-financial information such as environmental, social and human-right matters (European Commission 2019a, 14; see also the proposal). Likewise, environmental management and audit schemes, such as EMAS, which is regulated by Regulation (EU) 2017/1505,[45] can help to identify and reduce negative environmental impacts including deforestation (European Commission 2019a, 14).

Furthermore, there are two legal proposals on corporate due diligence regarding deforestation and forest degradation in supply chains. First, there is a proposal to introduce mandatory corporate environmental and human rights (regarding the people in the Global South) due diligence on EU level, as announced by the European Commissioner for Justice at the end of April 2020 (BHRRC 2020), which would be a step towards deforestation-free supply chains. In March 2021, the European

[42] Directive (EU) 2017/828 of the European Parliament and the European Council of 17 May 2017 amending Directive 2007/36/EC as regards the encouragement of long-term shareholder engagement, 20/05/2017, OJ 132.

[43] Proposal for a Regulation of the European Parliament and of the Council on disclosures relating to sustainable investments and sustainability risks and amending Directive (EU) 2016/2341, 24/05/2018, COM(2018) 354 final.

[44] Directive 2014/95/EU of the European Parliament and the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups, 15/11/2014, OJ L 330/1.

[45] Commission Regulation (EU) 2017/1505 of 28 August 2017 amending Annexes I, II and III to Regulation (EC) No 1221/2009 of the European Parliament and of the Council on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), 29/08/2017, OJ L 222/1.

Parliament adopted a resolution[46] with recommendations to the EU Commission to prepare and submit a legal proposal concerning a directive on mandatory due diligence and corporate accountability with suggestions for legislation. The legislative proposal will aim at holding companies accountable and liable when they harm human rights, the environment and good governance, or contribute to harming them (see also Sect. 3.6.3). Connected to this, and acknowledging the EU's contribution to global deforestation, the European Parliament adopted a resolution on deforestation[47] in October 2020 that shall minimise the risk of deforestation and forest degradation associated with products placed on the EU market. In its annex, the resolution contains recommendations to the Commission on an EU legal framework to halt and reserve EU-driven deforestation. Among other things, it states that the "commodities covered by the proposal and their derived products placed on the Union market should not result in, or derive from, the degradation of natural forests or natural ecosystems due to human activity" (Annex, 3.2) and "operators should take all necessary measures to respect and ensure the protection of human rights, natural forests and natural ecosystems (…) throughout their entire supply chain (Annex, 4.1; see also European Parliament 2020b). In June 2021, NGOs claimed that the adoption of both proposals is delayed (ECCJ 2021). However, given bad experiences with the bioenergy sustainability criteria (see Sect. 6.2), it remains an open question whether the intended regulation (instead of clear import bans or border adjustments as discussed also in Sect. 6.2) will represent a substantial step forward or not.

The first proposal for a Forest Risk Commodity Regulation (FRCR)[48] was released in November 2021. The proposal contains binding due diligence obligations for companies that want to place raw materials such as soy, beef, palm oil, wood, cocoa and coffee, as well as products derived from them (such as leather, chocolate and furniture) on the EU market. It has to be ensured that the commodities and products concerned do not originate from forest areas that have been deforested or degraded after 31/12/2020. They have to be produced in accordance with the laws of the country of origin. A benchmarking system on deforestation and forest degradation risk, inter alia, shall be used to ensure that only deforestation-free and legal products are allowed on the EU market. This could mark a turning point in the fight against global deforestation emanating from the EU (for initial reactions see DNR 2021b). However, ecosystems such as savannahs and wetlands, which are of great importance for climate protection and biodiversity as well, are not covered by the proposed regulation. The same applies to commodities such as rubber, pork, poultry

[46] European Parliament resolution of 10 March 2021 with recommendations to the Commission on corporate due diligence and corporate accountability (2020/2129(INL)), 10/03/2021, P9 TA(2021)0073.

[47] European Parliament resolution of 22 October 2020 with recommendations to the Commission on an EU legal framework to halt and reverse EU-driven global deforestation (2020/2006(INL)).

[48] Proposal for a Regulation of the European Parliament and of the Council on the making available on the Union market as well as export from the Union of certain commodities and products associated with deforestation and forest degradation and repealing Regulation (EU) No 995/2010, 17/11/2021, COM(2021) 706 final.

and maize, so that shifting effects are again to be expected. Finally, it should be noted that reliance on the (possibly weak) national laws in the country of origin might weaken the regulation, as was already discussed in Sect. 5.2.4 on the example of the EUTR and FLEGT.

On the consumer side, Regulation (EU) No 1169/2011[49] obligates producers to provide information on ingredients, including oils of vegetable origin which have to be specified in order to allow consumers to distinguish between various vegetable oils (Art. 18 para. 1 and Annex VII Part A No. 8 Regulation (EU) No 1169/2011). Consumers could, for example, decide to avoid products containing palm oil, which is regularly associated with deforestation. However, such instruments are only of an informational nature. They can be supportive, but they do not replace legally binding standards to effectively reduce deforestation.

Another entry point for sharing forest-related information is the Forest Information System for Europe (FISE), which was launched by the European Commission, in particular DG-ENV, DG-JRC as well as Eurostat and the European Environmental Agency. The information system provides data on the state and health of Europe's forests, e.g., for policymakers, exports, forest industry and forest owners, forest conservationists and scientists (FISE 2021). Such information systems can serve as a basis for decision making regarding the development of effective forest governance. However, given the motivational and governance problem findings, they cannot replace binding measures in terms of economic or command-and-control instruments.

5.2.8 Interim Conclusion on EU Legislation

We have seen that various areas of EU law touch on the subject of forests, in particular (timber) product law, nature and biodiversity conservation law, agricultural law and climate law. In addition, a growing number of EU strategies acknowledge the need to protect and manage forests in Europe and abroad in a more sustainable way. All these strategies are increasingly interlinked. This sounds promising at first, but these strategies are not legally binding and some of the legal acts announced in them are not expected to be adopted in the near future. A deeper analysis of existing, legally binding acts raises doubts on whether a substantial contribution to forest protection and thus also to the biodiversity and climate goals is actually being achieved, even if they contain promising approaches.

The EU Timber regulation falls short due to the fact that it can only be as effective as the legislation in the countries of origin of the timber and timber products. A

[49] Regulation (EU) No 1169/2011 of the European Parliament and the Council of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004, 22/11/2011, OJ L 304/18.

general definition of legal harvesting and the integration of standards for sustainable forest management would help here. Nature and biodiversity conservation law contributes to the preservation of species, including trees, in particular through habitat protection under the Habitats Directive, but is also insufficient to achieve the biodiversity objectives and needs further improvement, let alone enforcement deficits that are typical for command-and-control law, especially with regard to land use (Ekardt 2019; Stubenrauch 2019; Garske 2020). The CAP contains some good, forest-related support measures in the second pillar, but this pillar is underfunded. Above all the first pillar maintains agricultural structures that are counteractive, for example by keeping livestock farming and arable farming separate, which drives up the importation of animal feed – and thus also deforestation.

The LULUCF Regulation can be seen as the first and also necessary endeavour to include the LULUCF sector in a legally binding climate scheme. However, the scope for the Member States with regard to the accounting rules, especially for managed forest land, remains high and therefore lacks cohesiveness among them. However, it is still possible to offset the emission reductions achieved against the emissions generated between Member States. Furthermore, the no-debit rule is softened by various flexibilities on the one hand and is not sufficient to achieve climate neutrality in the sense of the Paris Agreement on the other. For this to happen, the no-debit rule would have to be extended to all three pillars of the EU climate regime and adapted to the requirements of the Paris Agreement. The latter is envisaged according to the LULUCF proposal in the future, although the intended timetable might be too slow to successfully limit global warming to only 1.5 degrees. Moreover, the problem of depicting is not solved yet, neither in general nor in particular regarding forestry, which might be improved in the future through the planned increased monitoring and less complex accounting rules.

The Renewable Energy Directive RED II thus far cannot avoid direct and indirect land use changes and hereupon based further deforestation on a global level, because it clearly fosters the energetic use of forest (grown) and agricultural biomass. The binding sustainability criteria remain weak and lack sufficient consistency regarding both types of biomass use. The underlying assumption of the climate neutrality of energy production from woody biomass cannot be substantiated due to the slow growth-rate of trees compared to the quick release of emissions while burning wood, unless waste and residues are considered With regard to agriculturally cultivated biomass, only palm oil is considered to have a high ILUC risk, but soy, for example, is not, albeit with a stricter phasing out of palm oil for energy use, increased recourse to soy is to be expected. All in all, the sustainability criteria approach collides with all typical governance problems (as command-and-control law and subsidy law do in most cases; see Ekardt 2019) – it cannot deal with shifting effects, enforcement problems, lack of ambition and problems of depicting. Even the planned expansion of the sustainability criteria under RED III cannot change this fundamental assessment. Additionally, a general departure from the promotion of energy generation from forest biomass is just as unintended as an earlier withdrawal from the energy recovery of palm or soy oil.

Further legal areas contain some starting points for forest conservation, but often lack a clear, binding and sanctionable objective and a significant governance effect on forests. They are either of more informational nature or depend on Member States' legislation, e.g., related to criminal law. It can be concluded that a coherent EU forest policy, which on the one hand aims at conserving forests within the EU and increasing their sink capacities and on the other hand ensures that EU measures do not lead to increased deforestation in other parts of the world, does not exist yet. Rather, it seems that awareness of the magnitude of the challenges facing the forest sector against the backdrop of the climate and biodiversity crisis and the need to move away from fossil fuels is only just beginning to emerge, while legal steps to address them are very hesitant and almost timid, and thus not up to the enormity of the challenge.

5.3 Interim Conclusion

This chapter has examined existing policy interventions at international and European level. International law is largely determined by MEAs related to forests (such as the Paris Agreement and the CBD), soft law, especially the SDGs, and the REDD+ funding regime. The latter has so far fallen short of expectations and will require better coordination, monitoring and financing in the future. In addition, the drivers of forest destruction cannot be effectively countered by a selective funding regime for forest conservation alone. In spite of all of this, an obligation for states to protect forests accordingly and manage them sustainably can already be derived from the – in parts legally binding – MEAs, supported by the SDGs – even if an international agreement on forest protection does not yet exist. The EU and its Member States are therefore called upon to ensure this through coherent legislation.

However, a review of EU law revealed that such coherent legislation on forest protection does not yet exist. Rather, different regulations are in conflict with each other. This is particularly evident in the relationship between the LULUCF Regulation and the RED II Directive. The LULUCF Regulation aims to integrate the land-use sector, including the forest sector, into the EU climate regime. However, it is necessary to close many of the existing loopholes in the future, as well as to reduce the existing broad leeway Member States currently have in accounting for additional sink capacities or emissions and, last but not least, to raise the overall ambition level. Thus far, sustainable forest management in particular, which leads to the preservation of C sinks or their expansion, is not ensured by the LULUCF Regulation, whereas the already described problem of depicting arises. The RED II Directive – counterproductively – also promotes the burning (i.e. energy utilisation) of woody biomass. In addition, the ILUC risk is not sufficiently limited by the Directive, but is additionally promoted by the insufficiently legally constrained promotion of agriculturally generated biomass. The sustainability criteria in their current form are not yet sufficient for this. The existing funding for sustainable forest management and conservation in Europe, so far realised mainly through the second pillar of the CAP, cannot compensate for all this and will have to be supplemented in the future by further funding opportunities.

The EU Timber Regulation, which sets out the obligations of operators who place timber and timber products on the EU market and thus influences timber harvesting practices in third countries, has so far been insufficiently stringent, lacks enforcement and above all refers to existing legislation in the country of harvest, which might however be weak. Within the EU, the nature conservation legislation in force also hardly protects forests adequately. Even in designated Natura 2000 areas, for example, it is not necessarily ensured that sustainable forest management takes place and that these areas are not subject to over-logging. Moreover, the Natura 2000 network does not yet cover all forest areas worthy of protection, which became currently clear in the German case.

A certain remedy could be created in the future within the framework of the planned measures of the new EU Forest Strategy and the still outstanding carbon farming initiative. However, these are so far only strategies or initiatives without legally binding force. With regard to improved forest protection, it will therefore depend on the measures derived from these strategies and their implementation – and also on the extent to which biodiversity goals can be meaningfully combined with existing climate goals.

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6 Enhanced Governance Options for Regulatory and Economic Instruments

Abstract

We developed a bundle of political-legal measures. These measures should ideally be adopted at EU level to avoid ecologically counterproductive shifting effects and competitive disadvantages (and thus also social acceptance problems), especially since parts of the corresponding regulatory measures are only legally permissible at EU level. The proposals are oriented towards climate and biodiversity goals and the avoidance of the aforementioned governance problems. To this end (and furthermore the greatest possible freedom) quantity governance systems are most effective when not directly targeting forests due to their heterogeneity but central damaging factors. In that, our study confirms our earlier research findings from other areas of sustainability governance. With regard to the dominant regulatory and subsidy-based governance for forests we show that it remains necessary to supplement these quantity governance systems with certain easily graspable and thus controllable – i.e. little exposed to the typical governance problems – regulatory and subsidy regulations.

We propose three quantity control systems for all fossil fuels (cap zero at the beginning of the 2030s) as well as animal products at the level of slaughterhouses and dairies (reduction target around three quarters) and for pesticides; supplementary border adjustments at the EU's external borders; a regulatory protection of old forests (and peatlands by the way) with almost no exceptions; extension of the livestock-to-land-ratio established in organic farming to all farming; far-reaching restriction of bioenergy use to certain residues flanked by import bans; national and international complete conversion of all agricultural and forest subsidies to "public money for public services" to promote nature conservation and afforestation in addition to the quantity control systems; clearer definition of forests; a total ban on certain disposable products regardless of their

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material and an obligation of full recycling or biodegradability for bioplastic products.

6.1 Governance Problems and Limits to Quantity Governance Directly Aimed at Forests – and Potentials for (Limited) Improvements by Regulatory Law

We have seen that regulatory law and subsidy law related to forests in the EU (and in its foundations in international law) are often inadequate. These instruments insufficiently protect primary and semi-natural forests in Europe. They do not sufficiently curb illegal deforestation in third countries. They do not define bindingly and with legal certainty what can be understood by sustainable forestry, i.e. monocultures/plantations are not excluded. They promote the energetic use of woody biomass, palm oil and soybean oil and thereby direct and indirect deforestation. They do not sufficiently promote recycling and reuse (cascade use) of resources. To the extent that meaningful actions are subsidised, these actions are chronically underfunded at the EU and national levels (via EAFRD) while the international subsidy regime (REDD+) offers too many loopholes.

The regulatory law issues can theoretically be eliminated relatively easy. For example, to prevent corruption in some European countries, special EU authorities could monitor regulatory law in more detail and should be granted corresponding competencies. However, this approach would most likely not work in most developing countries due to lacking institutional structures. Instead, payments for ecosystem services seem useful in these countries (see next section).

It is questionable whether corrections in regulatory law and subsidy law alone are sufficient. These governance approaches (as seen) are typically not able to effectively solve quantity problems, but the conservation and expansion of forests is a quantity problem (as is the protection of climate and biodiversity as a whole). Addressing individual areas, products, or actions typically leads to the governance problems discussed above: enforcement problems, shifting effects, rebound effects, problems of depicting (only the problem of lacking ambition could in theory be solved easily by more ambitious regulations). In previous articles we demonstrated that these governance problems can be best addressed by economic instruments such as cap-and-trade approaches (Ekardt 2019; Stubenrauch 2019; Weishaupt 2019; Garske 2020; Garske and Ekardt 2021). Policy instruments should – with a view to depictability and enforceability – preferably be based on easy-to-grasp parameters on a broad substantial and geographical scale to avoid shifting and rebound effects. But as regards forestry, trying to precisely address the GHG and biodiversity relevance of a certain forest, takes us once again to the limits of economic instruments in addressing a heterogeneous parameter. The wide range of emissions (and biodiversity decrease) and their precise measurement entail that ambitious cap-and-trade approaches are not suitable as a primary instrument. In that, forestry offers comparable policy challenges like peatland conservation measured against the above-mentioned climate and biodiversity targets (Ekardt et al.

2020). This is remarkable in so far as these cap-and-trade instruments, if they are linked to easily comprehensible control variables or governance units such as fossil fuels or livestock products, can otherwise handle governance problems very well and react to various motivational factors. If, however, a problem of depicting arises and cannot be dealt with by switching to an easily comprehensible control variable, economic instruments reach their limits. Knowledge about the exact relevance of a given (or potential) forest – or even single trees – seems still too fragmentary. This also causes issues with the baseline for calculating the emissions balance.

In contrast to peatland governance, the policy challenge of forests cannot simply be solved by some very ambitious and more or less exemption-free command-and-control obligations. Duties to rewet peatlands can make sense in general and are relatively easy to enforce. In contrast, it is pretty obvious that humankind will have to go on using forests in an economic way. Therefore, bans work only for some important areas where any kind of economic activity should be prohibited. For all other areas – and for afforestation –, other governance options are required.

6.2 Quantity Governance Addressing the Drivers of Deforestation (Livestock, Fossil Fuels)

The most important option is (once again) to radically address the drivers that cause deforestation and lacking areas for afforestation, namely livestock farming and fossil fuels in various sectors. To this end, earlier publications demonstrated that ETS approaches for fossil fuels and livestock on EU level are highly promising (Stubenrauch 2019; Ekardt 2019; Ekardt et al. 2018a, b; Garske and Ekardt 2021; Weishaupt 2019; Henders et al. 2015). The EU proposals of July 2021 point in the right direction as they plan to broaden the scope of fossil fuels covered by the EU ETS and intend to strengthen its cap. However, the cap would still be not ambitious enough, loopholes (such as LULUCF-related economic instruments of transnational climate law like the CDM or similar economic instruments under Art. 6 PA) would continue to exist, and old certificates would not be erased. Going precisely these steps is what has to be done to implement an effective quantity governance for fossil fuels. So far, the EU proposals are still not in line with Art. 2 para. 1 PA. Furthermore, there is no proposal for a livestock ETS. Our proposal is as follows (in detail see Weishaupt et al. 2020):

Livestock farming including animal feed is an important issue for deforestation and is a result of high consumption of animal products. This makes dietary shifts towards a more plant-based diet, which is more efficient and needs much less area per calorie, a valuable option in reducing the need for agricultural land. Enhanced technology like optimal fertiliser application or eating animal-derived food that leads to less CH_4 emissions can decrease the emissions of livestock farming. But the area needed (that is putting pressure on forests) barely changes. To reduce the area needed for animal husbandry and animal feed, reducing livestock animals seems to be most (cost) efficient, practical and predictable approach. To this end, various governance options have been debated including an import ban for animal feed, a tax on animal food and a ban on mass livestock farming. However, no ambitious instrument – measured against the radical global environmental targets – was ever implemented (neither in the EU nor somewhere else) or currently planned (this is still true with regard to the EU proposals of July 2021). International or even European taxes do not seem likely because EU taxes require consensus decisions in the council of ministers. National taxes will not have a noticeable effect in a globalised world and will cause shifting effects. In contrast to EU taxes, emissions trading (capping the number of animals or capping the GHG emissions of the agricultural sector) only needs a qualified majority in the council of ministers and a majority in European Parliament (Art. 192 TFEU). An ETS depends on addressees and governance units that can be easily assessed and controlled. Due to the high number of livestock farms (6.2 million alone in the EU), addressing the processing sector (13,000 slaughterhouses, 5400 dairy producers in the EU; Weishaupt et al. 2020 with further references) seems to be a more viable approach. Individual animal or output-based emission for kilogram of animal product can serve as governance unit.

A livestock ETS would drastically lower the number of livestock animals and most likely decrease imported feed (like soy from rainforest regions) due to more grazing within the EU (see again Weishaupt et al. 2020 on the tenable number of remaining livestock which is the relevant information for defining the cap of a livestock ETS). The latter effect can be intensified if livestock farmers are required to produce a certain amount of animal feed themselves. This shows that there are governance options to reduce livestock farming in the EU (or elsewhere) resulting in much less pressure on land systems, less deforestation for animal food (especially in the Amazon) and thereby contributing to free up land area for sustainable afforestation or reforestation. An ETS for fossil fuels and livestock farming would also reduce food waste which also causes land pressure (Garske et al. 2020).

A third quantity governance system for pesticides would be useful, too. Targeting the producer level, this instrument would play a central role for land use as a whole, but a less for forestry. Quantity control for pesticides would lead to price increases and reduce the overall use of pesticides along the determined quantity limit. As a result, various environmental problems – primarily biodiversity loss – in agriculture and forestry are addressed. This would be in line with the Farm-to-Fork strategy's goal of halving pesticide use in the EU, although we cannot discuss details, relevance, pros and cons in detail in the present contribution.

Effective EU sustainability policy is best achieved when, at the same time, a kind of climate club is formed with as many other states as possible taking similar measures and establishing uniform environmental standards. Otherwise, global problems remain unsolvable, and shifting effects will occur. Uniform standards can be established in international environmental treaties or anchored in plurilateral free trade agreements as they are currently negotiated and adopted in large numbers (Heyl et al. 2021). At the same time, border adjustments (see Ekardt 2019) have to be introduced to target those states that do not participate – again to avoid shifting effects, with ecologically and economically detrimental consequences. Such border adjustments or eco-tariffs create incentives for other countries to join the climate club. In line with that, in July 2021, the EU Commission proposed to introduce a border adjustment for the EU ETS. The same would have to be enacted for the livestock ETS and the pesticides ETS. Compared with civil law regulations, these instruments are a more promising way to establish global supply chains with uniform standards.

6.3 Additional Role of Subsidies and Regulatory Law – and Developing a Definition for Sustainable Forest Management

In order to achieve all environmental goals in agriculture and forestry, quantity governance systems of the kind mentioned have to be supplemented by regulatory and subsidy regulations with certain easily graspable and thus controllable governance units – i.e. little exposed to the typical governance problems. Notabene, subsidies cannot replace cap-and-trade approaches addressing the drivers of deforestation (on the following see Ekardt 2019; Ekardt et al. 2015). Changes in subsidies are inferior to establishing caps and levies, despite some similar effects, since subsidies cannot achieve the drastic reductions in terms of fossil fuels and livestock products. Moreover, especially cap-and-trade schemes are more cost-efficient than subsidy schemes since they have a more market-oriented structure. Furthermore, caps and levies have a broader scope than subsidies since they are usually more likely to address, e.g., both the acquisition and the efficient use of products. Social distribution issues do not only arise with caps or levies as subsidies are not for free either. In forestry, too, subsidy law and regulatory law should therefore focus on individual points where the effect of quantity control systems is not sufficient and where at the same time the problems of depicting, shifting and enforceability are not expected. In principle, EU regulations are again preferable because of their greater scope which avoids shifting effects (that come with competitive disadvantages for national economies and can weaken the social acceptance of environmental policy measures).

An ETS for livestock products should be supplemented by a livestock-to-land ratio (no longer for organic farming only), which moderately limits the number of animals per hectare and thus avoids a concentration of the remaining livestock and corresponding regional nutrient surpluses. In doing so, an optimal synergy of climate and biodiversity protection is achieved. If in contrast the reduction of livestock numbers was pursued solely by a livestock-to-land ratio, the flexibility of farmers would be low and the costs of the system correspondingly higher (Garske 2020; Weishaupt et al. 2020; Garske and Ekardt 2021).

As a framework, the no-debit rule in the LULUCF sector should also be tightened to set negative emissions as target. In fact, the ongoing amendment process of the regulation addresses this topic – however over a presumably (too) long period of time (the concrete level takes us back to the debates on targets and potentials; see Chaps. 1 and 4).

Another regulatory approach that could be implemented relatively quickly is an unconditional and comprehensive protection of natural and old-growth forests in developed countries under nature conservation law, especially in the EU. These forests sequester the most carbon and contain the greatest biodiversity. Protection could be achieved by establishing protected areas with strict prohibitions and controls. To avoid corruption, special EU authorities could monitor the process and should be given appropriate competencies. However, this approach would most likely not work in most developing countries. For these countries, subsidies in the form of payments for ecosystem services can be established (see below). In the area of forestry, however, it is comparatively obvious that humankind must continue to use forests economically. Therefore, total bans on forests only work for some important areas where any kind of economic activity should be excluded. Likewise, a total drainage ban on peatlands in the EU is useful, combined with a requirement to rewet most peatland sites (except in e.g. populated areas), as the (former) peatland locations are known and enforcement would be relatively easy.

Furthermore, the use of bioenergy should be restricted entirely or limited to residues. Exceptions could be made for individual flowering plants (Hennig 2017); conversely, it seems essential for biodiversity that a large part of dead wood remains in the forest. To these ends, an import ban on energetic biomass and a complete end to domestic bioenergy subsidies are useful. All these regulatory approaches are relatively easy to handle and do not suffer from problems of depicting and enforceability. This could replace the sustainability criteria regime in its current form, which suffers from well-known governance problems of regulatory and subsidy instruments. Alternatively, a moderate increase in general levies on land use would be conceivable (Hennig 2017; Ekardt 2019). An open question is whether in addition to the regulation of livestock farming and bioenergy, further import bans to e.g. protect rainforests are necessary and legally feasible under global trade law.

The previous proposals do not replace concrete instruments for the restoration of forest ecosystems and reforestation, which should be oriented towards mixed forests. To this end, subsidies appear necessary. In the EU, these subsidies could be combined with a reform of the CAP. For a sustainable bioeconomy, subsidies should only be provided for public services as a supplement to the instruments already presented. For example, subsidies could target famers and foresters by remunerating forestry and nature conservation measures. For developing countries, “standards in exchange for money” could be applied by including such countries in the ETS approaches addressing the drivers of deforestation and providing those countries the revenues of the system to address specified purposes such as afforestation.

In theory, Payments for Ecosystem Services such as REDD+ offer financial incentives for land owners to enhance the environmental performance of the land by allocating a financial value to certain ecosystem services (e.g. carbon sequestration or protection of biodiversity) (Banerjee et al. 2017, 2). Certain improvements of the system could be discussed. Clear tenure rights are important to allocate money to the responsible unit, and effective administrative structures are important to enable enforcement and avoid corruption (Alix-Garcia and Wolff 2014, 371 et seq.). Transaction costs need to be minimised to achieve high participation (Banerjee et al. 2017, 30). Wang and Wolf (2019) find that there are important co-benefits from PES schemes. Because ecosystem degradation frequently affects marginalised communities and people, PES schemes can provide a financial income to these people while at the same time conserving the ecosystem services they rely on. Also, illegal logging and hunting can be prevented if the underlying driver (poverty) would be addressed. However, the overall situation remains highly ambivalent. On the one hand, a monetary transfer to the Global South is clearly required. On the other hand, shifting effects due to production replacements (to a forest area which is not included in a PES system) can hardly be avoided – one of the reasons why sustainability criteria for bioenergy failed (Sect. 5.3.5) (Alix-Garcia and Wolff 2014, 372). However, the problem is likely to be partly addressed by other proposed measures including especially the livestock ETS combined with border adjustments, import ban for bioenergy and fossil phasing out.

All these measures will not only trigger technical innovations, but also frugality. This is generally true for quantity governance instruments, but particularly important for forests. The described quantity governance systems reduce the pressure of use on forests. This is especially important for the plastics discourse because fossil-fuel based plastic products can frequently be replaced by woody or agriculturally grown biomass products. However this replacement seems justifiable only if the introduced instruments initially reduce the pressure of direct and indirect land-use changes at the expense of forests. In addition, certain products – such as disposable plates and cutlery, regardless of the material – could be banned altogether, combined with import bans as these are easily enforceable regulations. Above all, bioplastics should be required to be fully recycled or biodegradable in the natural environment and not only under laboratory conditions, and better protected against harmful effects with regard to microplastics (see in detail Stubenrauch and Ekardt 2020).

Furthermore, countries could improve definitions of forests in regulatory law. Palm or timber plantations are almost useless for climate and biodiversity protection. Therefore, they cannot be considered forests. Changing the 2006 IPCC guidelines appears useful (Aalde et al. 2006). The current text says: "The Guidelines provide methods for estimating and reporting sources and sinks of GHGs only for managed forests, as defined in Chap. 1. Countries should consistently apply national definitions of managed forests over time. National definitions should cover all forests subject to human intervention, including the full range of management practices from protecting forests, raising plantations, promoting natural regeneration, commercial timber production, non-commercial fuelwood extraction, and abandonment of managed land." The text could be enhanced by further (and stricter) distinguishing natural forests, managed forests and plantations. According to the new EU Taxonomy, sustainable forest management is defined as the usage of forests and forest land in a way, and at a rate that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems. Reforestation needs to increase the heterogeneity of forests, include a diverse composition of tree species and subspecies, and improve structure and density of forests in order to benefit the climate. The integration of autochthone species in a concept of mixed forests is listed as one starting point (Schoene and Bernier 2012; Verkerk et al. 2020). The new generation platform (Riahi et al. 2017), which was launched in 2007, and climate smart forestry (CSF) (Nabuurs et al. 2017; Kauppi et al. 2018) provide further (albeit legally non-binding) approaches to support well-managed forests (Riahi et al. 2017). However, binding standards for the sustainable planting of trees and forest management are not established thus far.

6.4 Outlook

We have seen that forest governance requires governance options that follow a comprehensive approach, not only addressing forests. If done correctly, forest protection, reforestation and afforestation can offer valuable ecosystem services such as carbon sequestration, biodiversity and climate protection as well as sustainable livelihoods for people. The possibilities of forests to mitigate climate change are significant but limited. This makes forest (protection) instruments important, but not a substitution for a rapid decline in fossil fuel use and livestock farming. In fact, addressing these drivers is a major policy approach for forest policy. In any case, forest protection on a global and also European level goes hand in hand with an effective change in consumption patterns through legal instruments – not only, but especially in the industrialised nations. Successfully implementing frugality strategies for the demand of forestry- or agriculture-based energy and energy-intensively produced food- and feedstuff as well as increasing reuse and recycling of resources in general will be decisive to protect forests as large carbon sinks and biodiversity reservoirs. Quantity governance can address the drivers (also) of deforestation. Even if legal frameworks at the transnational level are clearly preferable due to their broader scope and to avoid economic disadvantages, also national legislation may have to be addressed and amended. For instance, some details of subsidies and regulatory law may be governed on national level. In any case, sustainability research can learn a lot from analysing forests and their governance from history until today. The problem of depicting as well as of shifting (or ILUC) effects are the most severe governance issues that call for effective and coherent governance solutions.

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Summary

This book analyses and develops overarching concepts for forest policy and forest governance and includes a detailed investigation into the historical discussion on forests. Besides that, the book examines opportunities and limits for negative emissions in a sector that – like peatlands – appears significantly less ambivalent compared to highly technical large-scale forms of geoengineering.

Our analysis shows that the climate and biodiversity targets under international law are much more ambitious (and legally binding) than most people assume. These targets alongside human rights obligations require a zero-emissions world before 2035. Methodologically, we apply a qualitative analysis of governance instruments (such as economic environmental instruments or command-and-control law). Prior to all this, there is a disambiguation of some epistemological questions. This seems necessary because especially (also) the sustainability discourse works oddly with the separations between "to be" and "ought to be", and objective and subjective, both of which are not congruent but transverse. Furthermore, social change depends on an interplay of various actors and the most important motives of all actors are not factual knowledge and values, but self-interest, path dependencies, collective good structures, conceptions of normality and emotions. This observation lead to the insight on certain central governance problems (rebound effects, shifting effects, enforcement problems, problems of depicting, and lack of ambition) that must be avoided to meet environmental targets. The problem of depicting plays a central role for forest governance (same for peatlands) since greenhouse gases and biodiversity of forest are very heterogeneous and therefore pose a great challenge for governance.

Forest history shows diverse ideas and underlying motivations of humans interacting with forests. While a decline in human population affected deforestation, population growth was connected to fears of timber shortage and corresponding more difficult and even hostile living conditions. To avoid that, humans regulated timber and forest consumption through penalties and laws, set up administrations, invented artificial silviculture and developed technologies as well as sciences. Moreover, they introduced sustainable forestry as a form of using natural resources to guarantee future use and supply. Until today, changes in human culture and land-use profoundly impacts the condition and distribution of forests. In recent history,

J. Stubenrauch et al., *Forest Governance*, Environmental Humanities: Transformation, Governance, Ethics, Law,
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globalisation and the use of fossil fuels causing global warming affected forests in spatial and temporal terms. The history on forest use also illustrates that there have always been trade-offs which were addressed more or less sustainably and equitably. Presently, this leeway is not merely up to human values and self-interest, but increasingly shaped or limited by ecological consequences. The common history of humans and forests reveals not only a close interrelationship but also an existential dependence of humans on intact forest ecosystems which is valid for the past, the present and the future.

Our analysis shows that the preservation of intact forest ecosystems is indispensable to protect climate and biodiversity in the long term, and the health and well-being of humanity. Despite this, the destruction of the last intact ecosystems (especially primary and old-growth forests) is increasing at rapid pace. This applies particularly to tropical forests but also to the last European primeval forests. The cause lies in humankind's gigantic hunger for resources, whether it be woody biomass or arable land to produce beef, feedstuffs such as soya, palm oil, rubber, etc. The transition to a post-fossil society and the partial replacement of fossil fuels with woody biomass is further pushing this development and therefore requires appropriate legal containment to finally achieve sustainable resource and forest management. Apart from that, demand-sight mitigation measures that steer consumption patterns (particularly but not only) in the western world, i.e. meat and biomass consumption, alongside frugality strategies are highly necessary.

At the same time, the book critically reviewed the potentials of afforestation and reforestation for climate mitigation, which is often presented as the new saviour to fulfil the commitments of the Paris Agreement and to reach climate neutrality in the future. It became clear that ultimately only biodiverse and thus resilient forests can function as a C sink in the long term (!). However, in the short term, the C storage capacity of newly planted forests is almost negligible and very small. In fact, due to necessary interventions in the soil, young forests are frequently a source of CO_2 and do not function as a sink. Potential trade-offs with regard to food security, biodiversity protection, e.g. of species-rich grasslands and wetlands, and the total amount of land available also come into play. In addition, existing forests worldwide are currently reducing their original sink capacity and release more CO_2 into the atmosphere. This is because of changing environmental conditions such as long dry seasons often coupled with unsustainable forest management. Overall, the expected future sink capacity of newly planted or existing forests is therefore often overestimated.

Nevertheless, monitoring and measuring GHG fluxes in forest ecosystems as accurately as possible is a necessary prerequisite for policy approaches (see Chap. 5). It became clear that this is very challenging. To date, it is hardly possible to achieve an accurate measurement of GHG fluxes in forest ecosystems and to monitor the development of forest ecosystems in a globally comprehensive and accurate manner. The problem of depicting is comparatively large in forest ecosystems as they are influenced by multiple factors. Efforts to reduce the problem of depicting as best as possible are therefore necessary. However, the problem will always remain to a certain extent which in turn has to be considered when developing policy instruments.

The international policy level on the protection of global forests is characterised by the following policy instruments:

- Multilateral environmental agreements (MEAs), in particular the CBD, the Paris Agreement, the UNCCD, CITES and the Ramsar Convention on Wetlands that provide legally binding targets to their parties. They require the protection of the climate, the conversation of biodiversity, the preservation of soils in drylands, and the preservation of wetlands and endangered species. These MEAs contain manifold references to global forest protection. However, the MEAs usually do not provide concrete governance instruments but only targets and overall provisions. Furthermore, although legally binding, MEAs lack effective enforcement provisions and thus cannot reach the desired effect.
- Funding regimes such as REDD+ that aim at incentivising forest protection provide at least some kind of instrumental approach – rather than only targets. However, they contain various shortcomings of forest governance: (1) weak accounting rules for saved emissions, (2) generation of carbon rights and their tradability in different (private or public) carbon markets so that double counting cannot be ruled out, (3) problem of long-term funding and (4) lacking equal involvement of marginalised groups and elite capturing of generated payments while not effectively tackling the drivers of deforestation. All in all, these funding regimes have so far failed to take the problem of depicting sufficiently into account. By the same token, there is no clear framework for establishing, e.g., economic instruments for the drivers of deforestation on international level. This is why these regimes so far could not reverse global deforestation.
- There is at least some soft law, e.g., established in the SDGs with all of the 17 SDGs connected to the protection of forests and their sustainable management. However, some SDGs may even be at odds with successful protection and restoration of global forests. Apart from that, international non-legally binding declarations try to tackle deforestation in certain world-regions, albeit again without the ability to address the main drivers of deforestation effectively and limited in their effectiveness. The same is true for voluntary international certification schemes, like FSC and the PEFC that aim at the sustainable management of forests and their protection, but lack participation, particularly in tropical countries and/or strict biodiversity criteria as well as strict implementation of their goals.

International obligations to protect forests are highly fragmented and lack an overarching and coherent forest policy. At the same time, the legally binding MEAs clearly require the involved parties to take actions to (1) preserve national forests and to (2) minimise their impact on deforestation and forest degradation outside their national borders. This has to be done through an adequate domestic or supranational (like on the EU level) climate, biodiversity and forest policy that is intertwined with the future development of sustainable trade agreements. The soft law provisions and specific funding schemes for forest protection point in the same direction and thereby underpin the legally binding MEAs. Although an international forest convention does not exist (that would most probably have the same implementation and enforcement problems like other MEAs), an obligation to protect forest ecosystems and to halt global deforestation can be derived from existing policies – especially from the overarching and legally binding targets in the PA and CBD.

The REDD+ funding regime has so far fallen short of expectations and will require better coordination, monitoring and financing. In addition, the drivers of forest destruction cannot be effectively addressed by a selective funding regime alone. In spite of all this, an obligation for states to protect forests and manage them sustainably can be derived from the – in parts legally binding – MEAs, as seen. The EU and its Member States are therefore called upon to ensure this through coherent legislation.

A review of EU law revealed that coherent legislation on forest protection does not yet exist. Instead, different regulations are in conflict with each other. The LULUCF Regulation and the RED II Directive offer a compelling example. The LULUCF Regulation aims to integrate the land use sector, including the forest sector, into the EU climate regime. However, it is necessary to close many of the existing loopholes in the future, as well as to reduce the existing broad leeway of the Member States in accounting for additional sink capacities or emissions and, last but not least, to raise the overall ambition level. Furthermore, the LULUCF Regulation does not support sustainable forest management which preserves or expands C-sinks of forests. Besides, the problem of depicting is present. The RED II Directive – counterproductively – promotes burning (i.e. energy utilisation) of woody biomass. In addition, the ILUC risk (shifting effect) is not sufficiently limited by the Directive but is in fact promoted by the insufficiently legally constrained promotion of agriculturally generated biomass. The sustainability criteria in their current form are not effective. Besides, existing funding for sustainable forest management and conservation in Europe which is so far mainly provided through the second pillar of the CAP, cannot compensate for these shortcomings and must be supplemented by further funding opportunities.

The EUTR sets out the obligations of operators who place timber and timber products on the EU market and thus influences timber harvesting practices in third countries. The EUTR is so far not stringent enough, lacks enforcement and above all refers to existing legislation in the country of harvest, which might be weak. Within the EU, nature conservation legislation also hardly protects forests adequately. For example, legislation does not even require sustainable forest management and protection against over-logging that in designated Natura 2000 areas. Moreover, the Natura 2000 network does not cover all forest areas worthy of protection, which was recently highlighted in the German case.

A certain remedy could be created in the future within the framework of the planned measures of the new EU Forest Strategy and the still outstanding carbon farming initiative. However, being strategies or initiatives they are not legally binding. Improved forest protection will therefore depend on the measures derived from the EU Forest Strategy and the carbon farming initiative, and their implementation.

It will also depend on the extent to which biodiversity goals can be meaningfully combined with existing climate goals.

We developed a bundle of political-legal measures. These measures should ideally be adopted at EU level to avoid ecologically counterproductive shifting effects and competitive disadvantages (and thus also social acceptance problems), especially since parts of the corresponding regulatory measures are only legally permissible at EU level. The proposals are oriented towards climate and biodiversity goals and the avoidance of the aforementioned governance problems. To this end (and furthermore the greatest possible freedom) quantity governance systems are most effective when not directly targeting forests due to their heterogeneity but central damaging factors. In that, our study confirms our earlier research findings from other areas of sustainability governance. With regard to the dominant regulatory and subsidy-based governance for forests we show that it remains necessary to supplement these quantity governance systems with certain easily graspable and thus controllable – i.e. little exposed to the typical governance problems – regulatory and subsidy regulations.

We propose three quantity control systems for all fossil fuels (cap zero at the beginning of the 2030s) as well as animal products at the level of slaughterhouses and dairies (reduction target around three quarters) and for pesticides; supplementary border adjustments at the EU's external borders; a regulatory protection of old forests (and peatlands by the way) with almost no exceptions; extension of the livestock-to-land-ratio established in organic farming to all farming; far-reaching restriction of bioenergy use to certain residues flanked by import bans; national and international complete conversion of all agricultural and forest subsidies to "public money for public services" to promote nature conservation and afforestation in addition to the quantity control systems; clearer definition of forests; a total ban on certain disposable products regardless of their material and an obligation of full recycling or biodegradability for bioplastic products.

Glossary of Environmental Humanities[1]

Afforestation is planting of new forests on lands which, historically, have not contained forests (Forest Governance Sect. 4.2.2).

AFOLU stands for agriculture, forestry and other land use (Forest Governance Chap. 1).

Balancing means weighing different normative goods. It is inevitable with regard to normative decisions, ethically and legally. However, the economic cost-benefit analysis is not a convincing balancing theory (Sustainability, Sects. 3.5 and 3.9).

Biodiversity hotspots meet two criteria: They must contain at least 1500 species of vascular plants found nowhere else on Earth (known as endemic species), and they must have lost at least 70% of its primary native vegetation (Forest Governance Sect. 4.1.1).

Bioenergy is energy made from biomass (like wood or energy crops) or biofuels (Forest Governance Sect. 5.3.3).

Cap-and-trade describes a policy that limits pollution, e.g., levels of emissions, through first set a cap and second split it into allowances that are traded by polluters (Forest Governance Sect. 6.1)

Carbon Sequestration is "the process of removing carbon from the atmosphere and depositing it in a reservoir" (UNFCCC 2018, Forest Governance Sect. 4.2.1).

Command-and-control law – working with bans and obligations – is susceptible to certain governance problems because it focuses on individual products, investments or activities. Nevertheless, it must provide essential additions to economic policy instruments for sustainability (Sustainability Sect. 4.10).

Cascading principle Under this principle, wood is used in the following order of priorities: (1) wood-based products, (2) extending their service life, (3) re-use, (4) recycling, (5) bio-energy and (6) disposal (Forest Governance Sect. 5.2.1).

[1] The following glossary contains some important terms for the present book as well as for environmental – or sustainability – humanities in general. Therefore, some terms contain, beside a reference to a respective chapter in this volume, also a reference to Vol. 1 of this book series: "Sustainability: Transformation, Governance, Ethics, Law" by Felix Ekardt.

J. Stubenrauch et al., *Forest Governance*, Environmental Humanities: Transformation, Governance, Ethics, Law,
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Cooperation can be driven by self-interest or altruism. Some overestimate and some underestimate the importance of cooperation for human behaviour, inter alia with regard to sustainability (Sustainability Sect. 2.6).

Culture and biology are the background to all motivational factors – the dispute over sociobiology shows that the dominant desire to latently deny one of the two factors is flawed (Sustainability Sect. 2.3 and 2.5).

Consistency, (technological) efficiency and frugality represent three sustainability strategies. The first two focus on technically smarter production and consumption (consistency, for example through recycling). Frugality, on the other hand, focuses on less production and consumption (Sustainability Sect. 1.3).

Corporate social responsibility and sustainable consumption as an instrument of sustainability rely on voluntary action by companies and consumers. These approaches take too little account of the interaction between the actors, the motivational situation and the difficulties of concretisation on the level of single actors (Sustainability Sect. 4.2).

Deforestation is the permanent destruction of forests and woodlands and conversion to non-forest uses (Forest Governance Sect. 4.1.2).

Economic policy instruments working by means of direct or indirect pricing of resources or sinks – can be designed as quantity control and thus adequately address sustainability as a quantity problem – and they also fit better with human motivation and the liberal basic principles than other governance instruments (Sustainability Sect. 4.5).

Embodied deforestation are consumption patterns leading to deforestation and forest degradation (Forest Governance Sect. 4.1.2).

Empiricism means an epistemology and at the same time a sceptic theory of justice, which are both not able to convince in essential respects (Sustainability Sects. 1.6, 1.7, 3.1 and 3.9).

Environmental humanities means research in disciplines such as economics, law, philosophy, political science, sociology, cultural studies, ethnology, etc. on questions of environment and sustainability – preferably from a transdisciplinary perspective (Sustainability Preface, Sect. 1.1 and 1.7).

Epistemology means the theory of what can be objectively recognised in facts and, if necessary, in norms. This also includes basic distinctions such as objective versus subjective, is versus ought, genesis versus validity (which do not coincide) – and a critique of some aspects of constructivism (Sustainability Sect. 1.6).

Forest degradation is the loss of the forests' capacity to provide their essential goods and services (Forest Governance Sect. 4.1.2).

Forest Reference Level means the counterfactual value of emissions and removals that would occur in managed forest land in the future based on the continuation of sustainable forest management practices, as documented in the period from 2000 to 2009 and assuming a steady ratio of raw material and energy use in the forward-looking estimation (Forest Governance Sect. 5.1.2).

Fossil fuels (oil, coal, gas) are the main driver of various environmental problems such as climate change, loss of biodiversity, human diseases, disturbed nitrogen cycles etc. due to their omnipresence in electricity, heat, mobility, plastics and in the agricultural sector (Sustainability Sect. 1.2 and 1.3).

Free trade and WTO can – in principle – fit well with free democracy, but only with constitutional and sustainable framing (Sustainability Sect. 4.11).

Freedom is the object of human rights. Under the auspices of sustainability, the understanding of freedom must be expanded, inter alia to include the elementary preconditions of freedom, an intertemporal and global dimension and an element of precaution (Sustainability Sects. 3.2, 3.3 and 3.4).

FSC is the abbreviation for Forest Stewardship Council, an international certification scheme for forest management (Forest Governance Sect. 5.1.3.4).

Good life (roughly equivalent to happiness) is the antonym to justice and describes an area that is legally and ethically inaccessible to any regulation (Sustainability Sect. 3.4).

Governance is about effective means – i.e. policy instruments – to implement policy objectives (and to balance them against other values or objectives) and sustainability strategies resulting from the objectives (Sustainability Sects. 1.7 and 4.1).

Governance problems such as rebound effects or shifting effects are typical obstacles to effective sustainability policy that can be empirically measured and derived from behavioural research (Forest Governance Chap. 2, Sustainability Sect. 4.4).

Human rights mean (ethically and in national, European and international law) the rights to freedom and the elementary preconditions of freedom. Human rights and fundamental rights are synonymous for the purposes of this book (Sustainability Sects. 1.7 and 3.2).

ILUC risk as a typical example for shifting effects means risk for indirect land use change and describes a typical governance problem that leads to land being indirectly changed, e.g., when regulation regarding biomass production for energy indirectly causes rising deforestation rates (Forest Governance Sect. 5.2.3).

Individual versus structure (or micro versus macro) is a popular distinction in research on behaviour and societies, but it is ultimately not feasible (Sustainability Sect. 2.1).

Interconnectedness refers to the way politicians, citizens, consumers, entrepreneurs and other actors influence and depend on each other. It is thus a chicken-and-egg game to ask for the main responsible entity (Sustainability Sects. 2.1 and 4.2).

Integrated solutions for various sustainability challenges such as climate change, biodiversity loss or disturbed nitrogen cycles are necessary. What is needed is addressing the overarching drivers such as fossil fuels and livestock farming (Sustainability Sect. 4.9).

Justice means the rightness of social order and human behaviour. In contrast, truth means the accuracy of statements about facts. Social distributive justice is a sub-aspect of justice regarding distributional issues (Sustainability Sect. 1.6 and 1.7).

Knowledge and values are constantly overestimated as motivational factors of human behaviour. But if one does not ask descriptively what drives us in fact, but asks normatively what we should do, values are the sole yardstick (Sustainability Sect. 2.2).

Law and ethics are normative systems, of which law is characterised by greater concreteness and the existence of state sanctions (Sustainability Sect. 1.7 and 3.1).

Liberal democracy is based on the liberal basic principles of reason, dignity, impartiality, freedom, (representative) democracy and separation of powers (Sustainability Sect. 3.2 and 3.5).

Livestock farming is – besides fossil fuels – the second major driver of various environmental problems (Forest Governance, Chap. 6, Sustainability Sects. 1.2 and 4.9).

LULUCF stands for land use, land-use change and forestry (Forest Governance Sect. 5.2.2).

Methodology with regard to sustainability must be multi-methodical and qualitatively oriented in essential parts, for example when it comes to human behaviour and governance. The methodology is different when it comes to normative questions, e.g., the interpretation of the law (Forest Governance, Chap. 2, Sustainability Sect. 1.7).

Nature-based solutions are (partial) solutions that naturally mitigate environmental problems like climate change, e.g., forests that naturally sequester carbon (Forest Governance Sect. 4.1.1).

Old-growth forests are old stands within either primary or secondary forests where old trees have accumulated in a way to form a different ecosystem than any younger class parts of the forest. Intact old-growth forests are – as primary forests – mainly characterised by their developed structures, which act as a distinct forest ecosystem. Plant, animal and microorganism communities and their abiotic environment form a functional unit (Forest Governance Sect. 4.1.1).

Paris Agreement is the most important global environmental agreement, which is vague in many respects, but sets a very ambitious – and legally binding – climate target in its Article 2 (Forest Governance Chap. 1, Sustainability Sects. 1.2 and 4.3).

Photosynthesis is a process by green plants and certain other organisms that transform light energy into chemical energy using carbon dioxide, sunlight and water (Forest Governance Sects. 3.1.1 and 4.1.1).

PEFC is the abbreviation for Programme for the Endorsement of Forest Certification Schemes which is an international forest certification scheme (Forest Governance Sect. 5.1.3.4).

Primary forests have never been logged but might be used by indigenous communities that contribute to their diversity and protection (CBD 2006, Forest Governance Sect. 4.1.1).

Reforestation refers to establishment of forest on land that had recent tree cover, whereas afforestation refers to land that has been without forest for much longer (Forest Governance Sect. 4.2.2).

Segregation means the separation of forest areas and the usage of its different parts to fulfil different demands (Forest Governance Sect. 3.6.2).

Soil Organic Matter (SOM) describes "the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition)" (Cornell University 2008, 1, Forest Governance Sect. 4.2.1).

Secondary forests have recovered either artificially or naturally after being logged (CBD 2006, Forest Governance Sect. 4.1.1).

Sustainability means the expansion of ethics, law and politics in intertemporal and global terms, i.e., intertemporal and global justice. In contrast, a three-pillar model of sustainability is not convincing (Sustainability Sect. 1.5).

Sustainability governance seeks an effective implementation of (human-rights-based) sustainability goals. Caps for fossil fuels and livestock farming play a key role for that (Sustainability Sect. 4.6).

Uncertainty and risk are characteristic of sustainability issues – with regard to both facts and norms. There are ethical and legal rules for dealing with them (Sustainability Sects. 3.6 and 3.7).

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Index

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