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Forecasting forest-related political decisions in a climate-constrained world – The remuneration of forest ecosystem services in Germany

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ABSTRACT

Political systems are under increasing pressures to respond to the impacts of climate change. We employ a numerical policy negotiation forecast model and apply it to forest-related political decisions on remunerating forest ecosystem services. Our results predict that German forest carbon sinks will be partially remunerated by government payment systems as will nature conservation efforts and climate resilient forest management. Our predictions indicate that there is substantial remaining upward pressure on each of these issues to go beyond present regulations.

1. Predicting policies in remuneration of forest ecosystem services

The growing demand by international and national climate policy for carbon sinks draws increasing political attention to the ability of forests to store CO_2 and to related policy instruments, such as payments for forest ecosystem services.

On the global scale the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change, 2018) suggested that many scenarios in line with the overall temperature change goal of 1.5–2 degrees C necessitate the build-up of substantial terrestrial carbon sinks to reach net zero emissions. The European Green Deal[1] entails a net zero goal for greenhouse gas emissions by 2050, the creation of a standard for land-based carbon removals (which includes the temporary forest carbon sink or removal function), a revised land use land cover and forestry (LULUCF) regulation, and a revised forest strategy that sets higher ambitions for European forests to serve as carbon sinks (European Commission, 2022, 2021a, 2021b, 2021c, 2020; Official Journal of the European Union, 2021). While forests are a proven carbon sink, forests fulfill a range of other functions, including biodiversity, nature protection, water storage, air purification, recreation, and other functions (e.g., *European Academies Science Advisory Council,* 2017). As our example of Germany will show, remunerating forest carbon sinks is often negotiated in tandem with other forest ecosystem services.

Responding to scientific and societal demands, climate policy has become a priority issue in Germany. In this context, forests are particularly relevant due to their ability to store CO_2 as well as the vulnerability of forests to a drier and hotter climate (Wissenschaftlicher Beirat für Waldpolitik, 2021). In turn, forest actors have to deal with new demands that imply climate-adapted forest management in the near future as well as in the long-term.

In 2021, Germany began to envisage a new remuneration system for forest ecosystem services which enhances the storage of CO_2 in the forests and strengthens the health of forests under conditions of a changing climate (Deutscher Bundestag, 2021). Despite scientific discussions of payments for forest ecosystem services for more than half a century (Forest Europe, 2019; Elsasser et al., 2016), this is the first time that remuneration of forest ecosystem services is seriously considered in Germany (Thomas et al., 2024). When negotiations started on such a remuneration policy in 2022, the research question arose whether such

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[1] For details, see https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en, last accessed: 10 April 2024. See also Chikh M'hamed, S., Sprinz, D.F., 2024. The Keys to the EU's Climate Neutrality Goal: Forest Carbon and LULUCF., in: H. Dyrhauge & K. Kurze (Eds.), Making the European Green Deal Work: EU Sustainability Policies at Home and Abroad. Routledge, 60–75. https://www.routledge.com/Making-the-European-Green-Deal-Work-EU-Sustainability-Policies-at-Home/Dyrhauge-Kurze/p/book/9781032160702.

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an innovative policy scheme will be concluded in Germany.

We used the Predictioneer's Game (Bueno de Mesquita, 2009; Sprinz et al., 2016), a numerical negotiation forecasting model, to predict the political decision about the medium-term remuneration system for forest carbon, the conservation services of forests, as well as climate-resilient forest management of forest ecosystem services in Germany. This article presents and discusses our forecasts of the political negotiations. The data collection was completed on 19 Oct. 2022 – i.e., before the first decision on partial remuneration of forest ecosystem services for 2022 was published on 28 Oct. 2022 (Bundesministerium für Ernährung und Landwirtschaft, 2022a, 2022b). Subsequently, the guideline was minimally amended without substantive impacts for the domain of our forecast, except that the EU agreed not to apply the de minimis rules to the regulation effective calendar year 2023 (Bundesministerium für Ernährung und Landwirtschaft, 2023).

In the following, we describe the position of our theoretical approach within the literature on the remuneration of forest ecosystem services (Section 2), summarize the various sources of influence (Section 3) that constitute a central empirical aspect in the computer experiments we run with the Predictioneer's Game, briefly introduce our policy forecasting model (Section 4), provide an overview of the various scales and data inputs for the Predictioneer's Game (Section 5), derive the central findings (Section 6), and conclude with an assessment of the relevance of our policy forecasts for German forest policy as well as for future research (Section 7).

2. Modeling and empirically-based policy predictions

The majority of the literature about payments for forest ecosystem services deals with technical and economic aspects (Forest Europe, 2019; Elsasser et al., 2016). The willingness to pay was explored theoretically and empirically - but rarely implemented politically. Recent research focused on policy integration and coherence of forest ecosystem service–related national policies but does not highlight the political decision process as such (Beland Lindahl et al., 2023; Blattert et al., 2023, Loft et al., 2022). The, hitherto, lack of a longer track record of actual funding mechanisms of forest ecosystem services explains the paucity of a literature on political decisions about this innovative tool (Thomas et al., 2024) – which we begin to remedy in this contribution. We therefore concentrate on predicting medium-term political decisions on the remuneration of forest ecosystem services in Germany beginning 2023 with data collected before the first regulation was promulgated in the fall of 2022.

We choose the Predictioneer's Game due to its ability to simulate the complex decision processes based on highly structured empirical inputs. The model has been previously used for, e.g., predictions of the future of Hong Kong after the 1997 handover from the UK to the People's Republic of China, the 2015 Paris Agreement on Climate Change, and the climate-related water policy of India (Bueno de Mesquita et al., 1985; Sprinz et al., 2016; Sprinz et al., 2020). This article constitutes the first predictions in the forest policy sector. Given its computational efficiency, it is particularly suited to computer experiments that capture the various sources of (potential) influence – which we relate to the augmented actor-centered power approach as outlined below.

3. Four sources of potential influence

The influence of actors vis-à-vis each other plays an important role in decision-making. While we have witnessed enduring debates on what constitutes influence, influence in negotiations is essentially based on two different elements of social relations, namely information and power (Krott, 2005, p. 13). Based on the "actor-centered power (ACP) concept," these two elements can be observed and quantified (Krott et al., 2014). In the following, we present three well-received sources of influence and augment it by the role of scientific information (Stevanov and Krott, 2021).

Building on Max Weber, we define actor-based power as a "social relationship in which actor A alters the behavior of actor B without recognizing B's will" (Krott et al., 2014). We distinguish three elements of potential influence in the ACP concept: (i) coercion, (ii) material and immaterial (dis-)incentives, and (iii) loyal information.

The first element, coercion, builds on force, which often refers to the threat of physical actions or those executed by state authorities. This includes physical action, threats of physical action, or other sources of influence such as control over the forest by private ownership and actions of the state to enforce this right.

The second element, material and immaterial (dis-)incentives, comprises all (dis-)incentives which actors or networks of actors may offer to or impose on other actors. This includes economic benefits and costs as well as immaterial (dis-)advantages, such as legitimation by values or processes. The power by (dis-)incentives is based on the scarcity of these resources (Moe, 2005). For (dis-)incentives, we observe the provision of material and/or immaterial benefits (e.g., financial support by private actors or by the state) and threats to impose costs.

The third element, loyal information, is defined as information which A directs at B - but cannot or is not verified by actor B (Simon, 1981). In practice, loyal information is observed by the provision of or threat to provide unverified information due to lack of will or inability to verify. This includes beliefs, ideology, or advanced technical expertise that cannot or is not verified.

Brewer and DeLeon (1983) define our fourth element, scientific information, as truth in terms of corresponding to reality. Elaborating on this definition, we require scientific information to also include clarity, consistency, and verifiability – which sets this type apart from loyal information. Here, we concentrate solely on the supply of information. Unlike loyal information (which only the relevant actor holds), scientific information and the methods to verify such information, once provided, are openly accessible to all other actors. In practice, the ability to verify scientific information is limited for each actor due to resource constraints, including time constraints. Consequently low scientific information of a specific actor implies s/he has to rely more on loyal information provided by other actors.

In so far as verification is *not* possible for an actor or for actor groups, other actors will be better endowed to hold loyal information. For example, if the German labor union for the construction sector, IG BAU, has little expertise on forestry issues, it is forced to "accept" arguments without critical checking. This implies higher scores for loyal information, e.g., by the forestry ministry as compared to IG BAU.

4. The predictioneer's game

We model the political negotiations with the help of the Predictioneer's Game (Bueno de Mesquita, 2009, 2010, 2011). The software was designed to evaluate policy negotiations where there is a possibility of a negotiated compromise in the presence of potential coercion (Bueno de Mesquita, 2011).[2] It applies game theory to predict negotiated outcomes, looking at a finite (yet potentially large) number of actor's bilateral interactions per round of negotiations, based on data inputs for each of the actors.

The model is based on non-cooperative game theory, assuming that stakeholders are rationally acting in what they consider to be in their best interest (Sprinz et al., 2016). It solves N(N-1) two-player games for a finite number of iterations to be selected by the user. The players are uncertain about the other player's negotiation type but update their understanding of other players using Bayes theorem. The game is solved for perfect Bayesian equilibria for each iteration (ibid.). The application of game theory makes the calculations of strategic interactions of the players possible when representing single issues on metric scales (Bueno de Mesquita, 2011).

[2] Negotiations can also result in the continuation of over the status quo ante.

While game theory is widely recognized as a useful analytical tool for policymakers seeking to enhance their understanding of real-world politics and negotiations, its applicability to complex negotiations, such as climate negotiations, has been met with skepticism by some scholars (Michaelowa and Michaelowa, 2012) arguing that the complexity defies easy explanation, and attempts to simplify them through underlying assumptions risk oversimplification (Madani, 2013). Nevertheless, proponents argue that game theory models can offer an elegant formalization of the strategic interactions inherent in any negotiations (DeCanio and Fremstad, 2013). DeCanio et al. further argue that models like the Predictioneer's Game can provide valuable insights by objectively reviewing verified facts, figures, and stated positions, and by encoding actors' behavioral traits. This article contends that the Predictioneer's Game not only provides invaluable insights into negotiations but also allows to capture the various sources of (potential) influence.

The model signals that the negotiations are expected to end when (a) "looking ahead one [..] [iteration], the average player expects her welfare to decline" (Sprinz et al., 2016, p. 177) or (b) in case a veto player expects her welfare to decline (ibid.). To generate an estimation of the predicted outcome for each round ("smoothed mean"), the Predictioneer's Game uses the mean voter theorem. The smoothed mean position in a specific round takes the "average of the mean-voter prediction in the first round in which one of the game-ending conditions has been met plus the average of the mean predicted outcome in the round before (if there is one) and the round after" (ibid., p. 178).

The model relies on standardized inputs, requiring five variables for each player per issue under negotiation, nearly all of which are scaled on a continuum:

- potential influence (see also Section 3 and below),
- stated position,
- salience of the issue,
- flexibility regarding the position, and
- veto power (binary).

All actual and potential actors involved in the negotiations are included in the data input file. The position scale reflects the issue under negotiation, and actor preferences have to be single-peaked. The distances between the scale points on the position scale must reflect proportional amounts of political effort to move from one point to the next. Potential influence must be assigned relative to each other (for details, see Bueno de Mesquita, 2009, 2011; Sprinz et al., 2016), yet is generic to the issue domain under consideration. Salience reflects the actor-specific weighting of the potential influence for the specific issue under negotiation, which may vary across issues under negotiations. Flexibility reflects the range of positions each actor is willing to seriously consider for negotiations with other actors. Finally, the right of veto represents the formal or de facto right of an actor to enforce the status quo ante if the negotiated outcome (smoothed mean) is too far away from its own position in the round in which the game ends. It is important to note that all data inputs are independent of each other.

5. Position scales, data sources & data processing

The Predictioneer's Game (PG) requires a structured set of input variables besides elucidating core variable scores for the actual and potentially relevant actors, namely the *position*, *salience*, *flexibility*, *potential influence* and *formal veto power* for each actor (see Section 4). In the following, we will briefly describe the

- three issues under negotiation and the position scales for each of these issues,
- values for the various types of potential influence, and
- salience, flexibility, and formal veto power on each of the issues under negotiation.

For the coding of the data input files, we draw heavily on the empirical work by Schaefers (2022), esp. for the derivation of the various sources of potential influence.

5.1. Actors

For the simulation, actual and potentially relevant actors for the political decision process are included. For decisions of the German Parliament (Bundestag), all parties represented in the Bundestag and the federal ministries relevant to the legislative procedure are included. Selected forestry and nature conservation associations that articulate and lobby for forestry interests are taken into account (Göhrs and Hubo, 2018). Moreover, they are characterized by a high number of members and/or their ability to commit their members to certain actions (e.g., trade union) (Krott, 2005). In addition, the European Commission is included as it has to decide on the appropriateness of subsidies in line with common market rules and has potential veto power if subsidies would violate common market rules.

5.2. Position scales

We concentrate on three core issues to be decided by the German Federal Ministry of Food and Agriculture (BMEL), namely

- Issue 1: Which quantities of forest carbon shall be remunerated?
- Issue 2: How many nature conservation aspects shall be included?
- Issue 3: How many criteria of climate resilience of forests shall be included?

We coded each of the issues as follows.

Issue 1: Which Quantities of Forest Carbon Shall Be Remunerated?

The position scale (see Table 1) represents increasing *quantities* of forest carbon to be remunerated for their carbon sink function. Intermediate values are possible – as holds true for all other scales.

As forests also fulfill many other ecosystem services, we also included nature conservation functions (issue 2) and climate resilience of forests (issue 3) in our set of predictions.

Issue 2: How Many Nature Conservation Aspects Shall be Included?

From the literature as well as from our expertise on forests, we derived ten criteria for inclusion on this scale. For each of the criteria listed, we considered whether the criterion is absent (scale value: zero), present and merely mentioned (scale value: 1), present to a low degree (scale value: 5), or present to a high degree (scale value: 10). We then summed up the potential inclusion across the ten criteria, allowing the position scale to vary from zero to 100 for each actor. As all actors had to be individually assessed on the position scale, we coded values according to the general tendency of criteria inclusion for each actor in summary fashion (see Table 2).

As climate change is already impacting forests, remunerating the climate resilience of forests has to be considered for viable forests under climate change. Thus, we endeavored to forecast the inclusion of criteria for the climate resilience of forests in the decision-making by BMEL.

Table 1
Issue 1 Position scale: which quantities of forest carbon shall be remunerated?

Scale Value	Criteria
0	No change of forest carbon will be remunerated (status quo)
30	Change in forest carbon only
60	Change in forest carbon plus carbon in harvested wood products (HWP)
100	Change in forest carbon plus carbon in HWP, plus carbon substitution potential

Table 2
Issue 2 position scale: how many nature conservation aspects shall be included?

Criteria
Native tree species
Unmanaged forests
Old forests
Preservation of dead wood
Natural forest edges
Preservation and enhancement of natural soil functions
Natural regeneration of forests
Biodiversity-promotion by mixed age structures
Biodiversity-sensitive harvesting
Formal Forest Stewardship Council (FSC)-certification

Table 3
Issue 3 position scale: how many criteria of climate resilience of forests shall be included?

Criteria
Mixed stands with site-adapted, climate-resilient tree species
Conservation and increasing the genetic diversity of tree species
Active protection measures against biotic calamities
Development of structured, uneven-aged, climate-resilient stands
Formal extended Programme for the Endorsement of Forest Certification (PEFC)-Certification

Issue 3: How Many Criteria of Climate Resilience of Forests Shall be Included?

Based on the literature and our expertise, we derived five criteria (see Table 3) which are aggregated analogous to scale 2 (per issue), resulting in a range of position values, ranging from zero to 50.

Empirical work was undertaken during spring-fall 2022, resulting in a dataset as of 19 October 2022. Thus, our dataset precedes knowledge of government decisions taken for the year 2022 only (see Sections 6 & 7) on 28 Oct. 2022. The Predictioneer's Game is a deterministic model, thus "frozen" input data will always yield the same forecasts.

5.3. Potential influence, position, salience, flexibility, and formal veto power

Following our derivation of the various sources of potential influence (Section 3) as well as the requirements of the Predictioneer's Game (Section 4), we coded the potential influence, position, salience and formal veto power of each actor as follows.

The basis for the coding is documented in Schaefers (2022) where interests and the sources of influence of the relevant actors were analyzed (see Schaefers, 2022, Appendix A, Table A.1 and A.2). The data sources presented in Table 4 were analyzed qualitatively, covering the period from ca. 2011 to 2022.

Table 4
Types of data sources.

Empirical data source	Approximate number of documents/sources consulted
Participatory observation of actions (incl. Interview with a participant who has taken part in internal meetings of the German Forestry Council (DFWR) for ca. one-and-a half decades)	5
Empirical-analytical literature	40
Empirical data on actors' activities (e.g., reports from other actors, establishment of political programs, laws, and guidelines)	50
Self-representation of the actors (e.g., actor's homepage, position papers and press releases)	260

We estimate the values of the four scales (salience, position, flexibility, veto) by a two-step qualitative approach. First the basis for all estimates are the interests espoused by the stakeholders. Both formal and informal interests were considered. Interests are understood as long-term action orientations for individuals or groups which refer to the benefits they can derive from a certain object (here: forests) (Krott, 2005). Formal interests are publicly presented by the actor, whereas informal interests are tried to be kept hidden by the actor and can be identified, inter alia, from the actions taken by actors (Schaefers, 2022; Zhao et al., 2022). The interests are qualitatively estimated across three levels from the sources listed in Table 4. *Strong* refers to an interest which is observed frequently as guiding action by the stakeholder or mentioned as a priority. *Low* relates to an interest that is rarely observed as guiding action by the stakeholder or not stated as a priority. *Medium* are all interests which are classified in between both values. Second, based in formal and informal interests of each actor, we assign scores on the abovementioned scales. For example, *salience* refers to the amount of attention the actor pays to the specific topic under negotiation. The criteria for its values (>0 up to 100) are shown in Bueno de Mesquita (n. d.). Keeping the interests stable, which we have empirically observed for many decades in regard to forest actors (Krott, 2005), we derived the salience by evaluating the specific issues, e.g. remuneration of ecosystem services, from the point of view of the interests and the number of relevant policy issues on their agenda. As the number of issues grows, the salience the actor is willing to attach to a specific issue will normally decline (Schaefers, 2022).

The same interest-based method is applied to estimating the values for *position* and *flexibility*.

The evaluation of the *potential influence* consists of four scales, one for each of the independent elements of the augmented ACP approach (coercion, (dis-)incentives, loyal information, scientific information). Each element is scored using a three-point scale:

- 2 = high value,
- 1 = intermediate value for cases lower than 2 and higher than 0.1 and
- 0.1 = data indicate a very low value.[3]

The *potential influence* is summed across all four elements (see Appendix B).

6. Predicted policies

We undertake predictions of the negotiation outcomes in the German political context on three issues related to forests, namely whether their carbon sink function, their nature protection function, and climate resilience of forests will be remunerated (see position scales in Section 5). The data were finalized on 19 Oct. 2022, just before the release of the initial German governance ordinance on forest ecosystem services on 28 Oct. 2022. The data used in our analyses are reprinted in Appendices A and B. As our predictions concern the medium-term forecasts beginning calendar year 2023, we use the policy context for the mildly revised German government ordinance as of 15 May 2023 for assessing our predictions. As the EU Commission agreed not to apply de minimis rules effective 2023, we still flag potential veto possibilities by the EU, yet downplay their empirical relevance due to the absence of de minimis henceforth (see Section 7).

In evaluating the predictions with the Predictioneer's Game, we will use two "stopping" rules for the Predictioneer's Game, namely whether two or three "stopping signs" are consecutively offered by the Predictioneer's Game. The game is stopped when the utility of either the

[3] We had to set the minimum value to 0.1 to avoid that the actor is deleted from the prediction in case it scores zero on a particular dimension of potential influence.

Table 5
Predicting the quantities of forest carbon included.

Stopping Rule & No of Rounds	Smoothed Mean	Veto Exercised?
SR: 2 R: 1	46.6	No
SR: 3 R: 4	45.6	EU: perhaps yes (see fn. 4)

Stopping Rule (SR): "2" – two ones in adjacent rounds, "3" – three ones in adjacent rounds. Rounds (R): number of rounds, by stopping rule. We only display numerical results by stopping rules if they generate different results between SR = 2 and SR = 3.

average of all actors is declining or if this holds for the veto player(s) by the next round. The stopping rule involving two stopping signs is a more moderate rule while the rule with three stopping signs is more conservative and often points to longer negotiations. As we shall see further below, only in one case do differences in predictions arise. All predictions of the negotiation outcomes refer to medium-term decisions to be undertaken by the German government.

For each of the issues under negotiation, we conducted predictions with the potential influence represented by the composite of (see also Sections 3–5):

- coercion
- material & immaterial (dis-)incentives,
- loyal information, and
- scientific information.

First, on the issue of which components of forest carbon may be remunerated (see Table 1), our prediction with the dual stopping sign generated the smoothed mean result of 46.6, i.e., remuneration of change in forests as well as for select (but not all) aspects of HWP after one round of negotiations (see Table 5). As will hold for all other predictions in this article, we offer no specific predictions which particular aspects of HWP are included; by extension, this applies to the specifics of which criteria for nature protection and for the climate resilience of forests are included (see further below). The reader may interpret this as a general tendency of inclusion of quantities or criteria. More specific predictions are beyond the scope of this study. If the more conservative stopping rule is employed, negotiations including all sources of information last for four rounds and end at a smoothed mean of 45.6, i.e., only a notch lower than is the case for the moderate stopping rule (see Table 5).[4]

Overall, negotiations will be concluded after short negotiations. These brief negotiations are, however, quite conflictual (ca. 53%–66% of bilateral relations during rounds 1 through 4).

Second, how many aspects of nature conservation are included in German government remuneration packages for forests (see Table 2)? While we do not predict the inclusion of specific criteria in government regulations, we predict a general tendency to include the listed criteria. Our prediction results in a smoothed mean of 47, i.e., of the 10 criteria enumerated for scale 2 on nature conservation, all are included to a low degree, or five are included to a high degree and no other, or any mixture adding up to 47 regardless of the stopping rule chosen.

Overall, negotiations on the inclusion of nature conservation criteria will be brief, and 78% of bilateral relationships are conflictual in round 1, attesting to the contentiousness of the issue among actors when offering their opening positions.

Table 6
Predicting the inclusion of nature conservation.

Stopping Rule & No of Rounds	Smoothed Mean	Veto Exercised?
SR: 2 R: 1	47.0	no

Stopping Rule (SR): "2" – two ones in adjacent rounds, "3" – three ones in adjacent rounds. Rounds (R): number of rounds, by stopping rule. We only display numerical results by stopping rules if they generate different results between SR = 2 and SR = 3.

Table 7
Predicting the climate resilience of forests.

Stopping Rule & No of Rounds	Smoothed Mean	Veto Exercised?
SR: 2 R: 1	20.6	no

Stopping Rule (SR): "2" – two ones in adjacent rounds, "3" – three ones in adjacent rounds. Rounds (R): number of rounds, by stopping rule. We only display numerical results by stopping rules if they generate different results between SR = 2 and SR = 3.

Third, we forecast the degree of inclusion of remuneration provisions for the climate resilience of forests (see Table 3). As we elicited only five criteria for potential inclusion, the smoothed mean position ranges from zero to 50 (rather than zero to 100 as in the previous two scales). Regardless of stopping rule, our prediction results in a smoothed mean of 20.5 at the end of round 1, i.e., two of the five criteria of climate resilience of forests are included to a high extent or four of five criteria to a low degree (or any combination that sums up to ca. 20).

Our predictions point to a rapid conclusion of negotiations and minor inclusion of most (but not all) climate resilience criteria in the remuneration system, although 64% of bilateral relationships are expected to be conflictual in round 1 of the negotiations.

In order to probe the policy relevance of our results, they were exposed to a plausibility check. For this purpose, we compared our medium-term forecasts with the guideline for *Grants for Climate-Adapted Forest Management* announced by the BMEL on 15 May 2023 (Bundesministerium für Ernährung und Landwirtschaft, 2023) and the existing legal status quo of forest management in effect in Germany in late 2022, all of them based on the criteria of our three position scales. For the evaluation of the status quo legislation, the federal forest law (BWaldG), the forest laws of two federal states (Lower Saxony and Bavaria), and the guidelines for forest subsidies[5] (Bundesministerium für Ernährung und Landwirtschaft, 2022b) were reviewed.

Our comparison shows the following (see Table 8). First, comparing columns (1) and (2), the adopted guideline barely exceeds the values of existing laws and represents no change on issue 1, remunerating forest carbon removals. Second, our forecasts suggest strong upward pressure on remunerating forest carbon removals, which would be novel for the German forest regulatory system. Third, our predictions suggest further upward pressure on including substantially more criteria for both nature conservation as well as climate resilience of forests. Overall, our predictions suggest that the regulation as of 15 May 2023 will be markedly enhanced on all three issues. Our predictions, however, suggest, particular upward pressure on the carbon sink function of forests (issue 1).

7. The policy relevance of potential influence

We will briefly summarize the policy forecasts, discuss its policy implications, and offer a few suggestions for future research.

[4] As contrasted with all other runs on this issue, the EU might have wielded its veto under the demanding stopping rule. In this case, the overall outcome would have reverted to the status quo ante of no remuneration for forest carbon. As the EU veto right rested with the de minimis rule, this has become a moot point as the EU Commission withdrew it for the years 2023 onwards.

[5] Gemeinschaftsaufgabe Agrar- und Küstenschutz (GAK), engl. *Joint Undertaking for Agricultural and Coastal Protection*

Table 8
Comparison between prediction results, status quo and adopted BMEL guideline (BMEL, 2023).

Issue	Status Quo Legislation (regulatory obligation and standard for subsidies: BWaldG[a], NWaldLG[b], BayWaldG[c], GAK) (1)	Adopted Guideline (BMEL-Guideline 15 May 2023)[d] (2)	Results Predictioneer's Game (Smoothed Mean) (3)
CO_2 Storage (Issue 1)	0	0	46.6
Nature Conservation (Issue 2)	30	35	47.0
Climate Resilience (Issue 3)	12	15	20.6

We include all sources of information under SR = 2 in column (3) (see Tables 5–7).

[a] Bundeswaldgesetz (BWaldG), engl. *Federal Forest Law.*

[b] Niedersächsisches Gesetz über den Wald und die Landschaftsordnung (NWaldG), engl. *State Forest Act Lower Saxony*.

[c] Bayerisches Waldgesetz (BayWaldG), engl. *Bavarian Forest Act.*

[d] Bundesministerium für Ernährung und Landwirtschaft (2023): Bekanntmachung der Richtlinie für Zuwendungen zu einem klimaangepassten Waldmanagement. Vom 28. Oktober 2022 (geändert am 15. Mai 2023), engl. *Announcement of the guideline for grants for climate-adapted forest management*. https://www.klimaanpassungwald.de/fileadmin/Projekte/2023/F%C3%96SL/rl_klimaanpassung_2023.pdf

Our forecasts indicate that (i) forest carbon sinks shall be remunerated to an intermediate degree, and that (ii) considerable measures of nature conservation as well climate resilience of forests will be remunerated. As of the time of writing, remunerating forest carbon sinks has not yet materialized, while remuneration for the nature conservation functions of forests and their climate resilience has entered government regulations to a considerable degree, yet all of them do not constitute a major upgrade of pre-existing government laws and policies. The new remuneration system can be interpreted as a partial windfall profit for forest owners. The predicted outcomes of political decisions to support ecosystem services provision as designed by Winkel et al. (2022) have a reasonable chance to be implemented in Germany during this decade.

The forecasts by the Predictioneer's Game demonstrate that remuneration of forest ecosystem services is a highly conflictual issue. Therefore the policy relevance differs strongly for the different actors. In the following, we focus on the government and forest owners and their potential influence on the political results.

The issue of remuneration of forest carbon removals (issue 1) is the dominant issue in German forest climate policy. The forest owners try to make use of the climate crisis to enable forest ecosystem services to be remunerated for the first time in Germany. The forecast of ca. 46 shows that the forest owners are predicted to receive some medium-term remuneration for the CO_2 storage in the forest plus a few selected HWP. This prediction represents a substantial increase over the status quo of zero renumeration.

In the political bargaining, the organized interest groups of forest owners (AGDW and DFWR) enter negotiations with high position scores for the remuneration of forest carbon sinks. Our forecast shows that the main ministries involved in the negotiations, namely those for forestry (BMEL) and for the environment (BMUV), significantly increase their position scores from 30 to 45 (BMEL) resp. from 30 to 39 (BMUV) when the conservative stopping rule is applied. But in the fourth round both ministries are less conflictual and increase their salience on this issue. In addition, the BMEL more than halves its flexibility by round 4 as compared to round 1. This indicates that the ministries bargain for a score around 40 and do not accept an increase of the score of remuneration for forest carbon sinks, i.e., their positions are close to the predicted final outcome. This indicates that other actors are able to avoid even higher remuneration for CO_2. A key role is played by the powerful Green Party and the Ministry of Environment (BMUV) which is against enlarging the remuneration to include wood harvesting and wood products. Informally, the strong Ministry of Forestry (BMEL) also prefers not to enlarge the basis for remuneration beyond forest stands because this would exceed its area of competence and make it dependent on other ministries.[6] We note that remuneration of forest carbon sinks has not yet been included in government remuneration systems, yet a private voluntary market for forest carbon sinks exists.

In the case of remuneration for nature conservation (issue 2), the outcome of 47 within one round of negotiations reconciles the interests of forest owners with those of nature conservation actors. Compared to the legal status quo of 30 (see Table 8), the predictions point to a substantial increase in predicted provisions to safeguard nature conservation over the status quo, which implies that nature conservation actors are predicted to gain as compared to the lower existing standard of 30 (see Table 8).

In the case of forest climate resilience (issue 3), the result of ca. 20 is a reasonable step toward the maximum of 50 and exceeds the status quo of 12 (Table 8). Even if resilient forest management is not a priority for the nature conservation sector (Göhrs et al., 2022), they use their political power to push the BMEL ministry to formulate substantial standards for climate resilient forest management. The forest ministry is hindered to follow the informally preferred option of low standards which causes little conflicts with the groups representing forest owners (Krott, 2005).

To summarize, given the configuration of data inputs, the Predictioneer's Game forecasts that the forest owners - despite their power sources - are not able to shape the political decision on remuneration forest carbon and can only partially reduce the drive toward higher remuneration for forest conservation measures, yet they are able to get what they want on the climate resilience of forests. The additional financial means come with specified obligations for forest management, albeit taking part in the remuneration scheme is voluntary. The quick agreement (one round each) on nature conservation and climate resilience are correctly forecast. For the first time, the forest sector will receive remuneration for forest ecosystem services in exchange for additional obligations. These findings fit well with the European-wide analysis by Juerges et al. (2020) which stated that "in Germany […] governmental actors relied on a mix of coercion, incentives, and dominant information and market actors (like forest owners) relied mostly on incentives."

Our substantive forecasts mostly point into the right direction. Our analysis of this regulation (Table 8) states that forest carbon removals are not yet remunerated, and for nature conservation and climate resilient forest management, the 2023 regulations show barely an increase in standards over previously existing laws and policies. This

[6] Krott, M. Participant observation during the Zoom conference of the DFWR's policy expert group on 05 May 2022 regarding the Klimaschutz-Sofortprogramm 2022.

means that the implementation of the new guideline will generate new income for forest owners without substantial new obligations.

How can this difference between the empirical observed political outcome and the predicted outcome be explained? What does this imply for the political process of formulating a strong tool for remuneration of CO_2 storage in the future?

We suggest that the difference is caused by the policy window which opened up in 2022 to formulate a new guideline that remunerates forest ecosystem services for the first time and is meant to *start* a long term remuneration system. The ministry in charge of forests, BMEL, received the option to spend €200 Million from an ad hoc program in 2022 only ("Climate protection pop-up program (Klimaschutz-Sofortprogramm),[7] yet its 2023 version is meant to spend € 900 m over five years. The short period allowed (for the 2022 payments) induced strong time pressure on the BMEL to hammer out a guideline in a few months due to the annuity principle of German budgets.[8] Therefore the BMEL focused on the guideline which implies increased salience of the issue for BMEL – which was not captured by the data inputs for the Predictioneer's Game (the latter predicts the *medium*-term policy choices). In addition, the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, BMUV, received financial allocations from the climate and transformation fund for 2023+ which it can use for remuneration of nature conservation and forest climate issues. Subsequently, the BMUV reduced its salience during the 2022 negotiations, which is not captured by the data inputs for the Predictioneer's Game. A consequence of the reduced salience is that the resistance by the BMUV was not strong - which is supported by data from participatory observations.[9] The BMEL used the political window of opportunity to follow its interests in formulating a partial guideline for "forest climate remuneration" at the expense of the other two issues. Given the proximity of the BMEL to forest owners, it prefers remunerating forest owners in exchange for minor additional obligations. The results of the Predictioneer's Game indicate how the policy process will develop for the period 2023+: Our modeling results clearly predict upward pressure on all three issues, esp. on the issue to remunerate forest carbon. Whether this will be borne out in reality can only be assessed in the years to come.

In addition, we propose additional research with the help of the Predictioneer's Game. Varying specific inputs for specific actors could illuminate which results specific actors would expect if they increase their salience on specific issues or if the configuration of governing parties and their relative potential influence changes (e.g., after elections). Additional research could explore the impact of the various sources of political influence (see Section 3) on the predicted results. For example, the Predictioneer's Game enables to forecast the influence of scientific information (as compared to the other three components additionally used in this article) on the remuneration policy - which would clarify the highly contested issue of the role of science in forest climate policy. Finally, we suggest to consider the option to optimize the results for particular actors, i.e., they use available information to their greatest advantage in order to shape the overall outcome.

Structured policy prediction tools allow us to foresee forest policy, how it is shaped, and to make specific predictions about outcomes. Preliminary evidence suggests that we made correct directional predictions, and political observations show that the differences between predicted and actual outcomes are captured by the political pressures we witness in current forest policy. Given the generic nature of the Predictioneer's Game, it lends itself to much more finely grained specific predictions which aspects of nature conservation and the climate resilience of forests are to be remunerated in the future – and which will not be remunerated.

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CRediT authorship contribution statement

Detlef F. Sprinz: Conceptualization, Formal analysis, Funding acquisition, Validation, Writing – original draft, Writing – review & editing. **Tabea V. Schaefers:** Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Freya Lenk:** Formal analysis, Software, Writing – original draft, Writing – review & editing. **Max Krott:** Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data availability

Data will be made available on request.

Appendix A. Input data of the political actors (variables: position, flexibility, salience) (Schaefers, 2022)

Nr.	Actor group	Actor	Scale 1 "CO_2"			Scale 2 "Nature conservation"			Scale 3 "Climate resilience"		
			Position	*Flexibility*	*Salience*	*Position*	*Flexibility*	*Salience*	*Position*	*Flexibility*	*Salience*
1	Forestry	AGDW	100	30	30	10	10	40	20	25	50
2		DFWR	100	30	30	20	10	40	20	25	40
3		IG BAU	60	25	20	30	25	10	20	25	10

(*continued on next page*)

[7] Krott, M. Participant observation during the Zoom conference of the DFWR's policy expert group on 05 May 2022 regarding the Klimaschutz-Sofortprogramm 2022.

[8] Personal interview, 05 May 2022.

[9] Krott, M. Participant observation during the Zoom conference of the DFWR's policy expert group on 05 May 2022 regarding the Klimaschutz-Sofortprogramm 2022.

(*continued*)

Nr.	Actor group	Actor	Scale 1 "CO_2"			Scale 2 "Nature conservation"			Scale 3 "Climate resilience"		
			Position	*Flexibility*	*Salience*	*Position*	*Flexibility*	*Salience*	*Position*	*Flexibility*	*Salience*
4	Nature conservation	BUND	30	5	40	100	10	40	10	30	20
5		NABU	30	5	40	100	10	40	10	30	20
6		WWF	30	5	10	100	25	20	10	30	10
7		Greenpeace	30	5	30	100	25	20	10	30	10
8	Political parties	SPD	60	30	30	30	30	10	30	30	10
9		Grünen	30	5	50	100	5	30	10	25	30
10		FDP	30	25	10	10	25	5	10	15	10
11		CDU/CSU	100	30	30	10	15	20	20	30	20
12		Linke	30	5	20	70	5	20	20	5	10
13		AfD	0	0	20	10	0	20	20	0	20
14	Federal ministries	BMEL	30	40	30	20	20	40	30	30	50
15		BMUV	30	15	30	100	15	40	20	25	20
16		BMWK	60	40	15	10	20	5	50	15	10
17		BMF	10	25	10	5	20	10	25	20	10
18	EU	EU	30	25	10	20	35	10	25	35	5

Appendix B. Input variable "potential influence" of political actors (Schaefers 2022, revised)

No.	Actor group	Actor	Total influence *(Potential influence)*
1	Forestry	AGDW	4.1
2		DFWR	3.2
3		IG BAU	2.2
		Sum potential influence (actor group)	∑ 9.5
4	Nature conservation	BUND	1.3
5		NABU	1.3
6		WWF	0.4
7		Greenpeace	1.3
		Sum potential influence (actor group)	∑ 4.3
8	Political parties	SPD	4.2
9		Grünen	5.1
10		FDP	4.2
11		CDU / CSU	2.2
12		Linke	0.4
13		AfD	1.3
		Sum potential influence (actor group)	∑ 17.4
14	Federal ministries	BMEL	5.0
15		BMUV	4.0
16		BMWK	0.4
17		BMF	2.3
		Sum potential influence (actor group)	∑ 11.7
18	EU	EU	∑ 2.2

Note: Potential influences comprises the sum of coercion, (dis-)incentives, loyal information, and scientific information, per actor.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.forpol.2024.103231.

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- Supplementary Material -

Classification (1) and Evaluation (2)
of the Criteria of the
BMEL-Guideline from 28.10.2022 in the version from 15.05.2023
(Module 1 "Climate-resilient Forest Management")
on the three Issue Scales
"Forest Carbon storage", "Nature Protection Aspects" and "Climate Resilience of Forest Stands"

1) Classification of the Criteria of the BMEL Guideline on the three Issue Scales

Table 1 provides an overview of the summarized and translated criteria of the BMEL guideline (BMEL 28. Oct. 2022) and a classification to which of the three issue scales they can be allocated to.

Table 1: Overview of the criteria for climate-adapted forest management and classification on the three issue scales (present = x and highlighted in green, not present = -)

Kriterien der BMEL-Richtlinie (zusammengefasst)	**Translation of the Criteria of the BMEL Guideline** (summarized)	**Scale 1** Forest Carbon	**Scale 3** Nature Protection	**Scale 3** Climate Resilience
1) **Vorausverjüngung** durch künstliche Verjüngung oder Naturverjüngung	1) **Pre-regeneration** by artificial regeneration or natural regeneration	-	**x**	-
2) Vorrang der **Naturverjüngung**, „sofern klimaresiliente, überwiegend standortheimische Hauptbaumarten in der Fläche auf natürlichem Wege eingetragen werden und anwachsen"	2) Priority of **natural regeneration**, „provided that climate-resilient, predominantly site-native main tree species are naturally introduced and grow in the area"	-	**x**	-
3) **Künstliche Verjüngung** unter Berücksichtigung aktuell geltender Baumartenempfehlungen der Länder oder der jeweiligen Forstlichen Landesanstalten und Einhaltung eines überwiegenden **standortheimischen** Baumartenanteils	3) **Artificial regeneration** taking into account currently valid recommendation on tree species of the federal states or the respective state forestry institutes and adherence to a predominance of **site-native** tree species	-	**x**	-

4)	Zulassen von **Sukzessionsstadien** bei kleinflächigen Störungen aus Pionierbaumarten (Vorwälder)	4) Allowing **successional stages** in case of small-scale disturbances from pioneer tree species (pioneer forests)	-	**x**	**x**
5)	Erhalt oder Erweiterung der klimaresilienten, standortheimischen **Baumartendiversität** (Mischung)	5) Maintenance or expansion of climate-resilient, **native tree species diversity** (mix of species)	-	**x**	**x**
6)	**Verzicht auf Kahlschläge**. Sanitärhiebe bei Kalamitäten möglich, sofern mind. 10 % der Derbholzmasse als **Totholz** zur Erhöhung der Biodiversität auf der Fläche belassen werden	6) **No clear cutting.** Sanitary felling possible in case of calamities, provided that at least 10 % of the debris mass is left on the area as **deadwood** to increase biodiversity	-	**x**	-
7)	Anreicherung und Erhöhung des **Totholzanteils**	7) Enrichment and increase of the share of **deadwood**	-	**x**	-
8)	Kennzeichnung und Erhalt von **Habitatbäumen** (mind. 5/ha)	8) Marking and preservation of **habitat trees** (at least 5/ha)	-	**x**	-
9)	Neuanlage von **Rückegassen: Mindestabstand** von 30 m (40 m bei verdichtungsempfindlichen Böden)	9) Construction of new **skid trails: Minimum distance** of 30 m (40 m for soils susceptible to compaction)	-	**x**	-
10)	**Verzicht auf Düngung und Pflanzenschutzmittel** (ausgenommen bei der Behandlung von Poltern zur Vermeidung schwerwiegender Gefährdung des verbleibenden Bestandes und Entwertung des liegenden Holzes)	10) **No use of fertilizers and pesticides** (except for the treatment of wood piles to avoid serious danger to the remaining stand and to avoid devaluation of the lying harvested wood)	-	-	**x**
11)	**Maßnahmen zur Wasserrückhaltung** im Wald, Verzicht auf Maßnahmen zur Entwässerung	11) **Water retention measures** in the forest, no drainage measures	-	**x**	-

12) **Natürliche Waldentwicklung auf 5 %** der Waldfläche (obligatorisch, sofern Waldfläche > 100 ha, freiwillig, sofern Waldfläche ≤ 100 ha). Auszuweisende Fläche: mind. 0,3 ha und **20 Jahre nutzungsfrei** (ausgenommen: naturschutzfachliche Pflege-, Erhaltungs- und Verkehrssicherungsmaß nahmen)	12) **Natural forest development** on 5% of the forest area (obligatory if forest area > 100 ha, voluntary if forest area ≤ 100 ha). Area to be designated: at least 0.3 ha and 20 years without forest harvesting (except for nature conservation, maintenance and road safety measures)	-	**x**	-

2) Evaluation of the Criteria of the BMEL Guideline

Depending on the existence and expression of the criteria of the three issue scales in the adopted BMEL guideline, they are evaluated using the following scores: 0: non-existent, 1: merely mentioned, 5: weak inclusion, 10: strong inclusion. For each issue scale, the total values of the criteria is summed up.

Scale 1: Quantities of Forest Carbon

Criterion (Scale 1)	**Corresponding criterion of the BMEL guideline (Module 1)**	**Scale value (Expression)**			
		Non-existent (0)	**Mentioned (1)**	**Weak Expression (5)**	**Strong Expression (10)**
No change of forest carbon will be remunerated (status quo)	*No criterion included*	0			
Change in forest carbon only	*No criterion included*	0			
Change in forest carbon plus carbon in harvested wood products (HWP)	*No criterion included*	0			
Change in forest carbon plus carbon in HWP, plus carbon substitution potential	*No criterion included*	0			
Sum		0			

Scale 2: Nature Protection Criteria

Criterion (Scale 2)	**Corresponding criterion of the BMEL guideline (Module 1)**	**Scale values (Expression)**			
		Non-existent (0)	**Mentioned (1)**	**Weak Expression (5)**	**Strong Expression (10)**
Native tree species	3) **Artificial regeneration** taking into account currently valid tree species recommendations of the federal states or the respective state forestry institutes and adherence to a **predominantly site-native** tree species proportion. 5) Maintenance **or** expansion of climate-resilient, **native tree species diversity** (mix)			5	
Unmanaged forests	4) Allowing **successional stages** in small-scale disturbances from pioneer tree species (pioneer forests) 12) **Natural forest development** on 5% of the forest area (obligatory if forest area > 100 ha, voluntary if forest area =/< 100 ha). Area to be designated: at least 0.3 ha and 20 years without forest harvesting			5	
Old forests	*No criterion included*	0			
Preservation of dead wood	7) Enrichment and increase of the **proportion of deadwood**			5	
Natural forest edges	*No criterion included*	0			
Preservation and enhancement of natural soil functions	6) **No clear cutting.** Sanitary felling possible in case of calamities, provided that at least 10 % of the debris mass is left on the area as **deadwood** to increase biodiversity 9) Construction of new **skid trails: Minimum distance** of 30 m (40 m for soils susceptible to compaction) 11) Water retention measures in the forest, no drainage measures			5	
Natural regeneration of forests	1) Pre-regeneration by artificial regeneration **or natural regeneration** 2) Priority to natural regeneration, „**provided that**			5 *Criterion 1 contains a*	

	climate-resilient, predominantly site-native main tree species are naturally introduced and grow in the area"			*choice = no obligation.* *Criterion 2 prioritizes natural regeneration, but contains an additional condition*	
Formal Forest Stewardship Council (FSC)-certification	*No criterion included*	0			
Biodiversity-promotion by mixed age structures	4) Allowing **successional stages** in **small-scale** disturbances from pioneer tree species (pioneer forests) 8) Marking and preservation of habitat trees (at least 5/ha)			5	
Biodiversity-sensitive harvesting	6) **No clear cutting.** Sanitary felling possible in case of calamities, provided that at least 10 % of the debris mass is left on the area as **deadwood** to increase biodiversity 9) Construction of new skid trails: Minimum **distance of 30 m** (40 m for soils susceptible to compaction)			5	
Sum		**35**			

Scale 3: Climate resilience of Forest Stands

Criterion (Scale 3)	**Corresponding criterion of the BMEL guideline (Module 1)**	**Scale values (Expression)**			
		Non-existent (0)	**Mentioned (1)**	**Weak Expression (5)**	**Strong Expression (10)**
Mixed stands with site-adapted, climate-resilient tree species	5) Maintenance **<u>or</u>** expansion of climate-resilient, **native tree species diversity** (mix)			5	
Conservation and increasing the genetic diversity of tree species	*No criterion included*	0			
Active protection measures	10) No use of fertilizers and **pesticides** (**except for the treatment of wood piles to avoid serious danger to the remaining**			5	

against biotic calamities	**stand and devaluation of the lying harvested wood**)				
Development of structured, uneven-aged, climate-resilient stands	4) Allowing **successional stages** in small-scale disturbances from pioneer tree species (pioneer forests)			5	
Formal extended Programme for the Endorsement of Forest Certification (PEFC)-Certification		0			
Sum		**15**			

Summary:

Table 2 allows a comparison of the evaluation of the BMEL guideline and the results of the Predictioneer´s Game.

Table 2: Comparison of the evaluation of the BMEL-Guideline with the results of the Predictioneer´s Game

Issue Scale	**Predictioneer´s Game (PG) results (12. Dec. 2022)**	**BMEL-Guideline (28.10.2022, version from 15.05.2023)**
CO2	45.6	0
Nature Protection	47	35
Climate Resilience	20,6	15

- Supplementary Material -

Evaluation of the Status Quo of Forest Management in Germany (2022)

The status quo comprises the legal obligations for forest management and the standard of subsidies for forest management in 2022. Therefore, the federal forest law (BWaldG), the federal state forest laws (Lower Saxony and Bavaria as examples) and the guidelines for forest subsidies (GAK – Gemeinschaftsaufgabe Agrar- und Küstenschutz, engl. "Joint Task for Agriculture and Coastal Protection) were checked with respect to the existence of the established criteria of the three issue scales. Depending on the existence and expression of the criteria in the abovementioned laws and guidelines, they are evaluated as follows:

0: non-existent, 1: merely mentioned, 5: weak inclusion, 10: strong inclusion.

The highest value for each criterion was scored as the existing status quo and reported as the "maximum value across all four regulatory sources". The sum results in a total score for each issue scale. Table 1 shows the evaluation of the status quo and the translated corresponding parts of the laws and regulations considered.

The explicit criteria of the three issue scales 1 – 3 were analyzed. This means the existing links between timber production and other ecosystem services (which have nearly always an impact on CO2 storage) are *not* considered as part of the formal criteria fulfilling political aims.

Table 1: Evaluation of the status quo of forest management in Germany

Issue and criteria	Regulatory obligation for forest management 2022			Standard for subsidies for forest management 2022 (GAK 2022 – 2025)	Maximum value across all 4 regulatory sources (regulatory obligation and standard for subsidies)
	Federal Forest Act (*Bundeswaldgesetz, BWaldG*)	**Lower Saxony Forest Act** (*Niedersächsisches Gesetz über den Wald und die Landschaftsordnung, NWaldLG*)	**Bavarian Forest Act** (*Bayerisches Waldgesetz, BayWaldG*)		
CO2 (Scale 1)					
No change of forest carbon will be remunerated (status quo)	0	0	0	0	0
Change in forest carbon only	-	**NWaldLG, § 17a Silvicultural Aid:** "Aid for silvicultural measures in forestry funding **within the framework of the "improvement of the agrarian structure and coastal protection"** as well as aid granted in accordance with available budgetary funds of the Land shall only be granted for European tree species and site-appropriate tree species. If the Northwest German Forest Research Institute	-	- (*Option for CO_2 (see NWaldLG) criteria is not mentioned in GAK*)	

	0	arrives at a different assessment of sentence 1, the responsible ministry may define exceptions in the guidelines for granting subsidies. **Eligible are in particular tree species** which, in addition to their site suitability, are characterized by a **high CO2 storage capacity** and growth performance." (*NWaldLG mentions that remuneration of CO2 storage capacity is **possible within the framework of the GAK**, **not** solely by the NWaldLG*) 0	0	0	(*Even though the option of remuneration is stated in the state law, it is not mentioned in the GAK and thus not included at the federal level. The federal government is not bound here by the legislative criteria of the states*.)

					0
Change in forest carbon plus carbon in harvested wood products (HWP)	0	0	0	0	**0**
Change in forest carbon plus carbon in HWP, plus carbon substitution potential	0	0	0	0	**0**
Sum					**0**
Nature Protection (Scale 2)					
Native tree species	§ 11, 1: - Reforestation of forest areas (*no specification of the tree species*)	§ 11 Orderly Forestry, 2: - "site-**appropriate** tree species" (*not: **native** tree species*) 0	Art. 14 Forest Management: - Forest regeneration by site-appropriate tree species, <u>adequate proportion</u> of **site-native tree species**	**Measure group A, Measure forest <u>restructuring:</u>** „adequate proportion of site-native tree species shall be maintained" **Measure Group D, Measure <u>New forest establishment</u>**	**5**

	0		5	Planting improvements ➔ Site-adapted tree species + adequate proportion of site-native tree species 5	

Unmanaged forests		§ 11 Orderly Forestry, 3: - "a forest area **can** be left to its own dynamic development under the suspension of the utilization function […]" (*only an option, not a requirement*)	Art 12a Natural Forest Reservations: „natural or largely natural forest areas **may** be established as natural forest reserves at the request of the forest owner. [...] Apart from necessary forest protection and traffic safety measures, no management or timber harvesting shall take place in Natural Forest Reservations" (*no obligation*)	**Measure Group E, Measure <u>Contractual conservation in the forest</u>** Renunciation of usage according to nature conservation specifications	
	0	5	5	5 *(not 10, as it is very little money, optional provision is rarely used)*	**5**
Old forests	-	-	-	-	**0**
	0	0	0	0	
Preservation of dead wood	-	§ 11 Orderly Forestry, 2: - "adequate proportion of dead wood"	-	-	**5**
	0	5	0	0	

Natural forest edges	-	-	-	**Measure Group A, Measure forest <u>restructuring:</u>** <u>Forest edge design</u> (*low expression, since the specification only includes consideration of site-appropriateness and only a "sufficient proportion of site-native tree species"*)	**5**
	0	0	0	**5**	
Preservation and enhancement of natural soil functions	§ 1,1: Law purpose - Protection of the forest for the preservation of soil fertility	§ 1,1: Law purpose - Protection of the forest for the preservation of soil fertility § 11 Orderly Forestry, 2: - "forest access according to needs, with the greatest possible conservation of soil […]" - "Application of stock and soil conserving techniques"	Art 9: Maintenance of the Forest: - „any action by which the productive power of the forest soil is destroyed […] is prohibited" Art. 14 Forest Management: - Forest access in line with needs and in a nature-friendly manner - "Forest soil […] to be treated with care"	**Measure Group A, Measure <u>Soil protection liming</u>**	**5**
	5	5	5	5	

Natural regeneration of forests	-	§ 12 Reforestation: - Possible through natural regeneration, provided that this is appropriate for the site (*conditional priority of natural regeneration*)	Art. 14 Forest Management: - **Options** of natural regeneration are to be used for forest regeneration	-	**5**
	0	5	5	0	
Formal Forest Stewardship Council (FSC)-certification	-	-	-	-	**0**
	0	0	0	0	
Biodiversity-promotion by mixed age structures	-	-	-	-	**0**
	0	0	0	0	

Biodiversity-sensitive harvesting	§11: - Orderly and sustainable forest management - Reforest or supplement clear-cut or depleted forest stands within a reasonable period of time if natural reforestation remains incomplete	§ 11 Orderly Forestry, 2: - " Application of stock and soil conserving techniques" § 12 Clear-cuts restrictions: - Clear-cuts > 1 ha notifiable	Art. 14 Forest Management: - „Forest soil and forest stands shall be treated with care"	-	(*Management that protects stands and soils is required by state laws, but without direct link to biodiversity conservation*)
	0	0	0	0	**0**
Sum					**30**

Climate Resilience (Scale 3)					
Mixed stands with site-adapted, <u>climate-resilient</u> tree species	-	-	BayWaldG: Art. 22: other aids, 3: - "measures eligible for aid shall be specified in a forestry state aid program." In particular, to include: - ..., aid for the establishment of forests that are **appropriate to the site** and as close to natural conditions as possible	**Measure group A, measure <u>forest restructuring</u>:** Eligible: Reforestation, preplanting, underplanting with **site-appropriate** tree species by seeding and planting	(*silvicultural subsidies are granted, but the aspect of climate resilience is not directly mentioned in either state or federal laws*)
	0	0	0	0	**0**

Conservation and increasing the genetic diversity of tree species	-	§ 11 Orderly Forestry, 2: - **Reforestation**: Use of "**suitable** seed and planting material while **maintaining genetic diversity**" (*Aspect of genetics is mentioned, but only in terms of seed and plant material, not, for example, in regards to screening the genetic diversity of the existing forest stand*)	-	**Measure group D, Measure <u>New forest establishment</u>** Planting improvements ➔ Use of provenance-assured + site-appropriate propagation material (*only statement "provenance assured" and not e.g. additionally "different provenances")*	**1**
	0	1	0	0	
Active technical protection measures against biotic calamities		§ 13 Forest protection: - Counteract hazards "through **proven rules** of forestry practice" (*measures not specified*)	Art. 14. Forest Management - Use of chemical pesticides **to be avoided as far as possible**	**Measure group A, measure <u>forest restructuring</u>:** <u>Protection of forest plantings</u> **Measure group B, measure <u>timber conservation facilities</u>:** To prevent calamities of plant pests, facilities for wet storage should be promoted **Measure Group F, Measure <u>Forest protection measures:</u>**	

				- Monitoring, control of harmful organisms with attractants and other measures of integrated pest management, timber/pole protection nets **GAK: Measure group F, Measure reforestation** - Protection of forest plantings for the first 5 years	**10**
	0	5	1	10	
Development of structured, uneven-aged, climate-resilient stands		*Indirectly*: § 11 Orderly Forestry, 2: - "Aiming for healthy, stable and diverse forests"		**Measure group A, measure <u>young stock management:</u>** Mixing and stand area regulation in young forest stands (*„young forest stands" = even-aged stands, measures do not contribute to vertical structuring of forest stands*)	(*Only the Lower Saxony Forest Act specifies the term "orderly forestry" and in this context aims for "healthy, stable and diverse forests". However, there is no direct mention of the aspect of climate resilience*) **1**
	0	1	0	0	

Formal extended Programme for the Endorsement of Forest Certification (PEFC)-Certification	-	-	-	-	**0**
	0	0	0	0	
Sum					**12**

References:

Bayerisches Waldgesetz (BayWaldG):
https://www.gesetze-bayern.de/Content/Document/BayWaldG [accessed on: 20.03.2023]

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Niedersächsisches Gesetz über den Wald und die Landschaftsordnung (NWaldLG):

https://www.ml.niedersachsen.de/startseite/themen/wald_holz_jagd/wald_und_forstwirtschaft/gesetze-und-andere-bestimmungen-5129.html [accessed on: 20.03.2023]