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People are willing to pay for climate- and biodiversity-friendly policies in Finland: opportunities of wind power, forest management, and peatland restoration

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Land-use practices play a crucial role in addressing the most pressing threats to the well-being of present and future generations, namely, climate change and biodiversity loss. Our study employed a choice experiment (CE) method to delve into the preferences of Finnish citizens concerning policy measures aimed at mitigating climate change, as well as their associated outcomes. The investigation yielded three key findings. First, on average, respondents expressed a willingness to pay (WTP) for both the implementation of proposed policy measures and the subsequent outcomes. Second, there was notable heterogeneity in WTP among respondents, influenced by whether they resided in the capital region or elsewhere in the country. Third, to assess citizens' WTP for various policy combinations, we formulated alternative policy programs. These programs underscored the significance of forestry-related measures that not only address climate change but also yield positive biodiversity outcomes in shaping effective climate policies.

Keywords: climate policy measures; climate policy preferences; wind power; climate-friendly forestry; peatland restoration

1. Introduction

During the Paris Climate Change Summit in 2015, participating nations collectively committed to a pivotal objective: limiting the rise in the global average temperature to 1.5 °C (United Nations 2015). Subsequently, in 2019, the European Union unveiled the European Green Deal, a comprehensive plan aspiring to cut the EU's greenhouse gas emissions (GHGs) by 50% by 2030 and achieve carbon neutrality by 2050 (European Commission 2019). Concurrently, the Finnish government declared its ambition to attain carbon neutrality by 2035, with plans for carbon negativity shortly thereafter (Government of Finland 2019). Simultaneously, the worldwide challenge of biodiversity loss has garnered attention, with concerted efforts at both EU and national levels to address this issue (Government of Finland 2012; European Commission 2020; Ruckelshaus *et al*. 2020; Joly 2022). Given the inherent interconnections between these challenges, the future trajectory of land-use policy must be shaped by a coordinated

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*Corresponding author. Email: erkki.mantymaa@luke.fi approach to their resolution (O'Connor 2008; Elkerbout, Catuti, and Egenhofer 2020; Asbeck *et al.* 2021).

Globally, one of the primary contributors to GHGs stems from energy production reliant on fossil fuels (Maroto-Valer, Song, and Soong 2002). Consequently, the most promising avenue for emission reduction lies in transitioning to renewable energy sources. Especially in the 2000s and 2010s, this sparked increased global interest in biofuels (Koh and Ghazoul 2008; Verdade, Piña, and Rosalino 2015). The same happened in the Nordic countries, such as Finland, Norway, and Sweden, where forests are a significant source of biomaterial (de Jong *et al.* 2017; Eggers *et al.* 2020; Höglund *et al.* 2013; Iordan, Verones, and Cherubini 2018; Torvanger 2021). However, it is crucial to acknowledge that the production of biofuels carries various adverse impacts, including substantial GHG emissions, threats to forests and biodiversity, elevated food prices, and competition for water resources (Koh and Ghazoul 2008; Verdade, Piña, and Rosalino 2015). As a result, both political and public interest in biofuels has waned over time (Koh and Ghazoul 2008).

As a substantial increase in the utilization of bio-based fuels has proven challenging (Oumer *et al.* 2018), the EU has decided on large-scale electrification of energy production and transportation (Helgeson and Peter 2020). This transition necessitates a significant boost in renewable domestic electricity production (Wei, McMillan, and de la Rue Du Can 2019). In Northern Europe, wind power stands out as the most promising source of renewable electricity (Enevoldsen *et al.* 2019; Null and Archer 2008), having gained economic competitiveness in recent years. Consequently, investments in wind power are anticipated to surge in the future (Huttunen 2017), notwithstanding potential adverse effects at the local level (Groothuis, Groothuis, and Whitehead 2008; Jeffery, Krogh, and Horner 2014; Tolvanen *et al.* 2023). These impacts may diminish the acceptance of wind power and trigger resistance to turbine construction (Warren *et al.* 2005; Mäntymaa, Kaseva, *et al.* 2023b).

An effective approach to achieve carbon neutrality involves enhancing carbon storage in biomass and soil (Lal 2003; Wang *et al.* 2007). While the costs and potential volumes of carbon sequestration can vary (Richards and Stokes 2004), a comprehensive review by Raihan *et al.* (2019) has determined that carbon sequestration in forests and soil offers significant global potential compared to the expenses associated with CO_2 capture and storage systems (Vidas *et al.* 2012; Rubin *et al.* 2013). However, maintaining existing natural storage and increasing sequestration in trees and soil necessitates adjustments to the management of commercial forests and their growth soil, encompassing both mineral and peatlands. This, in turn, may impact wood production and employment in the forest sector (Kallio *et al.* 2018) and potentially reduce public support for these measures.

GHG measures associated with land use have the potential to either bolster or undermine biodiversity, a principle that extends to diverse forest management practices (Buotte *et al.* 2020; Burrascano *et al.* 2016). In Finland, for instance, the prevalent use of rotation or even-aged forest management practices conflicts with both biodiversity conservation objectives (Mönkkönen *et al.* 2014) and the pursuit of carbon neutrality (Schulze *et al.* 2012). Consequently, a prospective shift toward practices aimed at enhancing biodiversity is anticipated to also yield positive outcomes for carbon sequestration. This underscores the interplay between ecological diversity and carbon sequestration objectives, suggesting that changes geared toward biodiversity improvement can concurrently contribute to achieving carbon neutrality goals.

In addition to assessing the costs and potentials associated with various carbon sequestration and biodiversity protection methods, it is crucial to take into account the preferences of citizens regarding these policies (Nemet and Johnson 2010). Numerous studies have explored public preferences in different environmental domains, such as green energy and the transition from fossil fuels (Ntanos *et al.* 2018), the adverse effects of wind turbines (Bartczak, Budziński, and Gołębiowska 2021), and the enhancement of carbon sinks through soil and biomass management in forestry practices (Anup, Joshi, and Aryal 2014). Likewise, preferences related to biodiversity have been extensively investigated from diverse perspectives (Bartkowski, Lienhoop, and Hansjürgens 2015). Examining preferences, especially in terms of trade-offs between commercial forest use and other ecosystem services, including biodiversity, has been a subject of thorough investigation in the Nordic countries, Europe, and globally (van Rensburg *et al.* 2002; Yao *et al.* 2014; Lindhjem *et al.* 2015; Juutinen *et al.* 2022). Previous studies have played a pivotal role in evaluating environmental policies or management practices from a societal standpoint (Wegner and Pascual 2011; Mäntymaa *et al.* 2021). While some studies have delved into specific aspects of climate policy, such as limiting GHGs (Kotchen, Boyle, and Leiserowitz 2013; Williams and Rolfe 2017), and forest management policies (Mäntymaa, Artell, *et al.* 2023a), a notable gap exists in the literature regarding studies measuring people's preferences for alternative nationwide land-use policy options to mitigate climate change. Although citizens' preferences for the concurrent pursuit of increasing carbon sinks and reducing biodiversity loss have been explored at the local or regional level (Caparrós *et al.* 2010; Shoyama, Managi, and Yamagata 2013), there is a dearth of analyses at the level of national land-use policy. This underscores the need for comprehensive research in this domain to inform effective and inclusive national policies addressing climate change mitigation.

Given the significance of both alternative policy measures and their resulting outcomes in revealing respondents' preferences, Johnston *et al.* (2017) and Mariel *et al.* (2021) advocate for their equitable inclusion in the choice tasks of a choice experiment (CE) survey applied in this study. Recognizing that a measure can have outcomes that impact individuals in diverse ways, Mariel *et al.* (2021) emphasized the importance of considering both the desired results and the potential effects on various individuals. For instance, the establishment of a wind farm contributes to emission-free electrical energy, thereby enhancing societal welfare; however, it may concurrently alter the landscape in its vicinity (Zerrahn 2017; Mäntymaa, Pouta, and Hiedanpää 2021; Tolvanen *et al.* 2023). Conversely, different measures leading to a similar outcome may have distinct benefits or costs for various groups of people. Additionally, Chen *et al.* (2022) found that individuals not presented with potential outcomes were more likely to experience uncertainty about the effectiveness of a policy and leaned toward choosing the status quo (SQ). This underscores the importance of comprehensively presenting both policy measures and their potential outcomes to elicit informed and meaningful preferences from respondents.

Acknowledging the spatial variability in the potential effectiveness of policy measures due to environmental conditions is essential in conducting CE studies. Failure to incorporate the spatial aspect may result in biased individual or mean welfare estimates and an incomplete understanding of public preferences (Glenk *et al.* 2020). Neglecting the spatial dimension of policy measures can also hinder the measurement of welfare heterogeneity, directly impacting policy evaluation (Bateman *et al.* 2006; Johnston *et al.* 2015). Importantly, the significance of spatial patterns in policy evaluation can sometimes outweigh the effects of statistical and methodological issues (e.g. Schaafsma, Brouwer, and Rose 2012). In our specific context, the potential for implementing policies related to wind power, forest management practices, or peatland restoration is highly dependent on regional conditions. Therefore, it is crucial to provide spatial information concerning these policy measures in the CE survey. This approach ensures a more nuanced understanding of public preferences and facilitates a more accurate and comprehensive assessment of the potential impacts and acceptance of the proposed policies across different regions.

The objective of our study was to scrutinize individuals' preferences for various forms of climate policy measures impacting land use, as well as their preferences for the outcomes stemming from these measures. Employing CE, our investigation focused on three key facets. First, we delved into citizens' preferences and marginal willingness to pay (WTP) concerning climate change mitigation policy measures, specifically additional wind power, climate-friendly forestry, and the restoration of peatlands. Second, we explored individuals' preferences regarding the outcomes of these policy measures, encompassing a reduction in GHGs and an enhancement of biodiversity. In these analyses, we investigated the heterogeneity of preferences, accounting for the geographical location of the respondents (Bergman, Colombo, and Hanley 2008). Third, we conducted a comparative assessment of the potential benefits arising from both combinations of policy measures and combinations of their outcomes by calculating the welfare effects of conceivable policy programs. Data for our study were gathered through a national CE survey, notable for two innovative approaches. First, we concurrently included both climate policy measures and their outcomes as attributes in the choice tasks of the survey (Johnston *et al.* 2017; Mariel *et al.* 2021). Second, we incorporated a map in the choice tasks, enabling respondents to discern the geographical locations of policy measures across different parts of the country. Therefore, the exploration of policy choices among respondents residing in various areas covered by this study is not only interesting but also justified. This spatial perspective adds a valuable dimension to the analysis, considering the regional variations in potential policy impacts and acceptance.

2. Case study, material, and methods

2.1. Climate change mitigation policies: wind power, climate-friendly forestry, and peatland restoration

Estimates suggest that a significant upswing in renewable electricity production is imperative to meet the target of reducing GHGs and achieving a carbon-neutral society by 2035, as outlined by the Government of Finland in 2019. This necessitates further expansion in wind power infrastructure. The growth of wind power production has been remarkable; in 2010, its installed capacity stood at 197 kW, surging to 4,037 kW by 2022, contributing over 10% to Finland's electricity consumption (Stenberg and Holttinen 2011; Finnish Wind Power Association 2022). During this period, the number of turbines escalated from 106 to 1,112, primarily concentrated in western Finland (Finnish Wind Power Association 2022). The western region's wind-friendly conditions make it a strategic hub for wind power production (Paaso and Khosravi 2021). Given Finland's sparse population and extensive coastline, considerable potential exists for future wind power installations (Fingrid 2021).

Finland, boasting 86% forested land, totaling 263,000 km^2, stands as one of the most densely forested nations globally (Kulju *et al.* 2023). With judicious management practices, the country can harness its substantial potential for carbon sequestration in trees and soil (Hynynen *et al*. 2015). In recent years, forests have served as a carbon sink, offsetting roughly a third of Finland's total emissions (Hynynen 2021). However, due to heightened logging and diminished carbon sequestration, the land-use sector (LULUCF) turned into a net GHG source in 2021 (Haakana *et al*. 2022). Optimizing forest management practices, including continuous cover forestry, prolonged rotation, and increased retention trees, could bolster carbon sequestration. Continuous cover forestry, particularly in peatland forests, stands out as an effective CO_2 sequestration method (Nieminen *et al*. 2018), simultaneously minimizing impacts on the forest landscape and biodiversity (Pukkala 2016; Manning and Walmsley 2018). Extending rotation time and augmenting retention trees are additional strategies for forest owners to potentially enhance carbon storage and biodiversity (Foley, Richter, and Galik 2009; Santaniello 2017). The prime opportunities for climate-friendly forest measures are concentrated in the central and eastern regions, while southern and western areas are more predisposed to agriculture (Niemi and Ahlstedt 2008). Wind farm construction near the Russian border in the east faces limitations due to national defense concerns, as turbines may interfere with military radar operations (Lindgren *et al*. 2013).

Over a quarter of Finland's expanse comprises peatland, with approximately 60% of the original 104,000 km^2 drained between the 1950s and 1970s (Alm *et al*. 2007). Peatland drainage releases GHGs, and restoration through rewetting can restore these areas to their natural state, fostering increased carbon sequestration (Loisel *et al*. 2021; Strack *et al*. 2022). Presently, around 300 km^2 of Finnish peatlands have been restored (Ojanen *et al*. 2020). However, policy measures regarding peatlands are constrained due to their prevalent existence in the larger western and northern parts of the country.

2.2. Data collection and questionnaire

Data collection for this study involved surveying individuals aged over 18 residing in Finland. Initially, draft questionnaires were shared with a select group of both experts and laypeople, inviting suggestions for improvements. Subsequently, a pilot study, involving 200 respondents, further validated the questions and supported the selection of attribute levels. The choice tasks were presented through different modes, either with map illustrations (refer to Figure 1) or using texts and tables. Given the effectiveness of the map version, it was employed in the main survey.

We developed the choice design for the questionnaire using a Bayesian efficient design that was optimized for D-efficiency, employing the N-Gene version 1.2.1 software (Ngene 2018). D-efficiency, as described by Rose and Bliemer (2009), pertains to the effectiveness of the experimental design in extracting information from respondents while maximizing statistical efficiency and minimizing the variability of parameter estimates. Priors for the design were informed by the pilot study. The optimization process focused on the attribute levels of the measures, neglecting the attribute levels of the outcomes due to the correlation between the measures and outcomes. In total, 36 choice tasks were generated and organized into six blocks for respondents, ensuring each participant received six choice tasks. The D-error at the generation stage was calculated to be 0.066.

The main survey transpired online during April–May 2022, outsourced to a commercial survey company tapping into a volunteer Internet panel of 24,670 members. The sample exhibited representativeness in terms of age, gender, geographical location,

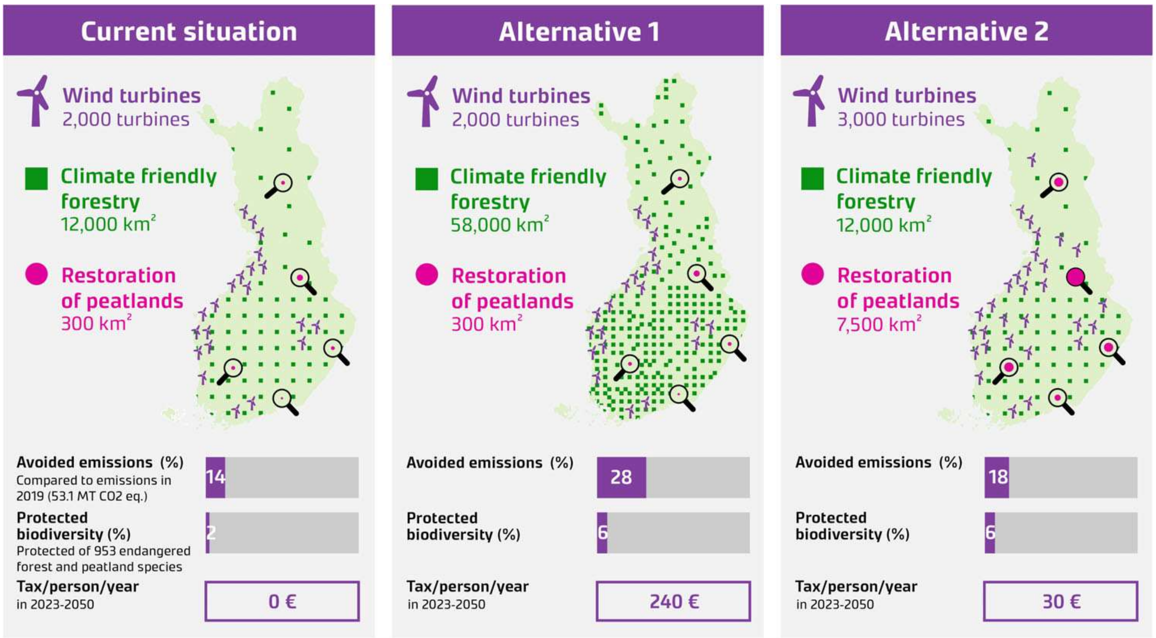

Figure 1. An example of a choice task used in the CE survey.

and income group, resulting in 2,103 responses and a 17.3% response rate. The final English-translated version of the questionnaire is available online as a Supplementary Material to this article.

The survey questionnaire comprised five sections: the first explored respondents' environmental surroundings and their connection with nature, the second delved into climate change information and associated attitudes, the third introduced three policy measures for climate change mitigation, the fourth centered on the CE scenario and related choice tasks, and the fifth gathered socioeconomic information, including residence and income.

Motivating respondents, the valuation scenario underscored the impact of policies not just on carbon sinks but also on forest and peatland landscapes and biodiversity. Costs associated with policies, such as peatland restoration and carbon sequestration in forests, were mentioned. The survey informed participants that subsidies for policy implementation would be funded by tax increases for all Finns. The construction of wind turbines, deemed profitable (Alonzo *et al.* 2022; Huttunen 2017; Lahti 2021), was anticipated to increase, though the exact number and locations depended on regional planning and permit grants. The implementation of measures was slated to commence in 2023, with outcomes materializing by 2050.

To determine the realistic levels of attributes for the policy measures and their outcomes in the choice tasks, we employed a range of pertinent studies, impact assessments, and strategy reports. The starting point for defining attribute levels was the decision of the previous Finnish government to strive for the country's carbon neutrality by 2035 and carbon negativity shortly thereafter (Government of Finland 2019). For the detailed selection of attribute levels, we initially assessed the potential and effects of a sustainable and carbon-neutral energy system and the development of new wind power capacity, drawing insights from reports by Lehtilä *et al.* (2014), Rinne *et al.* (2018), Huttunen (2017), Finnish Wind Power Association (2020), Gasum (2020), and Koljonen *et al.* (2020). Subsequently, we examined the opportunities and outcomes of climate-friendly forestry, utilizing literature on extended forest rotation

(Heinonen *et al.* 2017; Hynynen 2021; Pukkala 2018, 2022; Mäkelä *et al.* 2023), continuous cover forestry (Pukkala 2016; Lehtonen *et al.* 2021b; Mäkelä *et al.* 2023), and retention trees (Lehtonen *et al.* 2021a; Mäkelä *et al.* 2023). In the third phase, we evaluated the possibilities of peatland restoration based on references, such as the Ministry of Agriculture and Forestry (2011), Wilson *et al.* (2016), Koskinen *et al.* (2017), and Tolvanen *et al.* (2018). Additionally, we referred to reports by Pukkala (2016), Heinonen *et al.* (2017), and Mäkelä *et al.* (2023) as background material to assess the impact of the measures on avoided GHGs. For insights into protected biodiversity, we consulted Saaristo, Mannerkoski, and Kaipiainen-Väre (2010), Kotiaho *et al.* (2015), Pukkala (2016), Heinonen *et al.* (2017), Hyvärinen *et al.* (2019), and Mäkelä *et al.* (2023). Since the outcomes are inherently contingent on the scope of the measures, we calculated attribute levels for outcomes using literature to ensure a realistic alignment with the measures. Drawing on several separate discussions with experts from diverse scientific disciplines and professions, we evaluated literature-based attribute levels for the policy measures and outcomes, ultimately defining the attribute levels for the pilot study.

Each participant encountered six choice tasks, encompassing the current situation and two hypothetical policy combinations (Figure 1). Respondents were required to select the most suitable alternative. In the current situation, all attribute levels mirrored the current state, where the tax attribute was zero due to the absence of a comparable tax in Finland. In each policy combination, the levels of three measures, as detailed in Table 1, underwent variation. The annual tax cost imposed on respondents throughout the project duration (2023–2050) was subject to random variation, spanning levels from €30 to €960. During the decision-making process, respondents had the opportunity to visually assess the spatial impact of policy measures at different levels, facilitated by the presentation of measure locations on maps (see Figure 1).

2.3. Econometric modeling

The modeling of choices in CE is grounded in McFadden's (1974) Random Utility Model (RUM), assuming that individuals opt for the alternative offering the highest

Table 1. Attributes and levels used in the choice experiment.

Attributes	Levels
Policy measures	
Number of wind turbines	2,000 (status quo, SQ), 3,000, 4,000
Surface area of climate-friendly forestry (km^2)	12,000 (SQ), 34,000, 58,000**
Surface area of peatland restoration (km^2)	300 (SQ), 2,500, 7,500***
Outcomes	
Avoided GHGs compared to 2019 emissions (%)	18 (SQ), 28, 37
Protected biodiversity, % of 953 endangered forest and peatland species	3 (SQ), 6, 9
Tax/person/year 2023–2050	€0 (SQ*), €30, €60, €120, €240, €480 and €960

Note: *In the current situation, the tax or tax increase was €0, while the policy combinations always had a tax of more than €0.
**22.1% of area of forest land.
***7.2% of original area of peatland.

utility in a given choice task. The utility of an alternative is contingent upon observed attributes, represented by explanatory variables in the utility function, and unobserved attributes, treated as random variables.

For the statistical analysis of choices in CE, we employed a mixed logit or random parameters logit (RPL) model, allowing for individual preference heterogeneity by incorporating random parameters for the attributes (Hensher, Rose, and Greene 2005; Train 2009). These random parameters, varying across individuals, capture the diversity in preferences. To explore whether spatial regions contribute to preference heterogeneity, we introduced variables accounting for the interaction between the respondent's location and the attributes (Moreaux *et al*. 2023). Coefficients for environmental attributes and the alternative-specific constant (ASC[1]) for selecting the SQ option were modeled with a normal distribution. To constrain the cost attribute coefficient to negative values, a one-sided triangular distribution was applied. Coefficients for attributes were assumed to be constant across choice tasks for each respondent. The estimated models provide mean coefficients and their standard deviations for individual coefficients.

Given the realistic correlation between attributes for policy measures and outcomes, we estimated two separate models – one for policy measures and another for outcomes. To incorporate the regional effect, person-specific interaction variables reflecting spatial influences on attribute valuation were included in the models. The models were specified in the WTP space (Train and Weeks 2005; Sonnier, Ainslie, and Otter 2007), and maximum likelihood was simulated using 1,000 Halton draws. The welfare effects of alternative policy options were quantified using the compensating variation[2] (CV) formula (Hanemann 1982).

2.4. Variables used in the analysis

Table 2 outlines the variables utilized in estimating the four RPL models, encompassing hypothetical policy measures and their corresponding outcomes. Given the diverse attitudes toward wind power, we refrained from making a priori assumptions about the signs of coefficients for the number of turbines (TURB3 and TURB4) (Johansson and Laike 2007; Swofford and Slattery 2010). Conversely, we anticipated positive coefficients for variables associated with climate-friendly forestry (FOR34 and FOR58) and restored peatlands (PEAT25 and PEAT75), indicating a preference for an augmentation in these attributes.

Respondents were categorized based on their place of residence into four regions: the capital region (CR), west coast, central or eastern Finland, and northern Finland. Exploring interactions between attribute-based variables and residential areas unveiled two significant interaction variables in the policy measures model (CR_TURB4, CR_FOR58, see Table 2).

In the outcomes model, the first two variables (EMIS28 and EMIS37) described the extent of avoided GHGs. The subsequent variables (BIOD6 and BIOD9) illuminated the safeguarding of endangered species. Divergent intensities of policy measures related to climate-friendly forestry (extended forest rotation, continuous cover forestry, increased number of retention trees) and varying peatland restoration surface areas would determine the levels of GHG emission reductions and biodiversity protection. Positive coefficients were expected for both sets of variables, indicating a preference for increases in these attributes. Moreover, two significant interaction variables in the

Table 2. Description and descriptive statistics of the regressors used in the RPL models.

Variable	Description
Dependent variable	
Choice	Choice of an attribute combination; binary variable, 1 = yes, 0 = no.
Independent variables in RPL models	
Model of measure related to land use	
TURB3	Increase of 1,000 turbines from the current 2,000 to 3,000 turbines; binary variable, 1 = yes, 0 = no.
TURB4	Increase of 2,000 turbines from the current 2,000 to 4,000 turbines; binary variable, 1 = yes, 0 = no.
FOR34	Increase in climate-friendly forestry from the current 12,000 km^2 to 34,000 km^2; binary variable, 1 = yes, 0 = no.
FOR58	Increase in climate-friendly forestry from the current 12,000 km^2 to 58,000 km^2; binary variable, 1 = yes, 0 = no.
PEAT25	Increase in restored peatlands from the current 300 km^2 to 2,500 km^2; binary variable, 1 = yes, 0 = no.
PEAT75	Increase in restored peatlands from the current 300 km^2 to 7,500 km^2; binary variable, 1 = yes, 0 = no.
CR_TURB4	People living in CR[a] * TURB4, binary interaction variable; 1 = yes, 0 = no.
CR_FOR58	People living in CR* FOR58, binary interaction variable; 1 = yes, 0 = no.
TAX	Increase in taxes; continuous variable with levels of €0, €30, €60, €120, €240, €480, and €960/year.
Model of the outcomes of land use policy measures	
EMIS28	Avoided GHGs 28% compared to 2019 emissions; binary variable, 1 = yes, 0 = no.
EMIS37	Avoided GHGs 37% compared to 2019 emissions; binary variable, 1 = yes, 0 = no.
BIOD6	Protected biodiversity 6% of endangered species; binary variable, 1 = yes, 0 = no.
BIOD9	Protected biodiversity 9% of endangered species; binary variable, 1 = yes, 0 = no.
CR_EMIS37	People living in CR * EMIS37, binary interaction variable; 1 = yes, 0 = no.
CR_BIOD9	People living in CR * BIOD9, binary interaction variable; 1 = yes, 0 = no.
TAX	Definition, see above.

Note: [a]CR: capital region

outcomes model were associated with the respondents' region of residence, both linked to the capital region, i.e. CR_EMIS37 for avoided GHG emissions and CR_BIOD9 for protected biodiversity. The final attribute in both models pertained to a tax increase, for which a negative coefficient was anticipated.

3. Results

3.1. Descriptive results

In this section, we delve into the descriptive findings, exploring the impact of respondents' regional residence on the selection of various attribute levels. We do this by illustrating the percentages of respondents choosing alternatives representing each attribute level in distinct geographic regions, without factoring in other attributes. Figure 2 portrays the distribution of choices based on tax levels in CR (31.2% of respondents), the west coast (25.8%), central or eastern Finland (40.7%), and northern Finland (2.4%) across survey choice tasks. Notably, the percentage of respondents opting for the SQ varied significantly among regions, with CR displaying the lowest (30.7%) and northern Finland the highest percentage (53.1%). For the initial tax level (€30), the proportions of choices were notably smaller (11.8–13.9%), with minimal differences between regions. However, for higher tax levels, the proportions decreased more gradually, reaching their minimum at €960. Remarkably, higher taxes saw the highest proportion of respondents in CR choosing that level, whereas northern Finland had the lowest.

Subsequently, we examine how respondents' regional residence influences the selection of levels for policy measures and their outcomes. Figure 3 mirrors the trends in respondents' reactions to attribute levels in the four regions. Residents of CR exhibited the lowest frequency of choosing the SQ across all attributes, while those in northern Finland did so most frequently. Conversely, the order for other attribute levels was typically reversed. Interestingly, more than half of residents in all regions opted for the SQ when it came to the turbine number (2,000), suggesting a notable opposition to extensive wind power construction.

Turning to the outcomes, less than half of CR respondents chose the lowest level of avoided GHGs (49.4%) and protected biodiversity (45.7%). In contrast, figures for other regions ranged from 59.2% to 66.0% and from 55.4% to 61.2%, respectively

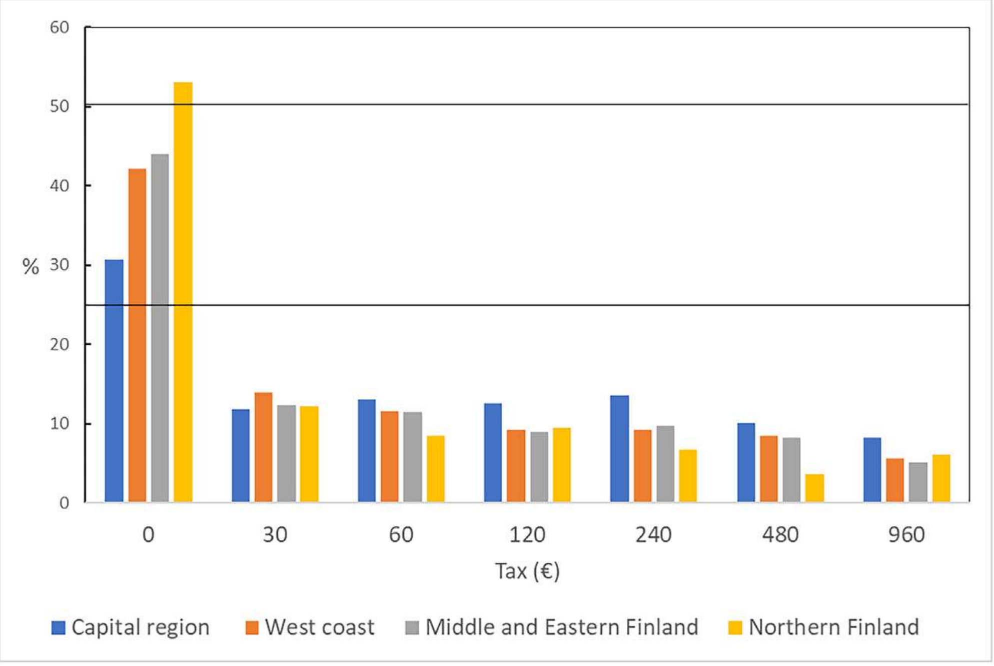

Figure 2. The proportions of respondents from the four regions in Finland willing to pay different levels of increased taxes in relation to the different attribute levels of policy measures and outcomes.

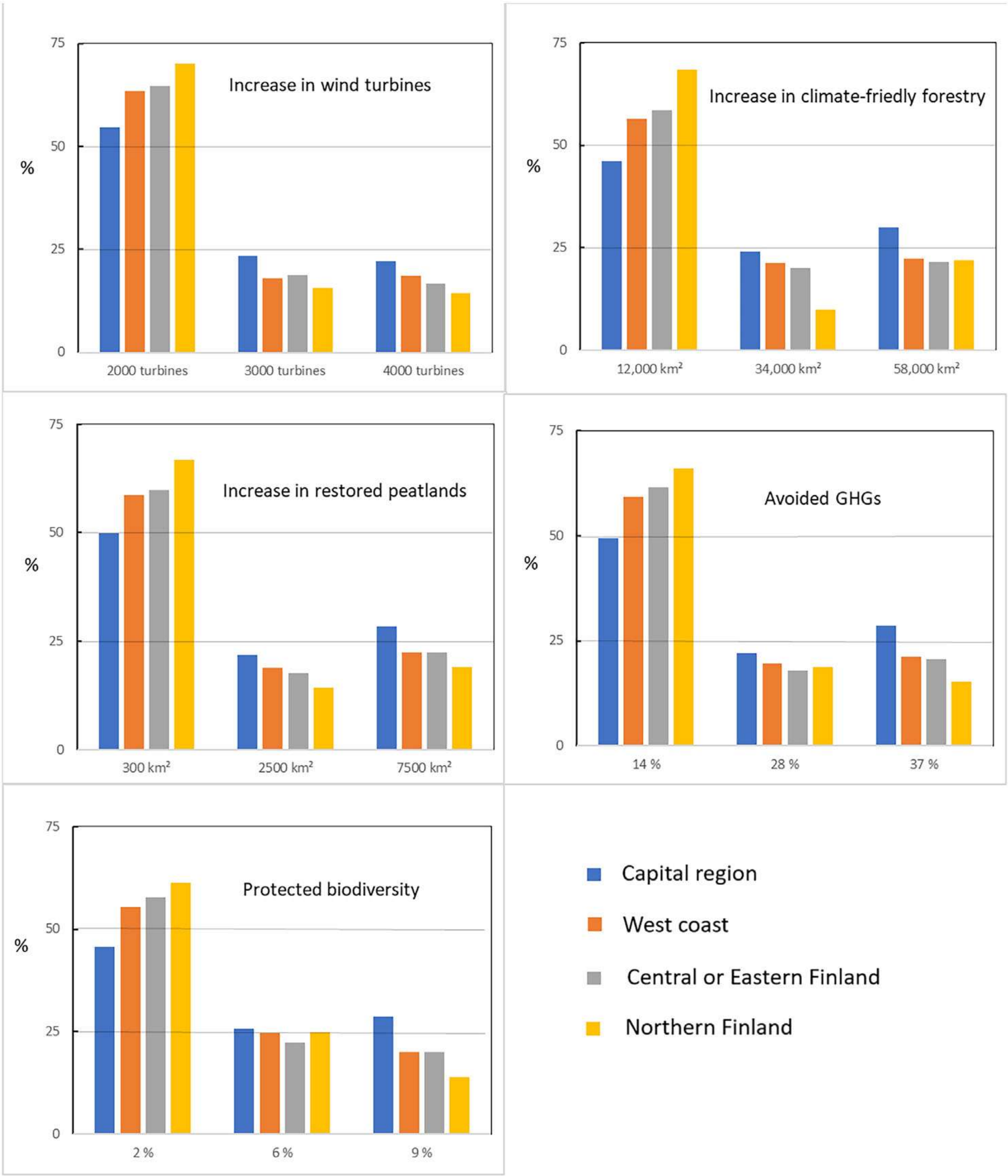

Figure 3. The proportion of respondents from the four regions of Finland choosing different attribute levels for an increase in wind turbines, climate-friendly forestry, and restored peatlands, avoided GHG emissions, and protected biodiversity.

(Figure 3). Notably, respondents expressed a more positive attitude toward biodiversity protection, with the proportion choosing the SQ varying between 45.7% (CR) and 61.2% (northern Finland).

3.2. RPL models of the policy measures

The RPL models for policy measure valuation, specified in WTP space, provided valuable insights into respondent preferences. The first model (RPL1), lacking interaction variables, and the second model (RPL2), featuring interaction variables linked to the respondents' region of residence, both exhibited significant negative coefficients for ASCs. These findings indicated a preference for alternatives involving change over the SQ, suggesting that compensation would be warranted if the proposed policy measures were not implemented. In the case of RPL1 (Table 3), this translated to an average annual compensation request of €163.25 if the current policy prevailed over the presented measures.

As anticipated, variables associated with climate-friendly forestry and peatland restoration displayed significant positive signs in both models. Similarly, the coefficients for different levels of wind turbines exhibited significant positive signs, suggesting that respondents were willing to pay for the proposed measures, including increased turbine construction. Notably, marginal WTP values were higher for the highest attribute level across all attributes, although the increase was non-linear, displaying a decreasing trend.

The coefficients for CR_TURB4 and CR_FOR58 shed light on the regional aspect, indicating that residents in CR were willing to pay an additional €44.37 annually for

Table 3. Results of the two RPL models for policy measures, one without interaction variables and the other with interaction variables, regarding the valuation of alternative land use policy measures specified in WTP space in Finland.

	RPL1 model without interaction variables		RPL2 model with interaction variables	
Variable	Coefficient	Std error	Coefficient	Std error
Means				
ASC	−163.25***	32.06	−169.96***	33.27
TURB3	88.76***	7.87	87.18***	8.05
TURB4	97.61***	9.54	82.78***	11.42
FOR34	124.03***	8.05	123.53***	8.13
FOR58	209.46***	10.16	177.56***	11.83
PEAT25	87.10***	9.17	84.67***	9.30
PEAT75	162.09***	8.52	160.71***	8.53
CR_TURB4			44.37**	19.61
CR_FOR58			101.06***	19.59
Standard dev				
NsASC	1,106.65***	39.68	1,101.31***	39.85
NsTURB3	49.19	27.49	63.95***	22.38
NsTURB4	202.46***	12.84	106.24***	1.13
NsFOR34	2.34	101.70	10.86	74.14
NsFOR58	226.39***	13.12	217.12***	15.23
NsPEAT25	5.22	99.03	1.90	79.37
NsPEAT75	88.28***	13.98	88.17***	14.18
NsCR_TURB4			116.24	49.60
NsCR_FOR58			90.88	64.53
Coefficient on TAX in preference space form				
Beta0TAX	0.0059***	0.0002	0.0059***	0.0002
S_b0_TAX	0.0059***	0.0002	0.0059***	0.0002
Fit statistics				
Log-likelihood function		−9,522.84		−9,506.31
McFadden Pseudo R2		0.299		0.300
AIC		19,075.7		19,050.6
AIC/N		1.543		1.541

Note: The coefficients indicate marginal WTP values for changes from the SQ to the levels of dummy coded attributes. Number of respondents 2,062.

***Significant at the 0.01 level.

**Significant at the 0.05 level.

an increase in turbines to 4,000 and €101.06 more for an increase in climate-friendly forestry to 58,000 hectares compared to respondents from other regions. A comparison between RPL1 and RPL2 suggested that the addition of CR_TURB4 and CR_FOR58 influenced the coefficients of TURB4 and FOR58. It is noteworthy that the coefficients of standard deviations for the random variables TURB3, TURB4, FOR58, and PEAT75 were significant, highlighting the heterogeneity in respondent preferences for these variables in both models.

3.3. RPL models of the policy outcomes

Table 4 details the results of two RPL models, RPL3 and RPL4, assessing the valuation of alternative policy outcomes in WTP space, the first without and the second with interaction variables related to the respondents' region of residence. In both models, ASCs exhibited significant negative coefficients, implying that respondents would require annual compensation if prevailing outcomes were realized instead of those associated with the proposed measures.

Table 4. Results of two RPL models for policy outcomes, one without interaction variables and the other with interaction variables, regarding the valuation of alternative land use policy outcomes specified in WTP space in Finland.

	RPL3 model without interaction variables		RPL4 model with interaction variables	
Variable	Coefficient	Std error	Coefficient	Std error
Means				
ASC	−243.44***	32.31	−275.52***	31.16
EMIS28	128.74***	10.02	127.38***	10.06
EMIS37	99.46***	13.32	74.30***	15.87
BIOD6	118.81***	13.29	116.74***	13.15
BIOD9	156.47***	14.26	120.06***	16.40
CR_EMIS37			77.57***	26.98
CR_BIOD9			108.76***	26.33
Standard dev				
NsASC	1,074.12***	37.41	1,071.32***	37.24
NsEMIS28	15.95	110.06	19.167	98.00
NsEMIS37	297.32***	17.16	290.11***	19.85
NsBIOD6	2.21	138.86	6.253	156.59
NsBIOD9	316.99***	16.55	302.33***	18.53
NsCR_EMIS37			128.05*	75.35
NsCR_BIOD9			89.69	97.20
Coefficient on TAX in preference space form				
Beta0TAX	0.0061***	0.0002	0.0062***	0.0002
S_b0_TAX	0.0061***	0.0002	0.0062***	0.0002
Fit statistics				
Log-likelihood function		−9219.23		−9195.78
McFadden Pseudo R2		0.321		0.323
AIC		18,460.5		18,421.6
AIC/N		1.493		1.490

Note: The coefficients indicate marginal WTP values for changes from the SQ to the levels of dummy coded attributes. Number of respondents 2,062.
***Significant at the 0.01 level.
*Significant at the 0.10 level.

Notably, all variables in the models displayed significant positive coefficients, indicating that respondents were willing to pay for the anticipated benefits of avoided GHGs and biodiversity protection resulting from the proposed measures. The coefficients for CR_EMIS37 and CR_BIOD9 suggested that respondents in CR were willing to pay more for increasing carbon sinks and biodiversity protection than respondents from other regions. Additionally, significant standard deviation coefficients for the random variables EMIS37, BIOD9, and CR_EMIS37 highlighted the heterogeneity in respondent preferences for these variables.

Comparing the models for policy measures and outcomes, it is observed that the absolute values of ASCs in the outcomes models were notably higher than in the former models. Common to both RPL2 and RPL4 were the emergence of CR in the interaction terms related to residential regions. Furthermore, models RPL2 and RPL4 resembled each other in the coefficients of TAX, indicating consistency in the impact of tax-related attributes across both policy measures and their outcomes.

3.4. Comparison of the combinations of policy measures or outcomes

Table 5 provides a comprehensive overview of the welfare effects resulting from different combinations of policy measures, derived from the results of RPL1. The possible policy programs, spanning the period 2023–2050, align with the target years of the CE survey. Two primary programs, “Minimum measures” and “Maximum measures,” were established, representing the lower and upper levels of all attributes, respectively. The associated WTPs for these programs were €299.9 and €469.2 per person per year, respectively.

Additionally, three specialized programs – “Wind Power emphasis,” “Forestry emphasis,” and “Peatland emphasis” – were delineated, each emphasizing one specific measure at a higher level while maintaining the other two at lower levels. For instance, in “Wind Power emphasis,” the number of turbines was elevated while climate-friendly forestry and peatland restoration were at lower levels. The average annual WTP for these programs was €308.7 for “Wind Power emphasis,” €385.3 for “Forestry emphasis,” and €374.9 for “Peatland emphasis.” This analysis reveals that an increase in wind power has a comparatively smaller impact on WTP than an increase in climate-friendly forestry or peatland restoration.

Table 6 extends the illustration of welfare effects, focusing on policy outcomes based on RPL3 from Table 4. Similar to Table 5, we defined possible policy programs, such as “Minimum outcomes” and “Maximum outcomes,” alongside intermediate programs – “GHG emphasis” and “Biodiversity emphasis.” Notably, the average annual WTP values per person for land use policy outcomes ranged from €218.3 for “GHG emphasis” to €285.2 for “Biodiversity emphasis.” This emphasizes that enhancing biodiversity levels to the maximum has a more pronounced impact on WTP than elevating carbon sinks to their maximum levels.

4. Discussion and conclusions

The examination of citizens’ preferences regarding climate-mitigating policy options in Finland revealed three primary findings. First, respondents, on average, expressed an annual willingness to financially support the implementation of proposed policy measures aimed at reducing GHG emissions and enhancing carbon sinks. Specifically, they

Table 5. Comparison of compensating variations (CV) for the potential programs of policy measures in Finland by 2050.

		Possible policy programs				
Attribute	Variable	Minimum measures	Wind power emphasis	Forestry emphasis	Peatland mphasis	Maximum measures
Wind turbines	TURB3	1	0	1	1	0
	TURB4	0	1	0	0	1
Climate-friendly forestry	FOR34	1	1	0	1	0
	FOR58	0	0	1	0	1
Peatland restoration	PEAT25	1	1	1	0	0
	PEAT75	0	0	0	1	1
	CV/person/year	299.9	308.7	385.3	374.9	469.2
	95% Conf. interval	250.7–349.1	256.3–361.9	332.0–438.6	327.0–422.7	413.9–524.5

Table 6. Comparison of compensating variations (CV) for potential programs of policy outcomes in Finland by 2050.

		Possible policy programs			
Attribute	Variable	Minimum outcomes	GHG emphasis	Biodiversity emphasis	Maximum outcomes
Avoided GHGs	EMIS28	1	0	1	0
	EMIS37	0	1	0	1
Protected biodiversity	BIOD6	1	1	0	0
	BIOD9	0	0	1	1
	CV	247.6	218.3	285.2	255.9
	95% Conf. interval	201.9–293.2	166.1–270.4	237.6–332.8	201.9–310.0

indicated a WTP of €97.61 for the highest quantity of wind turbines, €209.46 for the most substantial expansion of climate-friendly forestry, and €162.09 for the greatest increase in peatland restoration. Additionally, respondents were willing to pay for the proposed outcomes of these measures, with figures of €99.46 for the maximum GHG avoidance and €156.47 for the most significant increase in biodiversity. It is important to note that while marginal WTP values were generally highest at the upper levels of both measures and outcomes, the incremental rise in marginal WTP was non-linear, exhibiting a decreasing trend.

The presence of negative signs in ASCs suggested a preference among individuals for alternatives involving a departure from the current state. Consequently, compensation should be considered if the proposed policy measures are not implemented, or their anticipated outcomes are not realized. When comparing the models, it was observed that the absolute values of ASCs in the outcomes models were significantly higher than those in the measures models. The substantial constant in a model might imply that the attributes under study do not fully encompass all the effects valued by respondents. While it was anticipated that the constant would be more substantial in the measures model than in the outcomes model, given that outcomes are the attributes respondents ultimately value, this was not the case. One potential explanation for this outcome could be the omission of local outcomes, such as landscape impacts, from our considerations. Nevertheless, this finding underscores the importance of considering both measures and outcomes in the context of the CE survey.

Regarding the measures, the highest WTP values were allocated to the expansion of climate-friendly forestry, while for the outcomes, the greatest WTP was expressed for increased biodiversity protection. This alignment with our findings is reinforced by a study conducted by Caparrós *et al.* (2010), where afforestation areas of two tree species in Spain were compared. When factoring in biodiversity-scenic values, the study revealed a clear preference for the slow-growing native cork oak over eucalyptus. Our results further resonate with a CE-study by Shoyama, Managi, and Yamagata (2013) in Japan, where respondents prioritized preventing species extinction over mitigating climate change. The authors of that study recommended a comprehensive approach, integrating both climate and biodiversity goals into practical policies. Our findings agree with this recommendation, as for many endangered species, mitigating climate change is the precondition for survival.

While WTP for all measures aimed at reducing GHGs and increasing carbon sinks were positive, climate-friendly forestry garnered the highest average WTP. This result is likely influenced by the side benefits of adopting new forestry practices, which reduce clear-cuttings and enhance the presence of mature forests. Simultaneously, this approach improves the recreational opportunities offered by forests, a factor of significant importance for Finns (Karppinen, Hänninen, and Horne 2020; Juutinen, Kosenius, and Ovaskainen 2014). Conversely, the lower WTP for wind power extension may be attributed to the contentious nature of wind power among Finns (Janhunen 2018) and public awareness of the landscape damage caused by turbines (Zerrahn 2017; Mäntymaa, Pouta, and Hiedanpää 2021). Additionally, concerns about the negative impact of turbine placement on endangered forest and peatland species, including birds, bats, and mammals, contribute to this lower valuation (Tolvanen *et al.* 2023). Consequently, our study aligns with various Finnish attitude studies.

Second, our analysis identified heterogeneity in WTP related to both measures and outcomes, depending on the respondent's region of residence. Respondents in the country's most populated area, CR, demonstrated a higher WTP for increased wind turbines, expanded climate-friendly forestry, reduced GHG emissions, and increased biodiversity. CR has the lowest proportion of undeveloped environment per inhabitant and exhibits the lowest dependence on forestry. Previous research has yielded mixed conclusions about whether urban dwellers are generally more environmentally concerned than their rural counterparts (Yu 2014; Arcury and Christianson 1993). The observed heterogeneity aligns with common phenomena associated with the values of ecosystem services, influenced by locational differences and geographical areas (Foelske and van Riper 2020; Ali *et al.* 2023; Moreaux *et al.* 2023). Such preference heterogeneity may stem from spatial variations in values and preferences (Bergmann, Colombo, and Hanley 2008) or the spatial distribution of policy measures and outcomes (Moreaux *et al.* 2023). In Finland, residents in CR often exhibit distinct attitudes and values compared to those in other regions (Koskela 2008; Jartti, Rantala, and Litmanen 2014). Furthermore, we found preference heterogeneity beyond residential regions, possibly influenced by regional social and cultural atmospheres. A more detailed analysis of this aspect is warranted in future studies.

Third, in order to assess citizens' WTP for various policy combinations, we formulated alternative programs for both the measures and outcomes. Notably, concerning the measures, it is significant to highlight that a policy program focusing on the expansion of wind power demonstrates a lower increase in WTP compared to programs that enhance either climate-friendly forestry or peatlands restoration. On the other hand, when it comes to the outcomes, a program aimed at improving biodiversity levels substantially boosts WTP compared to a program increasing the level of avoided emissions.

Concerning the programs for the measures, the average annual WTP per person varied from €299.9 to €469.2. Using these figures, we calculated national aggregate monetary values by multiplying the average annual WTP per person by the Finnish adult population, which was approximately 4.5 million in 2019 (Statistics Finland 2022). This calculation resulted in €1,349.6 million for the" Minimum measures" program and €2,111.4 million for the" Maximum measures" program. As a conservative estimate, we factored in the survey's response rate (17.3%) and assumed a WTP of €0 for non-respondents, following the approach outlined by Bateman *et al.* (2006). With this adjustment, the aggregate WTP was €233.5 million for the" Minimum measures" program and €365.3 million for the" Maximum measures" program.

Similarly, when evaluating the outcomes of the measures across different programs, citizens, on average, demonstrated a WTP a minimum of €218.3 and a maximum of €285.2 for avoiding GHG emissions and increasing biodiversity. By extrapolating these figures to the adult population, the range extended from €982.4 to €1,283.4 million. A conservative estimation of total annual WTP yielded figures from €170.5 million to €222.0 million.

However, in the scenario where none of the presented measures were implemented, we concluded that citizens would need compensation to maintain their welfare at the current level. Using the ASCs from the models, i.e. –€163.3 for the measures and –€243.4 for the outcomes, and factoring in the total number of citizens, the results amounted to €734.9 million and €1,095.3 million. The corresponding conservative estimates were €127.1 million and €189.5 million, respectively. These amounts would need to be annually disbursed to Finns to prevent a welfare loss if the prevailing measures and outcomes were realized instead of the alternative policies related to GHGs and biodiversity.

The findings underscore the considerable WTP for policy options aimed at safeguarding the climate and biodiversity. However, assessing the magnitude of these estimates proves challenging due to the absence of comparable research on conservation projects in Finland. Yet, a partial comparison can be drawn by juxtaposing the WTP figures from this study with the costs associated with the Finnish government's HELMI habitat program, implemented from 2021 to 2030 (Gummerus-Rautiainen *et al.* 2021). The primary objective of HELMI is to enhance biodiversity through the protection of endangered habitats, with a dedicated budget of €6.2 million, specifically allocated for peatland restoration. Given that this funding aims to restore 593 km^2 of peatland, the average cost per square kilometer stands at €104,553.1. In our study, the average annual WTP for an increase in restored peatlands from 300 km^2 to 2,500 km^2 was €87.1 (Table 3). Extrapolating this to the entire population results in a generalized WTP of €392.0 million. When proportioned to the number of square kilometers stated for restoration, the aggregate WTP per km^2 amounts to €178,159.1. It is important to note that this is a conservative estimate, as it does not consider the model's ASCs, including the absence of an opt-out option in the survey (cf. Kataria 2009). Regardless, our WTP results per km^2 for peatland restoration clearly surpass the corresponding costs of HELMI, indicating that peatland restoration is economically desirable for society.

We can further contextualize our WTP results by comparing them with the financial support provided through the feed-in tariff (FIT) system by the Finnish government. This system, implemented from 2011 to 2017, aimed to subsidize new wind turbines in Finland, with support extending for 12 years after construction. The government allocated funds based on the discrepancy between the target price and the market price of electricity. For instance, in 2017, the government invested a total of €195.3 million in subsidizing wind power through FIT (Energy Authority 2018), which, adjusted for inflation to the value of money in 2022, amounts to €196.4 million. When we compare this support to Finland's adult population (4.5 million; Statistics Finland 2022), the average subsidy for wind power equates to €43.6 per person. In contrast, our study revealed that the average annual WTP to increase the number of turbines from 2,000 to 3,000 was €88.76 (Table 3), nearly double the FIT subsidy. This disparity is comprehensible in the context of heightened awareness and discourse about climate change and the imperative for non-fossil energy in recent years (Geiger, Swim, and Fraser 2017; Salonen, Siirilä, and Valtonen 2018; Ratinen and Uusiautti 2020), which likely contributed to an increased willingness of people to pay for wind energy.

Furthermore, we can draw comparisons between people's WTP for climate-friendly forest management and the allocation of funds under the Finnish government's 2023-introduced forest management incentive system, METKA. METKA provides subsidies for nature management of forests, health fertilization, the management of young and peatland forests, and forest burning to promote environmental values. In 2024, the government has earmarked €38.4 million for these subsidies, translating to €8.0 per person (Ministry of Finance Finland 2023). However, this constitutes only a small portion of the amount, €124.03 per person, that individuals in our study would be willing to pay to expand climate-friendly forestry from the existing 12,000 km^2 to 34,000 km^2.

In conclusion, based on these comparisons, we can affirm that government-implemented projects significantly contribute to enhancing people's welfare and are consequently socially profitable. Moreover, considering that the aggregated WTP figures from our study surpass the funding allocated for the programs, it indicates that Finns are prepared to allocate a substantially greater amount of funds to carbon balance and biodiversity policies than the government currently allocates.

In accordance with the recommendations of Johnston *et al.* (2017) and Mariel *et al.* (2021), we incorporated both measures and their outcomes in the same choice tasks. If the findings of Chen *et al.* (2022) are applicable to this study, it is possible that we mitigated some of the respondents' uncertainties and minimized the frequency of selecting the SQ option in the survey. Nevertheless, in our models and policy programs, we opted to treat the measures and outcomes separately, recognizing their correlation.

The data for this study were gathered in the spring of 2022, just a few months following the Russian invasion of Ukraine. At that time, the consequences of the conflict on the energy sector and prices were not immediately observable. Notably, restrictions on the trade of Russian fossil fuels had not been implemented, although public discussions on the matter were already underway. Consequently, the impact of these changes on people's attitudes and values remains uncertain. However, it is plausible that preferences for renewable national energy had experienced an increase compared to the period preceding the invasion.

The findings of this study underscore the willingness of citizens to embrace additional policy measures aimed at mitigating climate change, with a demonstrated readiness to financially contribute to achieving positive outcomes in reducing GHG emissions and enhancing biodiversity. When aggregating citizens' average WTP over the entire Finnish adult population, it translates into a substantial investment of several million euros for climate change mitigation measures and outcomes that prevent emissions and promote biodiversity.

The policy programs outlined in this study emphasize the significance of forestry-related measures that concurrently yield biodiversity outcomes in shaping effective climate policies. Nevertheless, the presence of heterogeneity in people's preferences, influenced by factors, such as residential region and associated social and cultural dynamics, implies that alternative policy combinations may yield both winners and losers. Consequently, striking a balance between socially conflicting measures necessitates careful consideration of these diverse preferences.

Notes

1. Stated by Train (2009, 24) "The alternative-specific constant for an alternative captures the average effect on utility of all factors that are not included in the model. Thus, they serve a similar function to the constant in a regression model, which also captures the average effect of all unincluded factors."
2. Compensating variation (CV) is "the amount of compensation paid or received, that will leave the consumer in his *subsequent* welfare position in the *absence of the price change* if he is free to buy any quantity of the commodity at the new price" (Bockstael and McConnell 1980).

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The authors report there are no competing interests to declare.

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Supplemental data

Supplemental data for this article can be accessed here.

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