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Using Choice Experiments as a Planning Tool for Reforestation after Extreme Events: The Case of the Vaia Windstorm in Italy

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Abstract: The forest areas and, more generally, the mountain territory, produce a significant flow of ecosystem services from which the entire community benefits. In October 2018, northeastern Italy was hit by an extreme meteorological event, the Vaia windstorm, which affected 91 municipalities in the Veneto region and destroyed nearly 20% of its forests in some areas, mainly composed of spruce (*Picea abies*) and fir (*Abies alba*). This study aims to understand and analyze what the affected population preferences are in relation to different reforestation strategies in the forests affected by the Vaia windstorm in order to have more resilient forests in the future. In this regard, a survey including a choice experiment was carried out in May 2022 involving a sample of 830 residents in the Veneto region. From our results, it emerges that a policy characterized by a mixed reforestation solution of 50% of planted area and 50% natural with fallen trees removed is the respondents' favorite reforestation policy, bringing an average benefit per year per family equal to EUR 226.5. Considering the reforestation policy proposed, the attribute considered most important (34%) was the presence of a natural forest with the removal of fallen plants, followed by reforestation with a planted forest (24%), while in third place we find the removal of fallen trees in forests damaged to a minor extent by the Vaia storm (20%).

Keywords: Vaia; storm; extreme events; climate change; discrete choice experiment; landscape; forest; reforestation; benefits; windstorm; bark beetle

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1. Introduction

The forest areas and, more generally, the mountain territory, produce a significant flow of ecosystem services from which the entire community benefits. Among these, cultural services and, in particular, those that can be grouped under the broad category of recreational services, assume particular importance. This becomes even more evident in the Alpine arch which, being located close to flat and densely populated areas (Po river plain), constitutes a vast recreational area from which the residents of the plain areas benefit. The Alpine mountains are subject to intense flows of hikers and tourists, which have significant repercussions for the local economy. In a study carried out in 2016, it was estimated that between spring and autumn, residents of the Veneto region made 10.9 million excursions in the Veneto mountains [1]. In the same year, in the mountain areas of the region, excluding winter, overnight stays amounted to 2.8 million (source: Veneto region). Using the data collected with this research, it can be estimated that the number of excursions made by residents between May 2021 and May 2022, excluding those related to skiing activities, was approximately 12.6 million.

Between Saturday 27 October and the early hours of Tuesday 30 October 2018, Italy was hit by an extreme meteorological event characterized by violent gusts of the sirocco wind (which reached speeds of up to 200 km per hour in some locations), storm surges and floods. In Veneto, the Vaia windstorm affected 91 municipalities (56 in the Belluno province, 26 in the Vicenza province and 9 in the Treviso province) and caused severe damage to

16,000 hectares of forest (4.1% of the forest assets) (Figure 1). The damage was particularly extensive in the Asiago plateau, in the Agordino and in the Alto Cadore-Comelico, where it damaged more than 20% of the forest area [2].

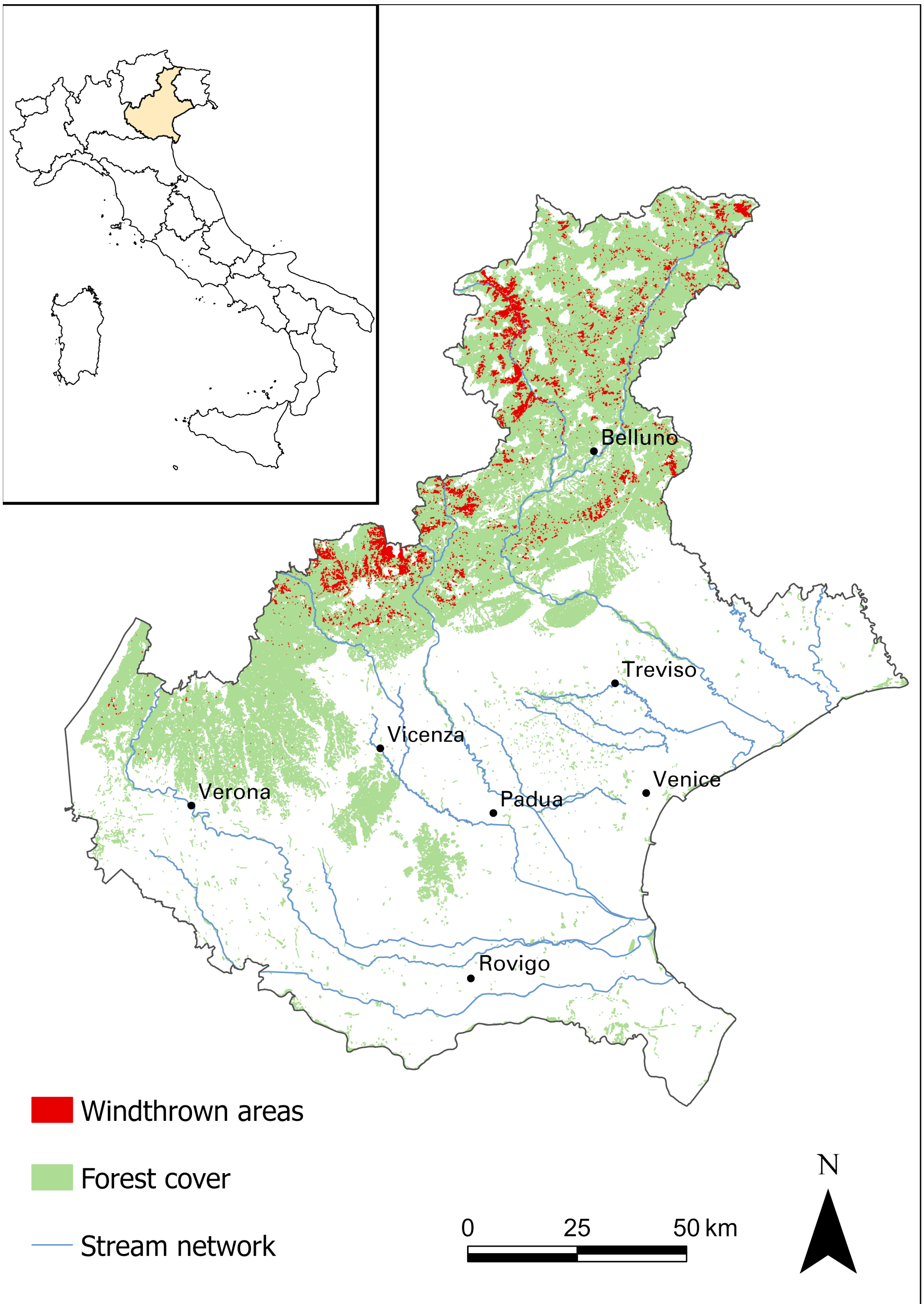

Figure 1. Map of the Veneto areas hit by the Vaia storm (courtesy by Professor Emanuele Lingua, Department of Land, Environment, Agriculture and Forestry (TESAF), Università degli Studi di Padova).

The Vaia windstorm had a double effect on the recreational use of the mountain area: it caused extensive damage to the infrastructure and trails network (Figure 2) and caused drastic changes to the landscape and environmental structure of entire valleys (Figure 3).

Figure 2. Effects of the Vaia storm: in this picture it is possible to see the fallen trees on the slope near the hiking path, and how it was necessary to restore the practicability of the hiking path by removing the fallen trees. Picture taken in January 2019 by the authors.

Figure 3. Effects of the Vaia storm: this picture shows how the storm modified the viewpoints along the hiking paths. More specifically, in this case the fallen trees were removed leaving new viewpoints on the mountains in the background. Picture taken in January 2022 by the authors.

Concerning the damage to the trails network, a study carried out by Zanotto [3] highlighted that around 20% (170 out of 889) of the total trails in the Veneto Region were damaged by the Vaia windstorm. The trails that were damaged by the Vaia windstorm and became no longer viable had a total extension of 1155 km, equal to more than 25% of the overall length of the regional trail network. However, the intervention of the CAI (Italian Alpine Club) allowed the reopening of many trails, so much so that already in November 2020 the number of trails that were not passable had halved.

A much more complex situation is the one relating to the transformations of the landscape and environment. If, on the one hand, it is evident that the impact on the forests has drastically changed the landscape, on the other hand, this has not necessarily resulted and will result in its deterioration. This will essentially depend on the choices that will be made regarding the restoration of the damaged areas and the recovery rate. In fact, different options are considered, including, among others, reforestation either with a more natural approach (nature-based solution) or with planted trees, the choice to leave some areas as meadows, and the choice to remove the fallen trees. The interventions to be implemented in the forest areas affected by Vaia should consider, among other criteria, the quality of the landscape and the landscape preferences expressed by the populations concerned, which, in the specific case of the mountain areas of the Veneto region, are made up of residents and all subjects who use them for tourist and recreational purposes. Such a need is prescribed by the European Landscape Convention (ELC) [4] signed in Florence on 20 October 2000 (and subsequently implemented in Italy by Law No. 14 of 2006) and provides a definition of landscape and some guidelines on how landscape should be considered in territorial policies.

In this regard, it should be remembered that the term landscape does not correspond to that of environment and territory. According to the ELC, "Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (art. 1, a). The landscape is therefore given by the perception of the landscape and not by the territory itself. In addition, according to the ELC, territorial policies will have to set themselves landscape quality objectives which designate 'the formulation by the competent public authorities of the aspirations of the public with regard to the landscape features of their surroundings' (art. 1, c). To this end, they will have to 'evaluate the identified landscapes, taking into account the specific values that are attributed to them by the subjects and populations concerned' (art. 6, C-b).

To value the benefits in monetary terms—as perceived by the affected population—of different restoration policies for the forests damaged by the Vaia windstorm, some methodologies are particularly informative. Such methodologies belong to the family of 'stated preferences methods', given that they allow valuing such benefits ex-ante, namely before the implementation of the policies. Stated preference methods include Contingent Valuation (CV) [5] and Discrete Choice Experiments (DCEs) [6,7]. Considering these two valuation approaches, despite the fact that both allow performing a monetary estimation of the benefits, DCEs are more appropriate to value different policy options and to detect respondents' preferences for such options. In fact, while CV detects the benefits of applying a single policy compared with another policy scenario (usually the status-quo), DCE allows estimating the benefits of the characteristics (attributes) of different policies, that, in our case, will affect the landscape. For such a reason, given that in our case we will compare more than two potential policies, in our study we decided to opt for the application of DCEs in order to fulfill the requirements of the ELC and estimate the preferences of the people affected by the Vaia windstorm with regard to the future landscape setting of their forests. Given that in our valuation scenario we are considering restoration policies after an extreme event, we will also consider the proposed policies in terms of the resilience of the affected territories towards future events.

The available literature has explored the individual's preferences toward forest management in various locations by the application of choice experiments and mostly found that visitors prefer natural forests with little intervention while the utility decreases for those landscapes marked by intense harvesting or artificial planting activities (Mostegl et al. [8], Giergiczny et al. [9], De Valck et al. [10], Upton et al. [11]). Some authors focused on structural attributes of the forest, such as the age distribution, tree species, spacing among trees, presence of understory and presence/quantity of deadwood (Mostegl et al. [8], Giergiczny et al. [9], Müller et al. [12], Arnberger et al. [13], Nielsen et al. [14]), whereas others used land use distribution, such as the percentage of natural regeneration as opposed to a planted forest or agriculture (Iversen et al. [15], Shoyama et al. [16], Vecchiato and Tempesta [17]). By using those attributes, the literature explored whether there were trade-offs among eco-tourism, forestry and biodiversity (e.g., Arnberger et al. [13], Sacher et al. [18], Riccioli et al. [19], Mäntymaa et al. [20], Horne et al. [21]); however, none focused on forest management and landscape aspects after an extreme event or on the resilience of the forest considering future extreme events. For example, Nielsen et al. [14] investigated public preferences and WTP for variations in forest characteristics which are likely to be affected when subjecting stands to nature-based forest management. The forest characteristics considered were tree species composition, tree height structure and presence of dead trees left for natural decay. The result of the study indicates that preferences for variation and naturalness of forests increase recreational benefits associated with the visually more diverse structures likely to develop in nature-based forests. Given the purpose and context of the study of Nielsen et al. [14], forest resilience was not taken into account. Unterberger and Olschewski [22] designed a choice experiment to elicit preferences of Swiss households for funding forest management practices aimed at reducing avalanche and rock fall risk. Despite the fact that their choice experiment dealt with risk management and somehow extreme events (avalanches and rock falls), the authors did not take into account explicitly in the DCEs the forest management practices in terms of forest composition, but rather presented a specific attribute shaped on the objective of the forest management (in particular of the "improved forest management also leads to better protected rail and road infrastructure"). In this respect, despite having a similar aim, the study of Unterberger and Olschewski [22] approached the problem in a different way, which does not provide specific answers on the possible reforestation approaches that should be considered after extreme events such as the Vaia windstorm for restoring the landscape and improving the territory resilience.

This study aims to fill this literature gap by trying to understand and analyze what the affected population preferences are in relation to different intervention strategies to restore the woods affected by the Vaia storm. In this regard, a survey was carried out in May 2022 involving a sample of 830 residents in the Veneto region. In the first place, the survey made it possible to improve the knowledge framework relating to the tourist and recreational use of the Veneto mountains. Secondly, through a Choice Experiment, an attempt was made to identify which reforestation options are most preferred by residents of the region and the benefits in monetary terms associated with them.

2. Materials and Methods

The target area of this study is located in Northeast Italy, where the Vaia storm took place (Figure 1). The study area is characterized by alpine coniferous forests mostly composed of Norway spruce (*Picea abies*) and Silver fir (*Abies alba*) [23] between 1500 m and 2200 m above sea level with slopes varying from 20 to 45% and in a valley geologically formed by dolomite limestone [24]. The storm, characterized by wind gusts of 200 km/h, affected nearly fifty thousand hectares and felled nine million m^3 of wood in an area considered to be one of the most important wood production sites in Italy, affecting the timber market with a sudden increase in supply and a consequent decrease in price [2,23,25,26].

This study applied the Discrete Choice Experiments Methodology (DCEs) [7,27], an approach—belonging to stated preference methods [28]—first developed by Louviere and Hensher [29] and Louviere and Woodworth [30] and that has seen several applications in a plurality of fields in the last 40 years, such as environmental economics, marketing, transport studies and health economics.

The pillars of such methodology are grounded in Lancaster [31] intuition that individuals derive utility not from a good itself, but from the sum of the utilities provided by its characteristics (attributes). A further important aspect is that utility by itself is not observable (and therefore measurable), but it is possible to observe people's choices, and these depend on the utility that can be derived from the chosen good or service. In other words, a specific good (choice option) is chosen among a bundle of possibilities in a choice set if its utility is greater than the other choice options presented. It is therefore possible to derive the utility of a good by observing the probabilities of choice of the good itself, which depend on its characteristics.

In this respect, the DCE methodology is based on the creation of a hypothetical market, where people are requested to choose among a set of choice options in a choice set representing the same good or service differentiated by its attributes (characteristics). Such choice sets are created using a technique called experimental design, and data are collected by means of questionnaires. A benefit of the DCEs methodology is that, due to the fact that it is based on hypothetical markets, it allows to evaluate the benefits of landscape policies both ex-ante or ex-post, while other methods—like those belonging to the revealed preference family—only allow to perform valuations ex-post. In this respect DCEs can be used ex-ante, as we did in this study to inform the policymakers about the policy actions that will maximize residents' utility. Other applications of the DCE methodology to value the landscape benefits of the rural development plan of the Veneto Region are, for example, the studies of Tempesta and Vecchiato [32] and Tempesta and Vecchiato [1].

In the following paragraphs, we will explain in more detail the experimental design used in this study and how the questionnaire submitted to respondents was developed.

2.1. The Experimental Design

Our application of the DCE methodology, and more specifically the experimental design, was articulated in the following working phases:

1. Identification of the reforestation actions to be valued;
2. Identification of the characteristics (attributes and relative levels) differentiating the main reforestation actions;
3. Definition of the choice sets to be presented to respondents, containing different reforestation scenarios.

The first phase was organised with meetings and consultations with experts in forest science, rural landscape, landscape planning and consultations with the interested stakeholders in order to understand the possible options of reforestation and their implications in terms of resilience to future events and landscape impact. During the meetings, it emerged that four main reforestation actions could be undertaken:

1. Perform an 'artificial' reforestation planting the new trees, typically conifers;
2. To opt for a 'nature-based solution' (NBS) [33–35] letting the forest to autonomously recover, usually resulting in a more heterogeneous structure of the forest (a mix of conifers and deciduous trees depending on the altitude);
3. Remove or do not remove the fallen trees;
4. Clean some areas from fallen trees and devote them to meadows.

Respondents were informed (see Appendix A) about the potential pros and cons of the different actions. In particular, they were told that 'artificial' reforestation has the benefit to be faster but will probably provide a less resilient forest for future extreme events, while letting the forest autonomously recover will have slower growing times providing a more resilient solution.

The first phase was, therefore, propedeutic to the second phase, where, taking into consideration the outputs of this preliminary investigation, we decided to consider the following attributes (summarized in Table 1 with their respective levels) in our experimental design:

1. The surface that will be devoted to pastures and meadows;
2. The surface that will be devoted to 'artificial' reforestation, planting the new trees after removing the fallen ones;
3. The surface that will be devoted to 'natural' reforestation removing the fallen trees;
4. The surface that will be devoted to 'natural' reforestation without removing the fallen trees;
5. The removal of fallen trees also in the forest only marginally damaged by the Vaia storm;
6. The cost per family per year (for ten years) in order to contribute to the public policy.

The cost attribute was necessary in order to organize our hypothetical market, and was presented in the DCE preamble as a necessary contribution in terms of an increase in taxes per family to cover the costs of the policy action undertaken by the Veneto region.

We decided not to consider differences in the tree species planted (e.g., conifers vs. deciduous trees) among the attributes due to the fact that they depend on the altitude of the planting area, and given that the areas hit by the Vaia storm have different altitudes, this would have resulted in an unfeasible or unrealistic attribute in our DCE design.

Table 1. The attributes and levels used in the DCE design.

Attribute	Level	Acronym in Data Analysis
The area that will be left as grass or pasture	0% 50% 100%	meadows_0 meadows_50 meadows_100
The surface on which natural reforestation will be carried out by removing the felled trees	0% 50% 100%	natural_removal_0 natural_removal_50 natural_removal_100
The surface on which natural reforestation will be carried out without removing the felled trees	0% 50% 100%	natural_0 natural_50 natural_100
The area on which the artificial afforestation will be carried out	0% 50% 100%	planted_0 planted_50 planted_100
The eventual removal of fallen trees in woods damaged to a minor extent by the VAIA storm	yes no	removal
The cost that each family will have to bear for 10 years expressed in euros, in the form of a tax levy	0 5€ 20€ 35€	cost

In the third phase, we elaborated the final design that was presented to the respondents combining the attributes and levels in order to derive the choice options to be presented in the choice sets. We opted for a full profile design, removing some impossible combinations of our attributes and levels from the final design (e.g., 100% surface pastures with other potential allocations of surfaces, just to quote one case). Such process led to a final set of 49 choice options (48 choice options plus the status-quo), that were randomly combined into 16 choice sets, with 3 choice options each. An example of a choice set is presented in Table 2, and, as it can be noted, each choice set included three choice options and one 'none of them' option representing the status-quo option, namely the scenario in case no reforestation policy will be undertaken. It should be noted that the status-quo option did not imply any monetary expense for the respondents. For the interviewees to make their choices with knowledge of the facts, they were informed in advance of the possible costs and benefits of the proposed actions. The information provided to respondents in the preamble of the DCE can be found in Appendix A.

Table 2. An example of a choice set presented to respondents.

	OPTION A	OPTION B	OPTION C	NONE OF THEM
Meadows surface (%)	0	0	50	0
Planted wood surface (%)	50	50	0	0
Natural wood surface (%) with the removal of fallen trees	0	0	50	0
Natural wood surface (%) WITHOUT the removal of fallen trees	50	50	0	100
Removal of fallen trees	no	yes	no	no
Cost (€/family per year)	20	35	5	0

To avoid 'fatigue effects', the design was blocked into 4 blocks: therefore, each respondent of each block was presented 4 choice sets, rather than 16. In this way, it was possible to avoid interviewees providing random answers due to the excessive fatigue resulting from the cognitive effort necessary to analyze in sequence a very large number of choice sets. In each choice set the respondent was requested to indicate her/his favorite policy action in terms of recovering the area hit by the Vaia storm.

2.2. Discrete Choice Experiments: Data Analysis and Models Specification

The DCE data were analyzed using econometric software Stata version 16 [36].

The data analysis followed two approaches. In the first approach, data were treated in a 'classic' way, considering the single levels of the attributes (in the case of categorical variables) or the attributes themselves (in the case of continuous attributes) used in the experimental design. In the second approach ('policy mix'), we included in the model the 9 different landscape policies presented to respondents (9 in total—see Table 3) plus the dummy or continuous attributes (trees removal and cost). The first approach allowed us to analyze the preferences for the single landscape components, while the second had the benefit to provide an aggregate analysis of the same attribute levels, considering the interactions between the single attribute levels and providing a direct measure of their utility and value.

Table 3. The landscape policy mix considered in the design and data analysis (the reported values should be interpreted as the % of surface recovered).

Policy	Surface Recovered (%)			
	Meadows/Pasture	Reforestation		
		Natural	Natural with Removal	Planted
policy_1		100		
policy_2				100
policy_3	100			
policy_4			100	
policy_5			50	50
policy_6		50		50
policy_7	50			50
policy_8	50		50	
policy_9	50	50		

In the first approach the following utility function was used:

$$U_i = \sum \beta_{ij} \cdot X_{ij} + \beta_{removal} \cdot removal + \beta_{cost} \cdot cost + \varepsilon \quad (1)$$

where U_i represents the utility derived by the *i-th* choice option, β_{ij} the coefficient of the *i-th* option for the X_{ij} surface attribute level (dummy coded), *removal* represents a dummy indicating the removal of fallen trees in marginally hit areas, *cost* is the cost attribute (continuous) and ε constitutes the error term.

In the second approach the following utility function was used:

$$U_i = \sum \beta_{ij} \cdot policy_{ij} + \beta_{removal} \cdot removal + \beta_{cost} \cdot cost + \varepsilon \quad (2)$$

where $policy_{ij}$ is a dummy indicating if the *j-th* policy is present in the *i-th* option.

For each approach ('classic' and 'policy mix'), two models were estimated, a Multinomial Logit (MNL) model [37] and a Random Parameter Logit (RPL) model [38]. This choice is due to the fact that the RPL models are more sophisticated and allow taking into consideration the presence of heterogeneity in the preferences of respondents.

To derive the benefits accruing from each policy/landscape setting, the willingness to pay (WTP) of the respondents was estimated as follows:

$$WTP_i = -\frac{\beta_i}{\beta_{cost}} \quad (3)$$

where β_i is the coefficient estimated for *i-th* attribute level (or policy in the 'policy mix' approach) and β_{cost} is the coefficient estimated for the cost attribute.

The DCEs also allow deriving the relative importance given by respondents to the attributes in making their choices. As described by Kuhfeld [39] (see also Troiano et al. [40] for an application), the importance of an attribute can be computed as the ratio between (a) the part-worth utility range for each attribute; (b) the sum of all ranges. Such a ratio should then be multiplied by 100. Therefore, it is possible to determine the relative importance as:

$$AttImportance_i = \frac{[|max(\beta_i) - min(\beta_i)|] \cdot max(Z_i)}{\sum_{i=1}^{n} ([|max(\beta_i) - min(\beta_i)|] \cdot max(Z_i))} \cdot 100 \quad (4)$$

where i identifies the *i-th* attribute and Z the attribute level of the *i-th* attribute (in our case Z can be 1 if the attribute levels are coded as dummies, or the maximum value of the attribute level when dealing with continuous attributes). Considering Equation (4), $min(\beta_i)$ equals zero when an attribute is continuous rather than discrete.

2.3. The Questionnaire

The survey was handled by means of a web survey, delivered to a panel of respondents by a specialized company. The questionnaire was organized in the following sections:

1. Section 1: socio-economics questions;
2. Section 2: questions on leisure activities and holidays;
3. Section 3: analysis of landscape preferences;
4. Section 4: questions to understand the knowledge of some forest issues and on the Vaia storm;
5. Section 5: Choice Experiment;
6. Section 6: questions to understand respondents' attitudes related to environmental issues.

2.4. Data Collection

Data were collected in the month of May 2022 by means of a Computer Assisted Web Interview (CAWI) handled by a specialized company. The data collection was based on an internet-based questionnaire submitted to a panel of respondents.

The sample was stratified by gender, age and province of residence in order to be representative of the target population, which was of residents in the Veneto Region (age > 18). A total of 830 questionnaires were collected, and 774 of them were suitable and complete for the DCE data analysis.

3. Results

3.1. Sample Socio-Economic Characteristics

The respondents' socio-economic characteristics are reported in Table 4. If we consider the three variables used to stratify the sample (gender, age and the province of residence), looking at Table 4, the sample used in this study can be considered quite representative of the Veneto population, with the only caveat being that, given the fact that the data collection was internet based, people over 75 are under represented as usual. This problem is common to CAWI surveys where usually the population considered is in the 18–75 age range but also traditional mail surveys often consider such an age interval (see for example Nielsen et al. [14]).

Table 4. Interviewees socio-economic characteristics.

Variable	Levels	n	%	∑%	Veneto (%) †
Gender	Male	396	51.2	51.2	49.1
	Female	378	48.8	100.0	50.9
	all	774	100.0		
Age	18–29	138	17.8	17.8	16.2 *
	30–44	198	25.6	43.4	24.0
	45–54	174	22.5	65.9	22.7
	55–64	150	19.4	85.3	20.3
	65–75	114	14.7	100.0	16.9
	all	774	100.0		
Occupation	Agriculture	10	1.3	1.3	
	Industry or crafts	159	20.5	21.8	
	Services (commerce, public employment, etc.)	358	46.2	68.1	
	Not active (retired, student, housewife)	247	31.9	100.0	
	all	774	100.0		
Education	Elementary or lower secondary school diploma	94	12.1	12.1	
	High school diploma	406	52.5	64.6	
	Bachelor's degree	274	35.4	100.0	
	all	774	100.0		
Province of residence	Verona	142	18.4	18.4	19.1
	Vicenza	131	16.9	35.3	17.6
	Belluno	32	4.1	39.4	4.1
	Treviso	137	17.7	57.1	18.1
	Venezia	132	17.1	74.2	17.3
	Padova	167	21.6	95.7	19.2
	Rovigo	33	4.3	100.0	4.7
	all	774	100.0		
Area of residence	Plains	662	85.5	85.5	
	Hill	80	10.3	95.9	
	Mountain	32	4.1	100.0	
	all	774	100.0		

† Data refer to CENSUS 2020. Regional values are reported for the variables used to stratify the sample. * Veneto data about age classes refer to the population with an age between 18 and 75 years.

Particularly important in this study was the stratification for the province of residence, which was quite coherent with the real population of the Veneto Region. Such an aspect was crucial given that the Vaia storm did not evenly hit the territory of the Veneto Region, but residents might be interested in the stricken areas for recreational purposes anyway.

Furthermore, the fact that the sample considered is representative of the targeted population allows us to use the obtained monetary estimates (WTP expressed as EUR/family per year) to calculate the benefits of the different interventions on a regional scale. In this respect, in the Veneto region there were 2,115,034 families in 2020 according to the Census Statistics (Retrieved from the Italian National statistics (ISTAT) webpage accessed on 27 June 2023: http://dati.istat.it/Index.aspx?QueryId=18979).

3.2. Discrete Choice Experiment Results

The DCE data analysis was conducted in two ways: the first considered the single levels of the attributes included in the design, while the second considered the "policy mixes" (nine in total—Table 3) presented to respondents. Through the first approach, it was possible to analyze the preferences for the individual reforestation options, while with the second it was possible to evaluate them in an aggregate way, with the advantage of deriving the benefits linked to the interaction of the landscape components of the reforestation policy.

A multinomial Logit model (MNL) was first estimated, and data were then analyzed with a Random Parameter Logit model (RPL) to take into consideration respondents' heterogeneity. The results of the models are reported in Table 5 and Table 6, respectively, where the first table presents the results for the "classic analysis" (preferences for the single components of the reforestation policy) and the second for the "full policy".

As can be deduced from the models' statistical indices, and in particular from the McFadden adj. R^2, the RPL models have a better performance than the MNL models and, therefore, the results of these models will be commented on hereafter, while also reporting those of the MNL models for completeness.

From the results reported in Table 5 relative to the RPL-1 model, it emerges that all the coefficients are statistically significant with the exception of the 100% meadow level. The model has a good interpretative capacity (McFadden adj. R^2 = 0.15). In the model, to avoid collinearity, the 100% natural forest level was excluded, which constitutes the status-quo option (do nothing) and at the same time the reference level. From the results obtained (Table 5), it can be seen that the presence of meadows and pastures on 50% of the new surface is preferred to their absence, while their presence on 100% of the surface area is not statistically different from their absence.

As far as the reforestation methods are concerned—planting new trees or opting for a natural reforestation process (with or without removing the trees that fell during the Vaia windstorm)—it is interesting to observe how the greatest utility is given by a natural reforestation process but with the removal of fallen plants. If fallen plants are not removed, respondents prefer "artificial" reforestation with the planting of new trees.

It is also interesting to note how great importance is attributed to the removal of fallen trees in woods damaged to a minor extent by the Vaia storm, from which respondents derive particular utility, probably for two reasons: they constitute a potential limit to recreational activities (walks, mushroom picking, etc.) and at the same time favour the proliferation of bark beetle, which would threaten the healthy trees of the forest [41].

It is important to analyze which is the preferred policy option regarding the reforestation of the areas affected by the Vaia storm (RPL-2 model, Table 6). The parameters in this case must be interpreted in relation to the omitted parameter, i.e., Policy 1 (100% of the natural forest area) which constituted the status-quo. From the data reported in Table 6, it emerges that Policy 5, characterized by a mixed reforestation solution of 50% of planted area and 50% natural with fallen trees removed, is the respondents' favorite reforestation policy, followed by Policy 8 (50% meadows and pastures and 50% natural with fallen trees removed) and Policy 4 (100% natural with the removal of fallen trees). As can be deduced, the three preferred intervention options envisage the presence of a natural forest, but with the removal of fallen trees: the natural reforestation, albeit with slower times than a human-driven intervention, seems to give greater guarantees in terms of "resilience", i.e., the ability of the forest to resist future catastrophic events.

Table 5. DCE results: MNL and RPL models with 'standard' ('classic') attributes and levels.

	MNL-1		**RPL-1** †	
	β_i	**WTP** ‡	β_i	**WTP** ‡
meadows_50 *	0.460 ***	126.30	0.496 ***	61.12
	[0.355,0.565]	[−13.10,265.69]	[0.320,0.673]	[17.39,104.86]
meadows_100	0.156		−0.163	
	[−0.069,0.381]		[−0.617,0.290]	
planted_50	0.723 ***	198.70	0.966 ***	118.95
	[0.601,0.846]	[−24.61,422.00]	[0.756,1.176]	[30.87,207.03]
planted_100	0.807 ***	221.78	0.874 ***	107.63
	[0.608,1.006]	[−28.08,471.64]	[0.583,1.165]	[29.39,185.87]
natural_removal_50	0.907 ***	249.24	1.188 ***	146.29
	[0.791,1.024]	[−35.20,533.69]	[0.983,1.393]	[39.56,253.01]
natural_removal_100	1.293 ***	355.06	1.376 ***	169.40
	[1.107,1.478]	[−42.47,752.58]	[1.059,1.693]	[49.25,289.56]
natural_50	0.192 **	52.62	0.168	20.71
	[0.060,0.323]	−10.80,116.04]	[−0.030,0.366]	[−4.09,45.51]
removal	0.442 ***	121.35	0.803 ***	98.83
	[0.349,0.534]	[−17.60,260.29]	[0.626,0.979]	[23.34,174.31]
cost ‡	−0.004 ◇		−0.008 *	
	[−0.008,0.001]		[−0.014,−0.002]	
Standard deviation of random parameters (RPL model)				
meadows_50			1.295 ***	
			[1.064,1.525]	
meadows_100			1.720 ***	
			[1.104,2.336]	
planted_50			1.339 ***	
			[1.012,1.666]	
planted_100			1.053 ***	
			[0.540,1.565]	
natural_removal_50			1.455 ***	
			[1.158,1.752]	
natural_removal_100			2.153 ***	
			[1.608,2.698]	
natural_50			0.716 ***	
			[0.295,1.137]	
removal			1.411 ***	
			[1.176,1.646]	
N	12384		12384	
subjects	774		774	
LL	−3815.9036		−3635.7387	
adj. R^2	0.1109		0.1528	
AIC	7649.807		7305.477	
BIC	7716.625		7431.688	

95% confidence intervals in brackets. WTP confidence intervals were computed using the Delta Method. * See Table 1 for a description of the variables acronyms. † Random parameters were assumed normally distributed. ‡ €/family per year (10 years). ◇ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 6. DCEs results: MNL and RPL models considering the policy mix approach.

	MNL-2		RPL-2 †	
	β_i	WTP ‡	β_i	WTP ‡
policy_2 ⋆	0.807 ***	220.90	0.760 ***	93.00
	[0.608,1.006]	[−27.39,469.20]	[0.478,1.042]	[26.23,159.77]
policy_3	0.156		−0.295	
	[−0.069,0.381]		[−0.744,0.154]	
policy_4	1.291 ***	353.36	1.310 ***	160.43
	[1.105,1.477]	[−41.32,748.05]	[1.014,1.607]	[50.90,269.96]
policy_5	1.622 ***	444.02	1.850 ***	226.48
	[1.441,1.802]	[−56.21,944.25]	[1.599,2.101]	[71.03,381.94]
policy_6	0.935 ***	255.88	0.942 ***	115.35
	[0.734,1.135]	[−27.13,538.89]	[0.668,1.217]	[39.24,191.46]
policy_7	1.184 ***	324.16	1.125 ***	137.78
	[0.992,1.376]	[−35.03,683.34]	[0.837,1.413]	[44.54,231.02]
policy_8	1.381 ***	378.16	1.491 ***	182.55
	[1.198,1.565]	[−45.77,802.08]	[1.200,1.782]	[58.48,306.61]
policy_9	0.635 ***	173.90	0.389 *	47.69
	[0.437,0.834]	[−16.70,364.50]	[0.049,0.730]	[1.62,93.76]
removal	0.440 ***	120.45	0.704 ***	86.16
	[0.347,0.533]	[−17.14,258.05]	[0.533,0.875]	[22.33,149.99]
cost	−0.004 ◇		−0.008 **	
	[−0.008,0.001]		[−0.014,-0.002]	
Standard deviation of random parameters (RPL model)				
policy_2			1.022 ***	
			[0.545,1.498]	
policy_3			1.656 ***	
			[1.071,2.240]	
policy_4			1.932 ***	
			[1.414,2.450]	
policy_5			1.224 ***	
			[0.767,1.681]	
policy_6			0.763 **	
			[0.184,1.343]	
policy_7			1.469 ***	
			[0.999,1.938]	
policy_8			1.585 ***	
			[1.163,2.006]	
policy_9			1.540 ***	
			[1.105,1.976]	
removal			1.399 ***	
			[1.170,1.628]	
N	12384		12384	
subjects	774		774	
LL	−3815.8153		−3688.0555	
adj. R^2	0.1109		0.1407	
AIC	7651.631		7414.111	
BIC	7725.872		7555.170	

95% confidence intervals in brackets. WTP confidence intervals were computed using the Delta Method. † Random parameters were assumed normally distributed. ⋆ See Table 3 for a characterisation of the landscape mixes. ‡ €/family per year (10 years). ◇ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

As regards the monetary quantification of the various intervention options, from the estimates obtained the preferred option (Policy 5–50% of the planted area and 50% natural with removal of fallen trees) would bring an average benefit per year per family equal at EUR 226.5 (lower limit 95% confidence interval EUR 71.03/family per year) compared to doing nothing (Policy 1). The second preferred option (Policy 8–50% meadows and pastures and 50% natural with removal of fallen trees) would bring a benefit of EUR 182.5/year per household, while for the third option in order of preference (policy 4–100% natural with removal of fallen trees) the benefit would be EUR 160.4/year per family. Lastly, it can be observed that the benefit given by the removal of fallen trees in woods damaged to a minor extent by the Vaia storm amounts to EUR 86.2/year per family.

It is interesting to note that for all the policies considered, the RPL model detects a significant level of heterogeneity in the preferences of the respondents (Figure 4).

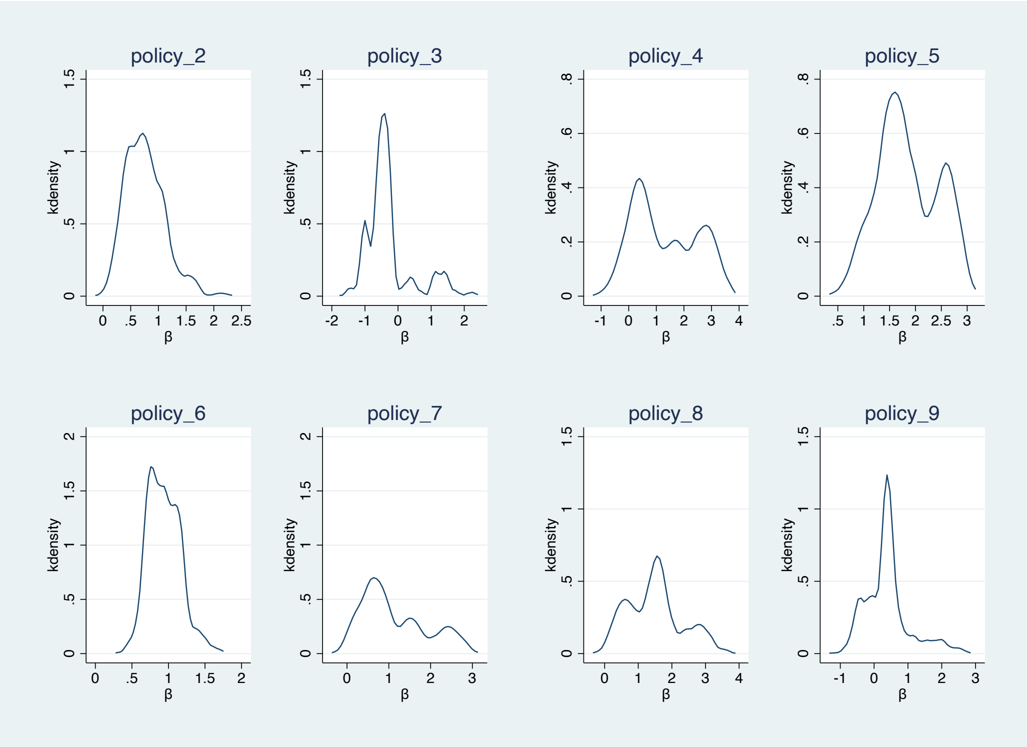

Figure 4. Kernel density graphs of the estimated parameters for the different policies (see Table 3 for a characterization of the policies) with the RPL model (Table 6).

From the data obtained, it was also possible to derive a ranking of which attributes have the greatest influence on the preferences of the respondents (Figure 5). To elaborate this statistic, the coefficients obtained with the RPL-1 model (Table 5) were used along with Equation (4). The attribute considered most important (34% of importance) was the presence of a natural forest with the removal of fallen plants, followed by reforestation with a planted forest (24% of importance), while in third place by importance we find the removal of fallen trees in forests damaged to a minor extent by the Vaia storm (20% of importance).

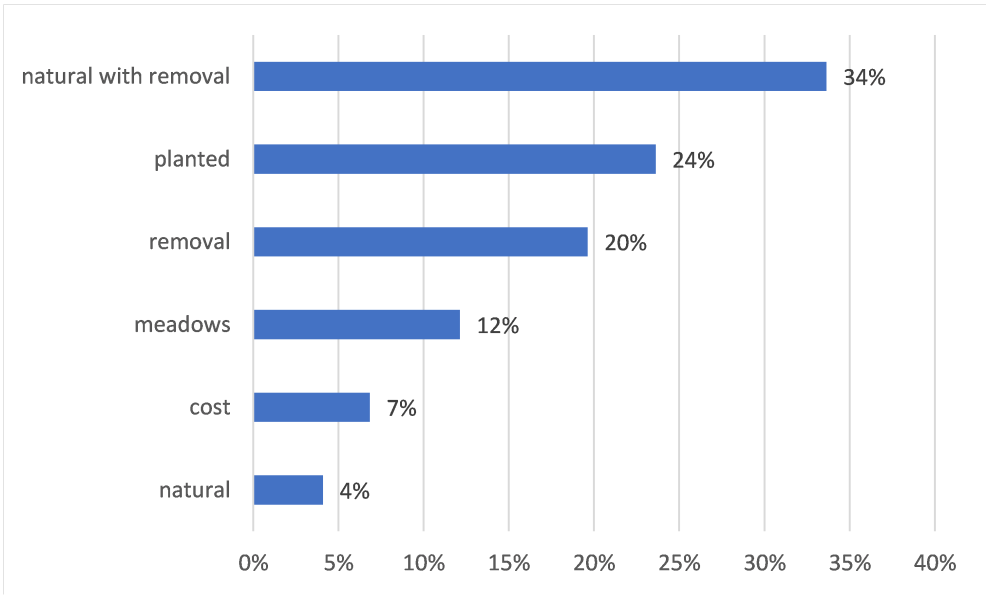

Figure 5. Relative importance of the attributes used in the DCEs.

4. Discussion

From the analyses of the preferences of the residents, some important clues emerged with regard to the reforestation policy that should be undertaken. Such aspects, which will be discussed in more detail in the following paragraphs, are related to the citizens' preferences for the adoption of NBS, namely for a policy that implies a landscape mix and the removal of the fallen trees (deadwood).

First, according to our results (Table 5) it emerged that the preferred policy implies the adoption of a NBS, relying on natural reforestation with the removal of fallen trees. In fact, such a measure brings the highest benefits in monetary terms (EUR 169.40 family/year looking at the RPL-1 model) among the other considered options. This result is also confirmed by the analysis of the relative importance of the different policy attributes, given that natural reforestation with the removal of fallen trees showed to be the most important attribute in determining respondents' choice. This preference for a natural forest was also found by Mäntymaa et al. [20], whose findings show that visitors of natural areas in Finland are willing to pay for improvements in the landscape, expressed in having no visible traces of intensive forest management along the routes and by Giergiczny et al. [9], who identified a general higher disutility associated with greater management intensity. The preference for the natural reforestation process found in this study differs from the findings of Riccioli et al. [19], who identified a high preference for conversion to high forest (planted), while natural evolution was the least preferred management system in areas located in Tuscany (Italy). It should be noted that the territory considered by Riccioli et al. [19] is quite different in terms of forests'composition (according to the authors, the main tree specie is oak—*Quercus robur*) from that of our study—Dolomites—where the prevailing tree species belong to conifers and beech trees (*Fagus*). Furthermore, the focus of the Riccioli et al. [19] study was on forest management for recreation.

Secondly, from the analysis of the different policy mixes, respondents' preference was accorded to the policy that generated a mixed landscape (50% of the planted area and 50% natural with the removal of fallen trees), testifying that the interactions between the attributes considered in the DCEs should be taken into account when considering the implications that such attributes might have on the landscape of the considered territories. This result is also confirmed by the ranking of the different policies, where the two most preferred options imply a certain degree of landscape diversification. In this respect, it should also be remembered that a NBS (natural reforestation) brings by itself a certain degree of diversification in the forest structure compared to an 'artificial' planted solution. A similar result was achieved by other authors that analyzed landscape policies related to forests, such as, for example, Vecchiato and Tempesta [17] in a peri-urban context and Nielsen et al. [14]. This result has some implications from a management perspective, given that in terms of timber production, a planted solution might be preferred, while from the provision of other ecosystem services (biodiversity, habitats, recreation, extreme events protection) a natural reforestation might bring greater benefits [42,43].

A third important result that emerged from our study was a strong preference for the removal of the fallen trees. This was the third most important attribute in driving people's choices, and this can be understood considering the specific context of our study. In fact, the Vaia storm caused the fall of thousands of trees (Figure 2), which heavily impacted the landscape and the usability of the affected territories for recreational purposes. This result emerged considering two attributes, the "removal of the fallen trees in woods damaged to a minor extent by the Vaia storm" and the attribute level "natural wood surface with the removal of fallen trees". The first attribute provided a direct measure of the preferences for fallen tree removal in marginal areas, while the second was preferred to the management option of "natural wood surface without the removal of fallen trees". While the monetary benefit for the "removal of the fallen trees in woods damaged to a minor extent by the Vaia storm" was EUR 98.83 family/year (Table 5, model RPL-1), the benefits of the removal in the more heavily damaged areas can be derived from the difference of the WTP for a natural reforestation with trees removal and a natural reforestation without tree removal (attribute levels natural_removal_50 and natural_50, respectively, in Table 5). Therefore, we can estimate that the benefits from the removal in the more heavily damaged areas are nearly EUR 115 family/year ($115 \approx$ €146.29 $-$ €20.71).

Keeping in mind the specific context of our study (extreme events), some comparisons of our results can be made with the studies that analyzed the perception of "deadwood" in the current literature. Respondents' preference for the removal of fallen trees is coherent with Paletto et al. [44], who found that the majority of people perceive standing dead trees and lying deadwood as having a negative aesthetic effect on the landscape. Similar findings are presented by Arnberger et al. [13] in the USA and Germany, where visitors expressed a dislike for the presence of deadwood in forests impacted by bark beetle. Our results, however, differ from those of Sacher et al. [18], who found no significant trade-offs between recreation and the presence of deadwood in natural areas in Bavaria (Germany). It should be remembered that Sacher et al. [18] focused on the recreation preferences and in particular on the impact of different attributes (tree species, deadwood amount and deadwood composition along with habitat availability for animals and plants) on the choice of a forest for recreational purposes. Our study considered a broader perspective that goes beyond recreation and estimates both use and non-use values of different forest management options. A further difference in the two studies relates to their context: in our study the territory was affected by a meteorological extreme event (the Vaia windstorm) and concerned with the spread of the bark beetle threatening the forest heritage. Last but not least, Sacher et al. [18] only focused on recreational preferences, without considering in the design the cost of the different actions for the respondents. In this respect, the results of Sacher et al. [18], despite being relevant, are not directly comparable with those of our study.

Looking at the monetary estimates for the benefits of the preferred policy (EUR 226.5, policy 5–50% of the planted area and 50% natural with removal of fallen trees, Table 6 model RPL-2), it is possible to affirm that our estimate is in line with previous research. In particular, Nielsen et al. [14] applied DCEs and found a WTP of EUR 262 for a scenario of replacing the baseline case stand of even-aged conifers with no dead trees left for natural decay with a mixture of conifers and broadleaves of varying heights, and leaving a few dead trees for natural decay. The comparison with other estimates results is quite difficult due to the heterogeneity of the studies in terms of contexts and methodologies. For example, Riccioli et al. [19] applied the CV method and found a much lower value, but considering only the recreational benefits of the forest management option and applying a different methodology. Our estimate also includes non-use values, which apparently have a heavy weight in the estimate. A similar discussion could be made considering the results of Zandersen and Tol [45], who carried out a review of studies that applied the Travel Cost Method, an approach only suitable for the estimate of use values, and in particular recreational benefits.

5. Conclusions

Our study achieved three main results, analyzed more in details in the Discussion section. First, according to our results (Table 5) it emerged that the preferred policy implies the adoption of a NBS, relying on natural reforestation with the removal of fallen trees. Secondly (Table 6), respondents' preference was accorded to the policy that generated a mixed landscape (50% of the planted area and 50% natural with removal of fallen trees). A third important result that emerged from our study was a strong preference for the removal of the fallen trees. This was the third most important attribute in driving people's choices, and this can be understood considering the specific context of our study (characterized by a massive tree's fall). Such an aspect could be justified by two peculiar factors of the situation created by the Vaia windstorm. The first factor relates to the magnitude of the impact of the Vaia windstorm in terms of fallen trees. In fact, the Vaia windstorm caused a massive felling of trees, and not just sporadic falls in the forest. A further aspect that justifies such preference relates to the serious bark beetle outbreak, probably amplified by the uncleared damaged forests, replicating a similar situation that occurred in 2004 in Slovakia in the Tatra National Park due to the Alžbeta windstorm [41].

Our results suggest that the benefits of the reforestation policies are quite high in monetary terms, and that in order to maximize such benefits, residents' opinions should be taken into account by experts and policymakers when dealing with reforestation planning. One aspect that should be considered in reforestation plans is how reforestation options will affect the resilience of the future forests, given that extreme events tend to be more frequent.

Despite from the fact that in the literature uneven-aged forests and natural reforestation seem to present a more resilient option to disturbances due to climate change, some challenges should be considered when opting for such reforestation strategies. According to Diaci et al. [46], the main factors that should be considered as facilitating when opting for natural reforestation are "the presence of advanced regeneration and seed trees, proximity to forest edge, less developed ground vegetation, decomposed coarse woody debris, tolerable deer browsing, and less extreme geomorphological features". In this respect, the preferred scenario that emerged in our study should be considered by experts according to the conditions of individual sites. The preferences expressed by the interviewed population, namely a mixture of natural and planted forest, seem reasonable in terms of practical feasibility in terms of silvicultural practices aiming at enhancing future forests' resilience to extreme events.

A further critical aspect that should be considered when taking into account reforestation policies and plans is related to forest ownership. According to FOREST EUROPE [47], the majority of forests in Europe are under public ownership (53.5% public owned and 46.5% privately owned). This implies that often public owners are in charge of the formulation of post-disturbance recovery plans, while private owners are usually supported with subsidies to implement such plans. Subsidies are justified by the fact that reforestation strategies, along with guaranteeing the restoration of the damaged area, "should also ensure the provision of a broad range of ecosystem services of public and community interested, combining timber production with services that meet societal and environmental demands" [48]. Again, the wide range of ecosystem services provided by forests to the local communities and recreationists, along with the use of public funding in post-disaster restoration, is a further aspect that supports the inclusions of public preferences into expert reforestation planning.

To conclude, considering the comparison of our results with previous studies in the literature (see Section 4), it is quite difficult to generalize different policies and ecosystem service benefit estimates, given that these are often context dependent. Therefore, especially when dealing with restoration after extreme events, we suggest avoiding the application of benefit transfer [49] approaches.

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Institutional Review Board Statement: This study poses no risk to participants, was noninvasive and the details of the participants remained undisclosed. The data are not sensitive or confidential in nature, the issues being researched do not upset or disturb participants, vulnerable or dependant groups are not included, and there is no risk of possible disclosures or reporting obligations. For this reason, this study does not fall within the remit of the Helsinki Declaration.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data that support the findings of this study are available upon request from the corresponding author.

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Abbreviations

The following abbreviations are used in this manuscript:

CAWI	Computer Assisted Web Interview
CV	Contingent Valuation
DCE	Discrete Choice Experiment
ELC	European Landscape Convention
MNL	Multinomial Logit
NBS	Nature-Based Solution
RPL	Random Parameter Logit
WTP	Willingness to Pay

Appendix A. The Hypotetical Market Preamble Presented to Respondents

The Vaia storm, as observed, impacted many trees, modifying the landscape and environmental structure of large areas and reducing the ecosystem services produced by the forest.

From the point of view of prevention, Vaia teaches us an important lesson on the frequency of these extreme events which are no longer exceptional but are becoming a regular reality for our forests. For this reason, among the risk prevention measures, forest planning acquires an important role, which must include the analysis of the risks that both the forest and the inhabitants in mountain areas (including tourists) face and an assessment of the actions to be taken to reduce its vulnerability.

In order to make the territory more "resilient" (that is, ready to adapt to future extreme climatic phenomena), various measures are being studied to deal with the damage caused by Vaia and this research aims to elicit the opinions expressed by citizens in this regard.

These measures primarily concern the opportunity to restore the forests or create meadows and pastures. Furthermore, as far as the forests are concerned, to decide how to carry out the reforestation. Finally, it should be highlighted the opportunity to remove felled trees present in the forests that have been damaged to a limited extent.

The intervention measures aimed at managing the areas affected by the Vaia storm are therefore the following:

1. Procedures to restore the damaged forest structure:
   (a) Natural reforestation with the removal of felled trees: involves the gradual spontaneous development of vegetation which could favor the selection of individuals and species more suited to the soil and climatic conditions of the forest. The recovery time of the forest would be longer, and it would take more time to guarantee the ecosystem services, but the forests could be more resilient. The removal of felled trees, although very expensive, especially in the most inaccessible areas, has the advantage of reducing the danger of the spread of the bark beetle, an insect that could seriously damage the trees that were not impacted by Vaia, causing extensive damage to the forest heritage.
   (b) Natural reforestation without the removal of felled trees: involves the gradual spontaneous development of vegetation which could favor the selection of individuals and species more suited to the soil and climatic conditions of the forest. The recovery time of the forest would be longer and it would take more time to guarantee the ecosystem services, but the forests could be more resilient. Not removing the felled trees would reduce the costs of the intervention but carries the risk that a high diffusion of the bark beetle could significantly damage the existing forests.
   (c) Artificial reforestation by planting new trees: the trees would grow more rapidly and there would be shorter recovery times (it will take less time to guarantee the ecosystem services offered by the forest), but the most suitable tree species for replanting would be chosen by man. In this case, it would be necessary to first proceed with the removal of the felled trees.
2. Creation of meadows and pastures: this implies the possibility of having mountain landscapes more similar to those of the past, also favoring an increase in the production of milk and typical cheese.
3. Possible removal of fallen trees in the forests that have suffered minor damage. This intervention, although less necessary, would in any case reduce the diffusion of the bark beetle and the consequent damages. It would also improve the usability of the forest from a recreational point of view.

These interventions involve additional costs for the Veneto Region which intends to promote the project, costs which will be covered with an increase in the tax levy per family per year for 10 years, which varies according to the type of intervention to be implemented.

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