Cent. Eur. For. J. 68 (2022) 203–213 sciendo DOI: 10.2478/forj-2022-0012 CENTRAL EUROPEAN Forestry Journal

ORIGINAL PAPER

Perceived climate change risks among other risks affecting private forest owners in a top-down decision-making process

Cosmin Coșofreț[1, 2]*, Laura Bouriaud[1]

[1] *Forestry Faculty, "Stefan cel Mare" University of Suceava, Universitatii Street 13, RO – 720229, Suceava, Romania*
[2] *Geomatics Laboratory, "Stefan cel Mare" University of Suceava, Universitatii Street 13, RO – 720229, Suceava, Romania*

Abstract
Forest management adaptation to climate change is a matter of forest type, disturbances regime, and forest owners' behavior face the climate change issue. Knowing factors that determine people respond to climate change challenges is essential to explaining their perceptions of climate change adaptation. We have conducted a study in North-Eastern Romania applying the Model of Private Proactive Adaptation to Climate Change. The aim was to identify private forest owners' perceptions about climate change and forest management threats and constraints and to analyse what variables differentiate private forest owners' adaptation behavior. The PFOs with higher education were aware of the forest regime regarding private management. They knew how to assess climate change risk, while those with secondary education were the only interest was obtaining wood. The PFOs' risk experience played an important role in adaptation. The perceptions and beliefs of PFOs were strongly influenced by socio-economic status, and they believe in climate change effects on forests but not on theirs. Adaption has become less urgent because forest management problems blur climate change beliefs. Assuming that the Romanian PFOs' perceptions and beliefs about climate change will follow the European trend, they will want to improve their knowledge about climate change impacts and adaptive measures. Therefore, aggregating the interested PFOs, creating suitable communication channels, and organizing trainings on forest management adaptation to climate change will be needed to prevent this need.

Key words: local climate change adaptation; private forest owner (PFO); perceptions; top-down decision

Editor: Zuzana Sarvašová

1. Introduction

More than 50% of European forests are private (Hirsch & Schmithüsen 2010), the percentage being similar for Romanian forests. If in developed countries from the NW part of Europe, PFOs (private forest owners) can manage their forests directly, in the former socialist countries from the Central and SE part of Europe, and the State requires that management implementation to be done by forestry professionals (Nichiforel et al. 2018)

Climate change proved to be a novel issue and a challenge for individuals, organizations, and governments (Nelson et al. 2016; Sousa-Silva et al. 2016). The combination of warming, alteration of precipitation regime, unpredictable pattern of extreme events, and disturbances regime fundamentally affects the forests (Jandl et al. 2019).

Despite the uncertainties, the scientific community has reached a consensus that human activity profoundly impacts the occurrence of climate change (Sousa-Silva et al. 2016; Coșofreț et al. 2022). Climate change projections on forests reveal a significant impact (Kirilenko & Sedjo 2007): increased frequency and intensity of pest outbreaks, windstorms, or landslides (Seidl et al. 2009; Vacek et al. 2019). In addition, the interaction of natural disturbances with anthropic disturbances has a different impact on the environment (Dale et al. 2001).

Individual perceptions of climate change and associated risks differed from others (Blennow 2012), Semenza et al. (2008) identified several categories of individuals' perceptions. First, although most of the population is aware of climate change at the global level, often was perceived as less urgent in everyday life due to the large degree of uncertainty (Weber 2006; Costa-Font et al. 2009; Poortinga et al. 2011).

However, uncertainty regarding the degree of climate change and its impact on forest resources has resulted in controversial and contradictory perceptions about the need and how to adapt to climate change (Yousefpour et al. 2014).

*Corresponding author. Cosmin Coșofreț, e-mail: cosmin.cosofret@usm.ro
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Climate change adaptation has become a significant challenge because adaptation will reduce vulnerability and increase climate resilience to changes (Fitzgerald & Lindner 2013; Sousa-Silva et al. 2018;Coșofreț & Bouriaud 2019). Climate change adaptation in forestry has to be taken at every hierarchical level of decision-making, in the end, the key actors are forest owners and managers (CPF 2008). The low implication of Romanian PFOs in taking decisions (Nichiforel et al. 2018) led to a lack of long-term adaptation strategies. In other European countries, PFOs' views about adaptation to climate change represent an important input (Fazey et al. 2010; Blennow 2012; van Gameren & Zaccai 2015).

The identification of cognitive factors that influence adaptation was done through different behavioral theories (Zobeidi et al. 2022) as the theory of planned behavior (Ajzen 1985), protection motivation theory (Rogers 1975) or theory of values-beliefs-norms (Stern et al. 1999). The methodological approaches have evolved to have a practical approach for recognizing adaptive capacity (Zobeidi et al. 2022). The Model of Private Proactive Adaptation to Climate Change (MPPACC) represents one of the approaches (Grothmann & Patt 2005) where perceived adaptive capacity was highlighted as the most important bottleneck in adaptation. The perceived adaptive capacity was influenced by social identity (Frank et al. 2011). These concepts were not always consistent, even if they correlated with objective adaptive capacity due to cognitive biases and heuristics (Miao et al. 2018). These concepts showed that the perceived adaptive capacity was considered more important in coping with future climatic changes (Tomlinson & Rhiney 2018). Psychological factors like awareness, perception of risk and beliefs can play an important role or can be a barrier in the adaptation process due to knowledge gaps (O'Connor et al. 1999; Nelson et al. 2016). Finally, Vulturius et al. (2018) assessed and compared the subjective influence and structural factors on Swedish forest owners' views and intentions regarding climate change adaptation through MPPACC.

Therefore, the study aims to apply MPPACC to identify PFOs' perceptions about climate change and forest management threats and constraints. We addressed two research objectives: i) to analyze how PFOs perceive climate change and its influence on their forests, and ii) to determine what variables differentiate PFO adaptation behavior.

2. Material and methods

2.1. Data collection

The unfinished heritage restitution did not allow us to do a stratified sampling, then the PFOs' identification was made through snowball sampling. The non-probability technique does not determine the sampling error and is used when the sample is not easily available (Biernacki & Waldorf 1981).

The unofficial estimates show 950 PFOs in the following municipalities of Suceava county, Romania: Moldovița, Vama, Frasin, Ostra and Stulpicani (Fig. 1) and for assessing the perceptions and behavior about climate change, we questioned 182 PFOs, in 2014.

The share of private forests varies in analyzed municipalities, the highest percentage being in Vama in the opposite being Stulpicani (Table 1).

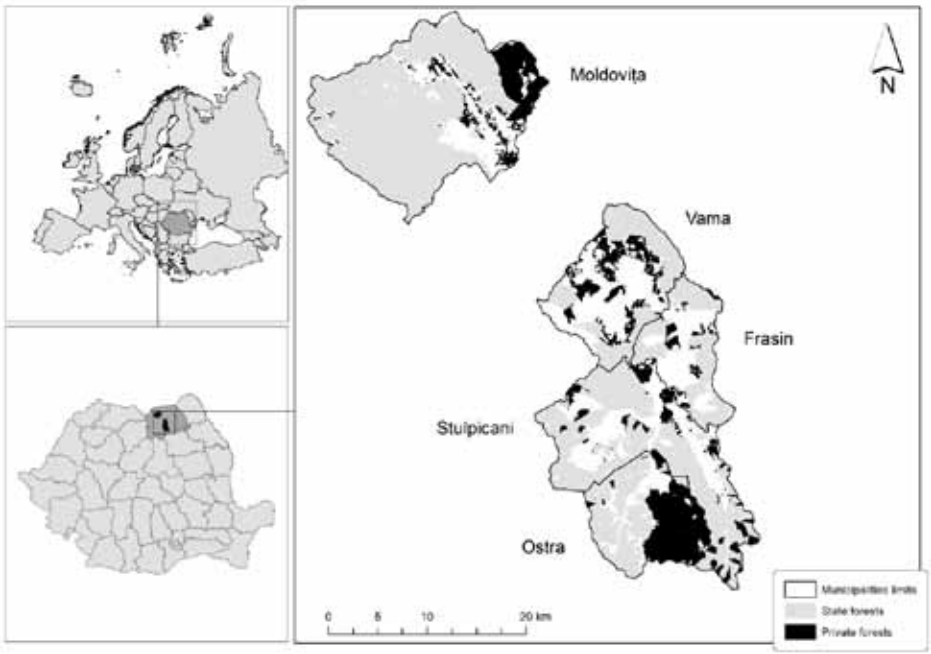


Fig. 1. Study location.

Table 1. Forest ownership in the analyzed municipality.

Municipality	Total forest area [ha]	State forest area [%]	Private forest area [%]	Questioned PFOs
Moldovița	17813	79	21	44
Vama	13479	44	56	49
Frasin	6659	75	25	15
Stulpicani	16506	78	12	46
Ostra	9379	55	45	28

2.2. Theoretical framework and conceptual model

For studying PFOs' perception of climate change, we chose the socio-cognitive model of private proactive adaptation to climate change because the frame included the public policies, individual cognition and individual perception of adaptive capacity. The Grothmann & Patt model (Grothmann & Patt 2005) is based on Protection Motivation Theory (Rogers 1983) and broadly applies to different fields of interest.

The Grothmann and Patt model was adapted to Romanian institutional and policy conditions being added variable (Other Risks) unrelated to climate change (Fig. 2).

The questions fitted to the MPPACC model created two important components (Table 1 in Appendix). The first component included: reliance on public adaptation and public policy (status of the managed forest) (Table 2), risk experience appraisal (main threats for their forest) (Table 3), and cognitive biases and heuristics (factors that can affect the adaptation capacity) (Table 4).

The second component of the model comprised climate change risk appraisal (perceived probability or expectancy to be exposed to a threat and perceived severity or threat severity impacts on things valued by PFOs) (Table 5). Finally, other risks were defined by knowledge about the forest regime and measures taken by State. Its implication in private forest management highlights the threats and struggles faced by PFOs in managing their forests (Table 6).

2.3. Data analysis

For identification PFOs' perceptions about climate change, the Multiple Correspondence Analysis (MCA) method was used, which is suitable for describing, analyzing, and visualizing qualitative information (Blasius & Greenacre 2014).

Based on MCA were analyzed the relations among respondents and variables. The individuals' description depends on variables that best discriminate the respondents' population (Blasius & Greenacre 2014). The variables and categories, most characteristic according to each dimension, were obtained with dimdesc function (Husson et al. 2017).

The top variables which determined the MCA dimensions were analyzed through contingency tables and tested their significance with Pearson's chi test. Data analysis was performed with the library FactoMineR (Husson et al. 2017) from R (R Core Team 2019).

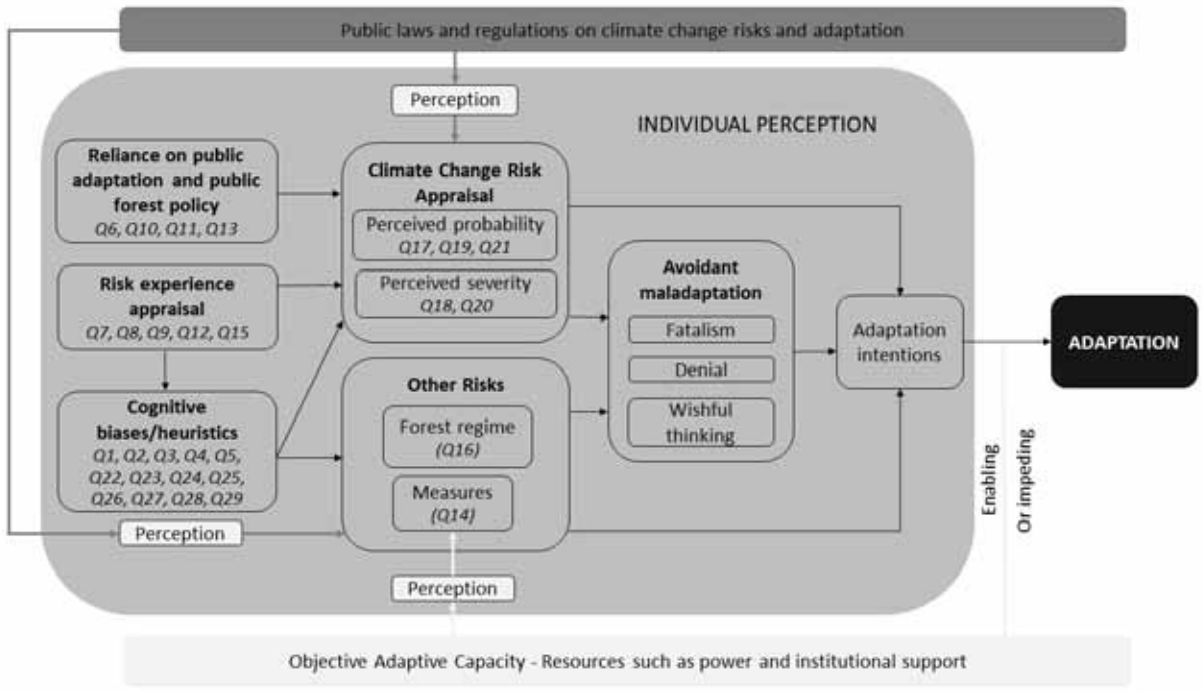


Fig. 2. Model of Private Proactive Adaptation to Climate Change adapted to Romanian institutional and policy conditions.

3. Results

3.1. Private forest owners' perception about climate change and management constrains

The reliance on public adaptation and public forest policy was assessed through questions about management, harvesting, expectation and intentions. The possibility of deciding on the future utilization of their forest led to 30% of PFOs who wanted to harvest their forests for different needs but almost half complied with the forest management plan. Half of the PFOs did not harvest last year, and those did for firewood. After the restitution process, the PFOs' expectations were related to their convenience (easy acquisition of firewood and wood for household needs) for half of the PFOs, and the rest inherited their descendants. The future intention of PFOs was to keep the forests and only less than 10% of PFOs wanted to clear cut it (Table 2).

Table 2. The private forest owners' opinions about freedom of decision about forest management, harvesting, expectations and future intentions with their forest property (N=182).

Q6 – Mngmt. If you had the freedom of decision in managing your forest, what future forest utilization would you prefer? * *Q6* – question number, *Mngmt* – abbreviation	Proportion [%]
Firewood and construction wood	33
Keep the forest as such	27
Comply with FMP provisions	19
Clear cut	10
Others	8
Protecting the forest	3
Q10 – Harvesting. Did you harvest wood from your private forest property in the last year?	
No	40
yes, firewood	40
yes, woodwork	15
I refuse to answer/ I do not know	6
Q11 – Expectation. When you get back your forest, what do you think or expect?	
not obliged to buy firewood	25
wood for household needs	24
inheritance	18
finally got back what was yours	14
earn money by selling wood	7
additional places for grazing	7
can sell the land	2
deforestation	1
I do not remember / I refuse to answer	1
other	1
Q13 – Intentions. What are your intentions for the future with your forest land?	
keep the same land use	59
no clear intentions	12
undertake afforestation	10
clear cut	9
sell it	6
use as grasslands	3
fence the forest	1

The risk experience was appraised through questions about the problems and benefits of forest management. In the PFOs' opinion, the main threats were represented by timber thieves, insect outbreaks or pests. The timber thieves represented a significant threat because forest guarding was not done properly due to the different socio-economic conditions of PFOs. However, in the last two years, most PFOs were not stolen. In addition, the benefits of becoming forest owners made forest access to their property, not a problem (Table 3).

Table 3. Forest management problems and threats for the private forest owner.

Q7 – Threat. Which are the most important threats for your forest? N=173	Proportion [%]
Timber thieves	38
Insect outbreaks and pests	25
No threats, in fact	16
Forest administration and forest managers	9
Windthrows	9
Landslides	4
Q8 – Guarding. How did you ensure the guarding of the forest received back? N=182	
Spoken agreement with the forester	37
With my family	24
Paid somebody	17
Was not necessary	17
Could not ensure the forest guarding	4
Q9 – Wood.Theft. Has your forest been the subject of timber theft during the latest two years? N=182	
No	54
Yes	32
I do not know	14
Q12 – Prbl.Bnft. For you, now, what does it mean to own a forest? N=182	
More benefits	68
More problems	32
Q15 – For.Access. Who has access to your forest? N=182	
Everybody	51
The forester	19
My family	15
The owner	7
No one	7

The factors affecting adaptation capacity (cognitive biases and heuristics) were assessed by describing the restitution process and identifying the PFO profile. The first restitution law from 1991 dispossessed 47% of PFO, 34% by the second restitution law in 2000, and 19% by the third restitution law in 2005. At the restitution moment, more than 60% of forest stands were mature (suitable for harvesting), and the forest composition was dominated by coniferous (58%) and mixed stands (34%). Most PFOs were unassociated, did not have higher education or forestry studies, and did not participate in nature protection and climate change training. The source of information regarding climate change was news and TV shows about climate change, most of them watched TV daily. The PFOs trusted the forester to share the information about the forest, and forest professionals did forest management (73%) (Table 4).

Climate change risks were appraised through questions about climate change's causes and future effects. The PFOs believe in the existence of climate change (80%) and that the global warming from the last decade had anthropogenic (35%) and mixed causes (34%). In the case of natural disturbances, the PFOs decided to cut the affected trees (60%), and 11% would use insecticides. In the next 50 years, the PFOs thought that climate change effects would be diverse, from catastrophic events to temperature and rainfall regime changes. Even if many respondents believed in climate change, they did not consider it a threat to their forests (44%) (Table 5).

Table 4. Forest characteristics (N=182).

Q1 – RetrLaw. In which year did you receive back your forest?	Proportion [%]
Law 18/1991 – first restitution law – (1 ha/PFO)	48
Law 1/2000 – second restitution law – (10 ha/PFO)	33
Law 247/2005 – third restitution law – (Restitutio in integrum)	19
Q2 – Area. Which is the area of your forest?	
<5 ha	83
5–10 ha	12
>10 ha	5
Q3 – Age. How old is your forests?	
>100	40
80–99	24
60–79	20
40–59	9
20–39	5
<20	2
Q4 – Composition. Tree species composition	
Coniferous	57
Mixed forests	34
Broadleaves	8
Q5 – Dist. The distance from the owner's house?	
5–10 km	43
3–5 km	30
>10 km	17
<1 km	10
Q22 – Ownertype. In which owner category do you belong?	
Unassociated forest owner	81
Member of a rural community	9
Forest owner joined an association	6
Owner land	3
Other	1
Q23 – Studies. Levels of studies?	
Secondary education	87
Higher education	13
Q24 – ForestryStud. Forestry studies?	
No	91
Yes	9
Q25 – TrainingCC. Have you taken part at courses/training in the field of climate change and protection of nature	
No	93
Yes	7
Q26 – InformationCC. Regarding climate change, which is the primary source of information?	
Journal news	53
TV shows on the subject	33
Internet	10
Discussions with the colleagues	3
Other	1
Q27 – WatchTV. How often do You watch TV news?	
Every day	71
2–3 times a week	24
Hardly ever	3
Several times a month	2
Q28 – InfAbFor. Who do you trust for the transmission of knowledge about the forest?	
The forester	54
No one	24
The family	12
Everyone	10
Q29 – WhoMng. Who administers your forest? Do you have contract for services (guard) with the forest district?	
Forest district	73
I do not have	15
Family	12

Table 5. Climate change opinions.

Q17 – ClimateChange. Which of the following opinions about climate change is closest to your opinion (tick one option)	Proportion [%]
Climate change is quite obvious	57
Climate change is a fact undeniable	23
Climate change cannot be proven at this time	10
I do not believe in climate change	10
I do not know	1
Q19 – CausesCC. In your opinion, the global warming in the last decade is due to (check only one answer)	
Only human activity (industrial development, pollution, population growth, etc.)	35
That both human activities and natural causes (natural and anthropogenic)	34
I do not know	20
Purely natural causes (cannot be controlled)	12
Q21 – InsectAttack. If your forest is at risk of dying due to of outbreaks or drought, what measures do you think should be taken?	
Cutting the affected trees	60
Silvicultural treatments	17
Insecticides	11
I do not know	5
Talk with the experts	4
Other	3
Q18 – EffectsCC. In your opinion, for the next 50 years, the effect of climate change will be manifested by (tick the three options)	
Tendency to catastrophic climate events (floods, droughts, storms, etc.)	23
Extreme temperature variations	17
Rising the temperature	15
Essential changes in hydrology (flood, flow reduction, drying up springs, etc.)	11
I do not know	10
Essential changes to the local climate (desertification, aridity, etc.)	7
Decrease the rainfall	5
Increase the rainfall	3
Will be no changes to the present / same climate as that now	3
It cannot be said	3
Lowering the temperature	2
Another opinion :	2
Q20 – RealthreatCC. For your forest, the climate change is a real threat?	
No	44
Yes	31
I do not know	25

PFOs can face other risks related to their knowledge about the forest regime, and almost 70% of respondents knew too little about it. Also, the State should help them have a better guard and subsidize the professional forest services for small PFOs (Table 6).

Table 6. The opinions about the measures that the State should take to help the private forest owners N=182.

Q14 – Measures. Which is your opinion about the State's measures to help the private forest owners?	Proportion [%]
To oblige the forest districts to guard the private forests against timber theft	23
To subsidize professional forest services	18
To inform and teach us about how to manage the forest	16
Something else	10
To change for non–compulsory the current obligation of wood marking previous to harvesting	10
To help us to create associations with other owners for managing forests together	9
I do not know	8
To buy our forests at market prices	4
Q16 – For.regime. What do you know about forest regime?	
I know too little	39
I have not heard. I do not know	31
I know rather well what does it means	18
I know very well what does it means	12

3.2. Private forest owners' adaptation behavior

The projected variables (questions) had low variance (19.2%-considered standard in MCA), and we resumed our analysis of PFOs' distribution only on two dimensions (Fig. 3).

The first dimension variables were Q16 – For.regime and Q6 – Mngmnt, which define PFO's perception of the forest, Q23 – Studies that showed their educational background and *Q17 – Climate change, Q20 – RealThreatCC, Q18 – EffectsCC,* which describe climate change threats. The first dimension explained the expectancy of being exposed to a threat.

The most characteristic variables for the second dimension were Q9 – Wood theft, Q7 – Threat, Q8 – Guarding, which highlighted the PFOs' perceptions of threats more imminent than climate change even if they believe in it (*Q17 – Climate Change*). The fact that variables *Q14 – Measures* and *Q5 – Dist* also determined the second dimension showed that the risk experience has an essential role in adaptation (Table 2 in Appendix).

From the comprehensive comparative analysis of top variables which created the first dimension, only five were found significant (*p.value <0.05*) and further analyzed. The PFOs who said that climate change is not a real threat had a greater incidence of not knowing what is forest regime, while those who said that climate change is real also had some knowledge about forest regime. Analyzing management and climate change threats resulted in the PFOs that did not believe in climate change threats would manage their forest for wood production, while those who admitted it had a more protective approach.

The PFOs with medium education did not acknowledge climate change as a threat and had little knowledge about the forest regime, while those with higher education showed the opposite. If they do not admit climate change as a threat, the knowledge about climate change effects is expected to be limited (Table 7).

Table 7. Significant contingency table of top variables determining the first dimension.

Variables	χ^2	d.f*	p.value
Q20–RealThreatCC ~ Q16–For.regime	14.74627	6	0.0223
Q20–RealThreatCC ~ Q6–Mngmnt	17.71938	8	0.0234
Q20–RealThreatCC ~ Q23–Studies	12.1707	2	0.0022
Q18–EffectsCC ~ Q6–Mngmnt	32.72876	16	0.0081
Q23–Studies ~ Q16–For.regime	15.16537	3	0.0016

** d.f. – degree of freedom.*

The comparative analysis between variables that determined the second MCA dimension resulted in six significant contingency tables. In this respect, the PFOs that believed in climate change were more affected by natural or anthropic disturbances than nonbelievers who did not experience any threats. On the other hand, there was no difference between PFOs (stolen or not) regarding forest services (marking and guarding), both wishing them free.

In the case of natural (insect outbreaks and pests) and anthropic disturbances, the PFO wanted a better and free guard from forest districts. The need for professional services was found at PFOs, which were stolen. In contrast, those who considered guard unnecessary did not observe wood thefts due to low implications or young forest stands, which are less attractive for wood thieves.

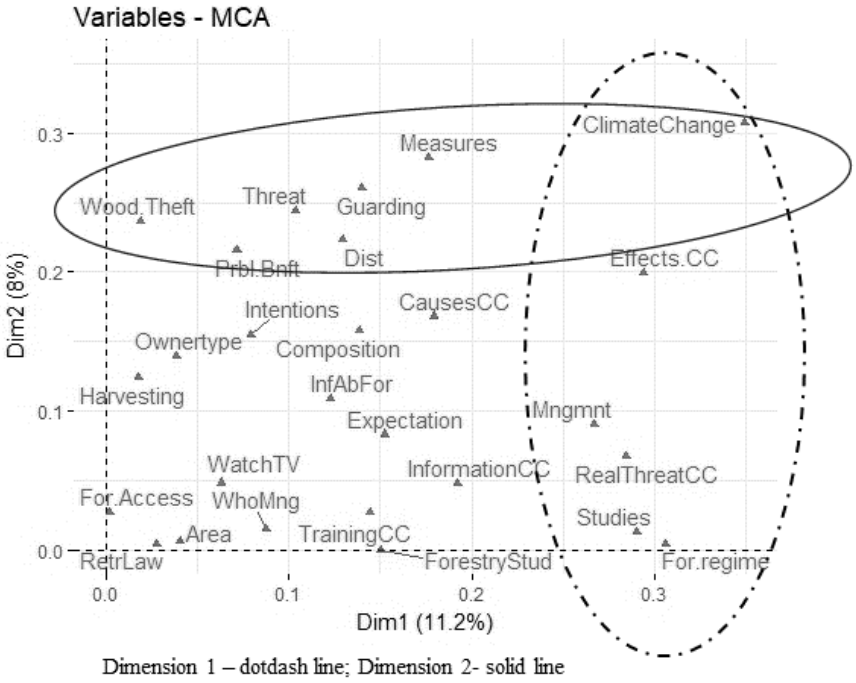


Fig. 3. Most characteristic variables for Multiple Correspondence Analysis first and the second dimension.

The PFOs who had not been stolen and did not consider guarding necessary were affected by natural disturbances or did not face any threats. Instead, timber thieves stole the PFOs affected by anthropic disturbances, and the guard of private forests consisted in a spoken agreement (Table 8).

Table 8. Significant contingency table of top variables determining the second dimension.

Variables	χ^2	d.f.	p.value
Q17–ClimateChange ~ Q7–Threat	20.606	8	0.0082
Q14–Measures ~ Q9–Wood.Theft	25.06889	10	0.0052
Q14–Measures ~ Q7–Threat	23.18693	10	0.0108
Q9–Wood.Theft ~ Q8–Guarding	15.89704	8	0.0438
Q9–Wood.Theft ~ Q7–Threat	32.54323	4	1.48135e-06
Q8–Guarding ~ Q7–Threat	16.77123	8	0.0325

4. Discussions

4.1. Private forest owners' perception about climate change and management constrains

In our case study, 80% of respondents believed in climate change, a similar attitude being identified by Semenza et al. (2011), 81% of respondents were aware of climate change, and 15% did not think that climate change is occurring. In Belgium, almost all PFOs (95%) believe that climate change is happening and will continue (Sousa-Silva et al. 2016). A study on 1000 French PFOs showed that 73% are aware of climate change. Most of them considered as climate change effects, the high intensity and frequency of droughts and storm events (Thomas et al. 2022).

In Bostrom et al. (1994) study, the most mentioned climate change effects were temperature increase, changes in precipitation patterns, and chronic flooding, which were also identified in Semenza et al. (2011) study. The same climate change effects were mentioned by 60% of Romanian PFOs. The Belgium PFOs mentioned the most the strong winds, heat waves, drought, and extreme precipitations (Sousa-Silva et al. 2016).

Concerning triggering factors of climate change, in Bostrom et al. (1994) study, 81% of respondents mentioned that human activities could be the cause of climate change. Also, most French PFOs think climate change is human-induced (Thomas et al. 2022). The Canadian PFOs believed that human activities induced climate change and the process is probably irreversible but with a low influence on their forests in short and medium term (Bissonnette et al. 2017). Conversely, the Austrian PFOs considered that climate change will impact their forests (Mostegl et al. 2019). In our case study, only 35% of Romanian PFOs considered only human activities as a triggering factor. Besides human activities, natural disturbances were mentioned as a cause of climate change by 30% of respondents in Leiserowitz et al. (2010) study, while our results showed a lower percentage (12%).

The analysis revealed that perceiving climate change risk is a matter of priority. For instance, forest management is problematic in the perception of the forest owners, with many unsolved issues (Blennow 2012). The strong desire of Romanian PFOs to have enough firewood and construction wood covered forest ownership problems such as guarding forests, obtaining harvesting permits, or forest management plans with a cut allowance to cover the household needs. Nowadays, these aspects have been improved in Romanian legislation. The small PFOs without an FMP can harvest up to 5 m^3/year/ha, and if they exceed 20 m^3, they need an authorized forest company (Forestry Code 2015).

For the Romanian PFOs, timber thieves, insect outbreaks, or pests represented the most important threats. A survey of 200 forest owners and managers at the European level showed that the top threats were pests, diseases and windstorms (Vinceti et al. 2020).

4.2. Private forest owner adaptation behavior

A third of German PFOs have academic education and regarding climate change, they stated that it will influence their forests, and adaptation it is a priority (Hengst-Ehrhart 2019). The education of French PFOs is heterogeneous, varying from low education to master's degree. Few PFOs have adapted their practices and were interested in climate change trainings (Thomas et al. 2022). The increased interest on workshops and trainings on climate change was also identified in Canadian PFOs (70%) (Bissonnette et al. 2017).

The first MCA dimension was determined by the expectancy to be exposed to a threat. From this dimension can be drawn two PFO types: those with high education (13%) who were aware of forest regime regarding private management and knew how to assess climate change risk compared to those whose only interest was obtaining wood. Also, Frank et al. (2011) acknowledged that social identity influences adaptive capacity.

The previous experience of German PFOs with various hazards was essential in assessing future damage risk (Hengst-Ehrhart 2019). Perceiving a higher risk of future damages did not make PFOs adapt forests at large scale, focusing on tree or stand level (Pröbstl- Haider et al. 2017; Hengst-Ehrhart 2019). In the case of small Canadian PFOs, the risks as pests, pathogens, temperature variations and precipitations were not especially linked to climate change (Bissonnette et al. 2017).

In the second MCA dimension showed that the Romanian PFOs' risk experience played an essential role in adaptation (Nelson et al. 2016). Further was identified the PFOs type which was aware of threats to which forest is exposed. This typology was also identified in the Belgium case study where the PFOs experienced climate change and were knowledgeable about climate change threats (Sousa-Silva et al. 2016). The second type of PFO is characterized by indifference even if they knew about threats, and the only concern is not to pay for marking in case of natural disturbances.

The Belgium PFOs believed and perceived the risk of climate change (71%), but half of them did not consider the implementation of adaptation measures (Sousa-Silva et al. 2016). If, for Austrian PFOs, the forest management was not a burden, the Romanian PFOs were overwhelmed by forest management problems and the forest adaptation to climate change would become less urgent (Weber 2006; Poortinga et al. 2011). Instead, for Canadian PFOs, the limited implication into forest management was considered a barrier in adaptation to climate change (Bissonnette et al. 2017). Also a high share of French PFOs did not adapt due to the following reasons: the current legislation, lack of money, or other priorities on forest management (Thomas et al. 2022, Bissonnette et al. 2017).

The Grothmann and Patt model showed no possibility of individual adaptation to climate change in a regulatory context. Besides knowing that the climate is happening, the adaptation process is inert (Thomas et al. 2022). Another issue of Grothmann and Patt model is the avoidant maladaptation which suggests that only PFOs are responsible without considering the socio-economic and political context (Deuffic et al. 2020).

5. Conclusions

In the Romanian context, the forest management adaptation to climate change is pending on PFOs' perceptions and views about the stressing problems of today's forest management. Perceptions and beliefs are strongly influenced by socio-economic status and the majority believe that climate change affects the forests but not theirs.

Supposing that the belief in climate change will increase, and the implications in forest management decisions will still be limited, in that case, the adaptation of forests to climate change will not be their primary objective.

In the literature, it was identified that no matter how great the belief in climate change is and how strong climate change impacts their forests, the PFOs return to the same inert routine of managing the forest after the initial emotions. However, a high request for trainings and workshops was observed because the PFOs want a better understanding of climate change impacts, adaptation measures and how can be applied to their small forest properties.

Therefore, we assume that Romanian PFOs' perceptions and beliefs about climate change impacts on their forests will follow the European trend and want to improve their knowledge about climate change impacts and adaptive measures. An aggregation of interested PFOs, creating suitable communication channels for them and organization of training on forest management adaptation measures to climate change will be needed.

Acknowledgement

This research was funded from European H2020, Grant 817903 EFFECT and by Fem4Forest – Forests in Women's Hands, project ID: DTP3-500-1.2 funded by European Union through Interreg Danube Transnational Programme.

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Appendix

Table. 1. Questions fitting MPPACC model and analyzed using Multiple Correspondence Analysis.

No. Crt.	Model of private proactive adaptation to climate change (MPPACC)	Questions abbreviation in *italic* are open questions and in **bold** are close–ended questions) Eg.: *Q1*– question number and *RetrLaw* – abbrevation used in Multiple Correspondence Analysis MCA
1	Reliance on public adaptation and public forest policy (Table 2)	*Q6–Mngmnt*, **Q10–Harvesting, Q11–Expectation,** Q13–*Intentions*
2	Risk experience appraisal (Table 3)	*Q7–Threat*, **Q8–Guarding, Q9–Wood.Theft, Q12–Prbl.Bnft,** *Q15–For.Access*
3	Cognitive biases/heuristics (Table 4)	*Q1–RetrLaw, Q2–Area, Q3–Age, Q4–Composition,* **Q5–Dist, Q22–Ownertype, Q23–Studies, Q24–ForestryStud, Q25–TrainingCC, Q26–InformationCC, Q27–WatchTV,** *Q28–InfAb-For, Q29–WhoMng*
4	Climate change risk appraisal (Perceived probability) (Table 5)	**Q17–ClimateChange, Q19–CausesCC,** *Q21–InsectAttack*
5	Climate change risk appraisal (Perceived severity) (Table 6)	**Q18–EffectsCC, Q20–RealthreatCC**
6	Other risks on forests/threats (Forest regime, Measures) (Table 7)	**Q16–For.regime, Q14–Measures**

Table 2. The most contributing variables in Multiple Correspondence Analysis dimensions.

MCA Dimension 1			MCA Dimension 2		
Variables	R2	p.value	Variables	R2	p.value
Q17–ClimateChange	0.349192	1.22E–15	*Q17–ClimateChange*	0.307479	2.54776E-13
Q23–Studies	0.290377	5.07E–15	*Q14–Measures*	0.28201	2.52922E-11
Q16–For.regime	0.306051	5.41E–14	*Q9–Wood.Theft*	0.236561	3.68905E-11
Q20–RealThreatCC	0.284336	1.17E–13	*Q8–Guarding*	0.260572	6.9465E-11
Q18–EffectsCC	0.29401	1.33E–12	*Q7–Threat*	0.244015	9.48933E-11
Q6–Mngmnt	0.266881	1.45E–10	*Q5–Dist*	0.223799	9.40973E-10
ForestryStud	0.150218	7.03E–08	Prbl.Bnft	0.215449	2.38227E-09
CausesCC	0.179285	1.18E–07	EffectsCC	0.199481	5.82313E-08
InformationCC	0.192219	1.24E–07	CausesCC	0.168386	3.67703E-07
TrainingCC	0.144599	1.29E–07	Composition	0.15793	1.07824E-06
Measures	0.176371	2.13E–06	Harvesting	0.124275	7.42572E-06
Expectation	0.152274	7.00E–06	Ownertype	0.139506	2.40377E-05
Composition	0.138708	7.48E–06	Intentions	0.15449	0.000120057
Dist	0.129436	1.87E–05	InfAbFor	0.108888	0.000136113
Guarding	0.139818	2.33E–05	RealThreatCC	0.067769	0.001939069
InfAbFor	0.12306	3.48E–05	Expectation	0.083477	0.003891153
Threat	0.103878	2.19E–04	Mngmnt	0.090615	0.004970608
WhoMng	0.087791	2.81E–04	WatchTV	0.048664	0.01179569
WatchTV	0.062932	3.07E–03	TrainingCC	0.02789	0.02463685
Prbl.Bnft	0.071642	4.23E–03			
Area	0.040514	2.52E–02			
Intentions	0.079414	4.27E–02			