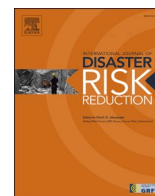


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## Determinants of local community participation in forest fire management in the northern Iran

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### ABSTRACT

Forest fire is one of the environmental events that occur under the influence of human and non-human (such as lightning, volcanoes, etc.) factors. In Iran, forest fires are a recurring problem. Human activities, such as negligence by local communities or travelers, play a major role in their occurrence. Intentional and unintentional fires pose the most significant threats, leading to the destruction of vast forest areas, especially in northern Iran, in recent years. In this regard, the participation of local communities in the management of such occurrences is essential. The purpose of this study was to analyze the determinants of local community participation in forest fire management (CPFFM) in Northern Iran, focusing on Nowshahr township. The research includes seven independent variables: quality of extension services (QES), awareness of rules and regulations (ARR), social norm (SN), place attachment (PA), environmental belief (EB), pro-environmentalist attitude (PEA) and social capital (SC) and their impact on CPFFM was measured. This research is a type of descriptive-correlational and causal-relational research that was conducted with a survey. The statistical population included local communities living on the edge of the forest in Nowshahr township (N = 78,786), of which 350 people were selected as a sample using stratified random sampling with proportional assignment. The research instrument was a questionnaire whose validity was confirmed by subject experts and the reliability of its items was achieved with Cronbach's alpha coefficient ( $0.711 \leq \alpha \leq 0.921$ ). The results of causal analysis indicated that QES ( $\beta = 0.522$ ), SN ( $\beta = 0.156$ ) and ARR ( $\beta = 0.305$ ) have the highest direct effect on CPFFM, respectively. Also, EB had the greatest non-causal effect (0.083) on CPFFM. This research, by emphasizing the variables of human ecology from the point of view of environmental psychology in the conceptualization of some key variables affecting CPFFM, can be useful for decision makers and planners of forest fire management.

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## Abbreviations

CPFFM	Community participation in forest fire management
QES	Quality of extension services
ARR	Awareness of rules and regulations
SN	Social norm
PA	Place attachment
EB	Environmental belief
PEA	Pro-environmentalist attitude
SC	Social capital

## 1. Introduction

Fire is one of the environmental events that devastate a large part of forests and pastures. The causes of fire in the forest are natural and human. The four main natural causes of forest fires are lightning, volcanic eruptions, sparks from falling rocks, and spontaneous combustion. Natural causes account for a varying percentage of forest fires, depending on regional factors. Globally, lightning is the primary culprit, responsible for 50–60 % of fires. Volcanic eruptions contribute 1–2%, while sparks from falling rocks or rock friction cause another 1–2%. Spontaneous combustion accounts for approximately 1 % of forest fires [1]. Human activities, such as negligence by local communities or travelers, play a major role in forest fires occurrence. Intentional and unintentional fires pose the most significant threats, leading to the destruction of vast forest areas, in recent years. In this context, the most efficient way to minimize forest damage is to establish fire management preparedness and the essential forecasting to address it [2]. Fire, an inherent component of forest ecosystems, necessitates effective fire management to regulate its impacts during forest management. “Forest fire management” is the process of planning, preventing and fighting fires to protect people, property and the forest resource. It also involves fire to attain forestry, wildlife and land-use objectives [3]. In other words, forest fire management encompasses strategies to prevent, control, and suppress wildfires in forested areas. It involves proactive measures like prescribed burning, fuel management, and firebreak construction, as well as reactive measures like firefighting and post-fire recovery efforts [4,5].

In Iran, hundreds of forest fires occur, burning thousands of hectares of trees, shrubs, and plants. In addition to economic losses and the social impacts like human casualties, endangering the livelihood of forest inhabitants and their migration, fires also result in environmental damage. Human factors, such as the carelessness of local communities or travelers, contribute to the occurrence of forest fires. It is noteworthy that the most significant threats in this context are intentional and unintentional fires, which have resulted in the destruction of a substantial portion of forests, particularly in northern Iran, in recent years [6]. Based on this, it is essential to implement appropriate measures for forest fire management. One crucial action in this regard is fire prediction. The stages of crisis prevention include prediction and prevention of the occurrence of a crisis (including more interesting and updated knowledge, prediction, prevention, mitigation, preparedness, detection, suppression and recovery the phases of wildfire management) and preventing the occurrence of any type of event is more cost-effective than fighting against it. Preventing forest fires is another instance of natural occurrences that require management, with the involvement of local communities being essential in the planning process [7].

The role of local communities, cooperating with local communities and the utilization of natural resources personnel are of great importance for mitigating forest fire impacts. Local communities can have a crucial role because of their better access to fire occurrence sites and quicker presence compared to natural resource personnel, particularly in hard-to-reach areas. Certainly, the role of natural resource personnel is also vital in coordinating local communities and providing training [8,9]. As the main component of participation in the natural resources’ preservation, local communities can play an important role in forest protection, including firefighting.

Indeed, issues related to natural resources are interrelated with the life of local communities, because local communities often rely on these resources for their livelihoods, cultural practices, and overall well-being. Therefore, the success of any kind of program in the field of natural resources requires the participation of local communities. Their traditional knowledge, and their ability to contribute to sustainable solutions that benefit both their communities and the environment. Hence, the role of people in decision-making, planning and the execution of forest restoration and protection programs is really important. Also, we can refer to the important role of local communities, village councils and non-governmental organizations (NGOs) to prevent forest fires [2,10].

Local communities have potential abilities and have achieved a lot of knowledge and experience during the years of residing in the proximity of the forest. In fact, with the effective use of these social capitals, forest protection can be considerably enhanced. Indeed, the desire and ability of local communities to participate in forest management is affected by various internal and external factors [11]. Forest protection involves local communities in various ways, including participation in firefighting efforts. Examples of local community participation in forest fire suppression include cases “early detection and reporting of forest fires”, “fire prevention and education”, “fire suppression support”, “evacuation assistance” and “post-fire recovery and rehabilitation”. Overall, local communities play a crucial role in forest fire control by being vigilant, proactive, and supportive in preventing, detecting, and responding to forest fires.

Fire management can be considered as a solution to prevent damage out of the control of forest ecosystems and its adverse economic and social consequences [12,13]. Fire management can help prevent damage beyond control of forests, ecosystems, and its negative impacts on the economy and society by implementing strategies such as prescribed burning, fuel management, early detection

systems, and community education. These strategies aim to reduce the intensity and spread of wildfires, protect valuable resources, and enhance the resilience of ecosystems. Additionally, fire management can help maintain biodiversity, reduce the risk of catastrophic wildfires, and promote sustainable land management practices [1,6,14]. In this regard, in order to reduce the negative impacts of fire, the relevant organizations first need to know the vulnerable areas so that they can use the information and time management, take quick actions along with detailed planning as well as the required facilities, equipment and training and be able to play an effective role in controlling and reducing damages caused by fire.

However, it should be noted that forest fires are destructive forces, but they can occur naturally. Because of this, certain plants and animals have evolved to depend on periodic forest fire for ecological balance. Prescribed burns can mimic the benefits of forest fire while also lowering the risks associated with larger, uncontrolled fires. Fires are essential in removing exotic plants from the ecosystem, giving an edge to native species so they can germinate and grow. The forest fauna depends on these native plants for food. Dead wood, withering plants and weaker trees are removed by fire, allowing sunlight to stream through the fire-opened areas [15]. Integral to this concept is that fires can be beneficial or harmful depending on how, where, when, and why they burn. Each fire can have both beneficial and harmful aspects. Decisions made in managing a wildfire can capitalize on potential benefits while seeking to reduce potential losses [16].

For example, in California in the United States of America, a total of 7718 fires have burned 3,451,428 ACRES of vegetation, more than 3 % of the state's 10 million acres of land [17], 2020. Also, in 2009, 25 people were killed and 8.4 million acres were burned by a fire in the state of New South Wales, Australia. 480 million animals have been killed in Australia by forest fire. The most fires occurred in the state of Victoria, which has caused the extinction of more than 30 plant and animal species, the death of 23 people, and the loss of about six million acres of forest [9].

In Iran, there are 14,319,000 ha of forest and 84,814,000 ha of pasture. In 2020, with 2814 fires, 38,666 ha were destroyed [18]. It is necessary to mention the lack of supporting institutions, limited resources, lack of sufficient training, lack of facilities and lack of up-to-date equipment for fire prevention and extinguishing have fueled the destruction of forests. In addition, change of use, fuel supply, general poverty of local people and lack of social and economic development have endangered the sustainability of forests [19]. Most of the forests in Iran are situated in the provinces of Mazandaran and Guilan in the north. Nowshahr Township with an area of 662,033 ha covers 27.9 % of the area of Mazandaran province beside the Caspian Sea (Fig. 1). This basin is one of the four basins of natural resources in Northern Iran, which is of great importance with 5 reserves with an area of 7895 ha 315,413 acres of forest, including special forest species and 33 forest parks with an area of 7400 ha [18]. Common land use and vegetation cover types in Nowshahr township include urban areas (buildings, roads, and infrastructure), agricultural land (farmlands, orchards, and crop fields), forested areas (natural forests or planted forests), grasslands (open areas covered with grasses and shrubs), water bodies (rivers, lakes, and wetlands) and bare land (areas with minimal vegetation cover or exposed soil). In the meantime, over 80 % of Nowshahr township encompasses forests and pasturelands [Ibid]. Based on the statistics of fires and the shortage of such as advanced fire fighting equipment, limited funds and lack of human resources in this region, the need for the cooperation of local communities and non-governmental organizations is of great importance. Therefore, this study aims to analyze the determinants of local community participation in forest fire management (CPFFM) in Nowshahr township. The novelty of this research, in addition to the spatial focus on Nowshahr Township, is the analysis of fire management from the point of view of environmental psychology.

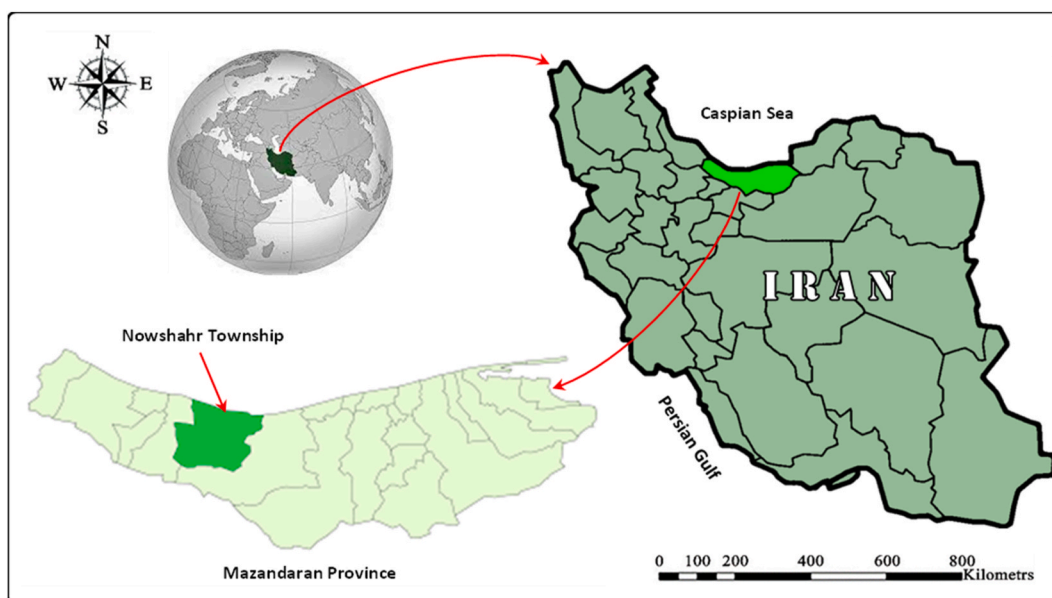


Fig. 1. Geographical location of Nowshahr Township.

## 2. Theoretical background

Environmental psychological studies indicate that when people have the opportunity to express their thoughts and participate in a decision that influences their destiny, they will show more innovation and have more responsibility, which this issue should be taken into consideration in the field of CPFFM [20]. A solution such as sharing the role of local people can be of great help in controlling and reducing the level of fire activity in the forests of the region; as the lives of these people depend on the forest and they attempt to protect it. In this regard, the use of the local capacities of the region and also using the local knowledge of the people in forest management are the cheapest and easiest possible solutions [21].

The analysis of the people’s participation in forest fire management can be investigated from different aspects. One of these aspects is analysis from the perspective of environmental psychology. In this regard, various theorists (i.e., [22–24]) consider the type of Pro-environmentalist attitude (PEA) as one of the most important variables affecting participation in the protection of natural resources which is examined in the form of three types of egoistic attitudes (the individuals who are more interested in their own interests and the benefits of others and nature are not of great importance for them), altruistic (people for whom the interests of other people are of great importance besides their own benefits) and biospheric (people who advocate themselves, others and non-human factors benefits in the nature). Researches have shown that people with a egoistic view of participation show less participation and people with a biospheric view demonstrate the highest participation in the protection of natural resources, and individuals with an altruistic view are moderate in this regard [23,25]. In fact, for CPFFM, one of the most important factors to identify is to understand and change people’s PEA [26].

In this regard, Stern [22] states that one of the primary factors in the occurrence of environmentalist behaviors is the level of people’s awareness, which is an effective action for creating a desirable PEA. It seems that the level of awareness of local communities about fire management, especially the awareness of rules and regulations (ARR), is an effective variable on CPFFM. Indeed, ARR itself is affected by the level of education of individuals Eckerberg & Buizer, 2017; [24,27,28]. Therefore, the quality of extension services (QES) can be considered as an important variable in the analysis of CPFFM.

Based on the Value-Belief-Norm (VBN) theory [22], it can be said that from the point of view of environmental psychology, two variables of environmental beliefs (EB) and social norm (SN) can be considered in the prediction of CPFFM. EB is the type of view and attitude regarding whether environmental issues are true or not. SN is also a social behavioral model that regulates environmental relations and actions, the majority of society adheres to it.

Place attachment (PA) is another variable whose relationship with environmental behaviors has received much attention in the field of environmental psychology and there are many studies in this area (i.e., [29,30]). PA is a cognitive and emotional experience of the link and interest in the place of residence [31]. It seems that individuals with more PA demonstrate more participation in forest protection Degnet et al., 2022.

Social capital (SC) is a set of networks, norms, values and perception that facilitate intra-group and inter-group cooperation in order to obtain mutual benefits and achieve common goals more efficiently [32]. SC is an effective factor in people’s participation in forest conservation and sustainability through affecting PEA [2,33]. Thus, it can be considered in the prediction of CPFFM.

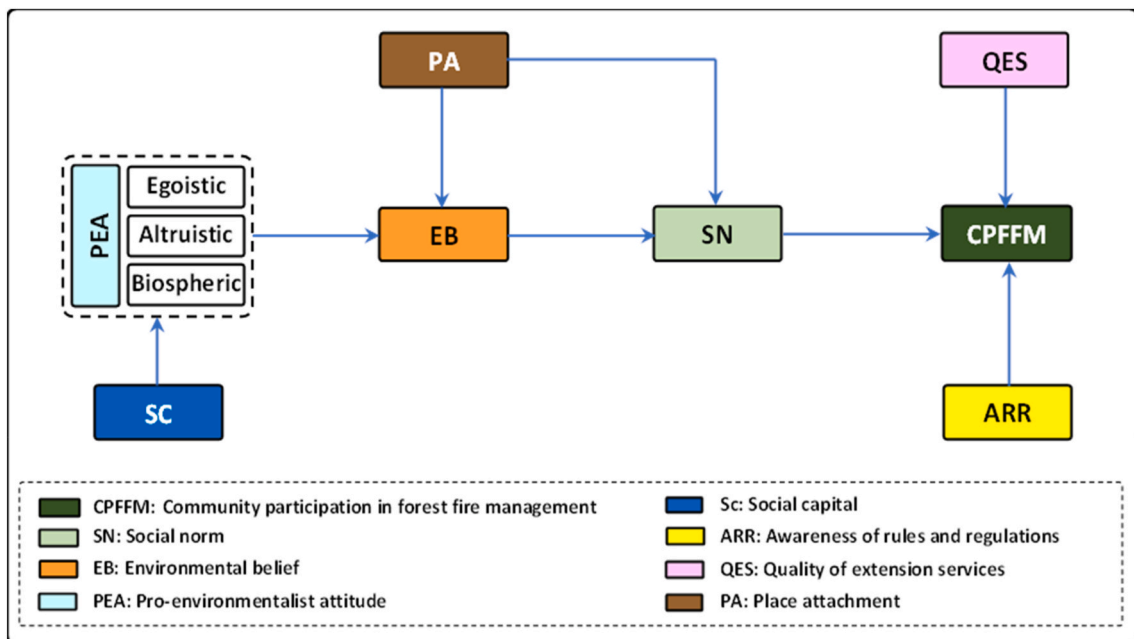


Fig. 2. Conceptual framework of the study.

**Table 1**

The size of the statistical population and the desired samples based on the sampling method of stratified random sampling with proportional appointment.

	Category	Subcategory	Population size (N)	Sample size (n)
Nowshahr Township	Central	Kherod Kenar	29,583	131
		Baladeh Kojor (Central)	20,269	90
	Kojor	Kalej	7199	32
		Zanos Rastagh	3097	14
		Panjak Rastagh	3404	15
		Environs Kojor	15,234	68
			<b>N=78,786</b>	<b>n= 350</b>

In addition, in the analysis of environmental psychology of people's participation in the natural resources protection, several researches have analyzed individual and professional characteristics (e.g., ages, gender, work history, etc.) (i.e., [23,24,29,30]). In this study, due to the homogeneity of the society from the point of view of most of the individual and professional variables and their non-significance of correlation with CPFFM, they were not included in the inferential and causal analysis.

As it was mentioned, based on the literature review, the causal chain of factors affecting CPFFM can be presented in the form of a conceptual framework as shown in Fig. 2.

### 3. Research methodology

In this study, a quantitative paradigm was employed. The research design was non-experimental and the data collection method was a survey. The statistical population included local communities living on the edge of the forest in Nowshahr township (N = 78,786). The sample size (n = 350) was estimated based on table of Krejcie and Morgan [34] and to select the samples, stratified random sampling method with proportional appointment (Table 1) was used (the strata included 5 sub-sections in 2 main sections of Nowshahr township).

The data collection instrument was a questionnaire whose content validity was confirmed by a panel of relevant experts in the two fields of "Agricultural extension and education" and "Forest and fire management". Also, its reliability was obtained based on Cronbach's alpha test for the given variables (Table 2). The measurement of the items related to the variables presented in Table 2 was performed using a five-part Likert scale with (coding 1 to 5). SPSS<sub>26</sub> software was used for data analysis, Pearson correlation coefficient was used to determine correlation between variables, and regression was applied for path analysis.

### 4. Results and discussion

#### 4.1. Analysis of the individual characteristics of the studied local communities

Descriptive results showed that 301 respondents were male (86 %) and 49 were female (14 %). The average age of the respondents was about 30 years. The age group of 30–40 years with 49 % and the age group of more than 50 years with 8 % had the highest and lowest frequency, respectively. 68 individuals (19.6 %) had the experience of fire and 282 people (80.6 %) had no such experience. 196 people (56 %) have participated in extension-educational courses related to fire management and the rest (44 %) had not received any training in this field.

#### 4.2. Correlation analysis between variables

"Pearson" correlation test was employed to analyze the relationship between variables (Table 2). The results indicate that except for the PA variable, the other variables have a direct and significant relationship with CPFFM. This result is inconsistent with the researches of Souza-Alonso et al. [26] and Valizadeh et al. [29]. In fact, the effect of PA on CPFFM is indirectly through the effect on EB and SN. The results of studies by Yeboah & Kaplowitz [41] and Kimengsi & Ngu [2] verify this issue.

According to the VBN theory [22], the analysis of the relationship between PEA, EB, SN and CPFFM variables indicates a significant correlation and is consistent with the conceptual framework shown in Fig. 2. QES and ARR also showed a significant correlation with CPFFM, which is consistent with the results of studies by Araiesh [38], Habibi et al. [37] and Sagala et al. [10]. The results obtained from the correlation analysis show that based on the framework presented in Fig. 2, the variables have the necessary prerequisite (having significant correlations) to enter into a causal analysis.

#### 4.3. Causal analysis of the effective variables on CPFFM

According to the obtained theoretical framework (Fig. 2), a causal chain of existing variables can be illustrated. The results

**Table 2**  
List of variables and their items and Cronbach's alpha values for each variable.

Var.	No.	Items	References	
Community participation in forest fire management (CPFFM)	CPFFM: ( $\alpha = 0.825$ ), Semantic interpretation <sup>a</sup> : Good			
	1	Before the fire	Fire prediction	Eckerberg & Buizer [35]
	2		Fire prevention	
	3		Cultivation and involvement of local people	Kimengsi & Ngu [2]
	4		Identifying and informing about areas prone to fire	
	5		Patrol and care and rebelliousness	Degnet et al. [36]
	6		Not burning the rest of the stem, straw and stubble after harvesting the crop	
	7	During the fire	Detection and identification when the area involved in fire	Researcher made <sup>b</sup>
	8		Notifying the relevant institutions	Abedi [28]
	9		Participation in fire extinguishing	Researcher made
	10		Necessary cooperation with natural resources officers to transport possible casualties caused by fire	
	11	After the fire	Revival and reconstruction of destroyed lands caused by fire	
	12		Planting saplings in the destroyed lands caused by fire	
	13		Helping to not change the use of destroyed land due to fire	Abedi [28]
	14		Cooperation with relevant institutions to identify the cause or causes of fire	Researcher made
	15		Providing their experiences regarding fire suppression and ... to related institutions (natural resources)	
16		Caring for the injured and helping them recover as quickly as possible		
Quality of extension educational services (QES)	QES: ( $\alpha=0.819$ ), Semantic interpretation: Good			
	1	The extension service experts provide the beneficiaries with the necessary information about forest fires.	Habibi et al. [37]	
	2	In interaction with tourists about fire prevention in the forest, necessary guidance is provided through local communities.	Researcher made	
	3	There is satisfaction with educational and promotional services related to forest fire prevention activities.		
	4	Adequate educational-promotional workshops have been held to extinguish fire in the forest.		
	5	Training courses on forest fire prevention have been sufficient.		
	6	Whenever necessary, you can communicate with natural resources experts by phone or in person regarding fire.	Araiesh [38]	
	7	Training workshops to exchange opinions about fire control are of high quality.	Researcher made	
8	The sequence of fire control training in the forest has the necessary order.			
Pro-environmentalist attitude (PEA)	PEA: ( $\alpha=0.921$ ), Semantic interpretation: Perfect			
	1	Egoistic	I am not responsible for the forest fire.	Ndzifon Kimengsi & Deodatus Ngu [39]
	2		The forest fire has nothing to do with me and the relevant bodies should deal with this issue.	
	3		If there is no economic use of forests, I don't care about forest fires.	Researcher made
	4		In the event of a forest fire, I have the right not to participate in extinguishing the fire for my own health.	
	5		Without financial and personal benefit from the forest, I cannot consider forest fire.	
	6	Altruistic	Protecting forests against fire is one of the environmental priorities.	Ndzifon Kimengsi & Deodatus Ngu [39]
7		Human survival depends on healthy natural resources (especially forests); So, it is obligatory to protect it.		

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Table 2 (continued)

Var.	No.	Items	References
	8	Cutting forest trees for the expansion of agriculture and production is a big mistake.	Steg & Vlek [40]
	9	By protecting natural resources against fire, the life cycle of animals and plants is improved.	Researcher made
	10	Farmers do not have the right to destroy and create fire in the environment to increase the level.	Steg & Vlek [40]
	11	Biospheric By protecting the forest against fire, this divine gift remains for future generations.	Researcher made
	12	Forests are the right and property of all humans and we should not destroy them with our behavior.	Steg & Vlek [40]
	13	Exploitation of the forest should be in such a way that it does not threaten the life of humanity.	Researcher made
	14	I use the forest only as much as my family needs.	
	15	Having a purely economic and personal view of the forest is endangering the life of humanity.	
<b>Place attachment (PA)</b>	<b>PA: (<math>\alpha=0.888</math>), Semantic interpretation: Good</b>		
	1	The forest environment makes me happy and I will not let the fire take away this peaceful environment from me.	Souza-Alonso et al. [26]
	2	The forest gives me a sense of mental peace that I cannot find anywhere else.	Researcher made
	3	I don't like to be forced to migrate from this area because of the forest fire.	Valizadeh et al. [29]
	4	For me, the forest is full of sweet memories of the past and hope for my future.	
	5	For me, the forest guarantees the livelihood of myself and my family.	Researcher made
<b>Social norm (SN)</b>	<b>SN: (<math>\alpha=0.914</math>), Semantic interpretation: Perfect</b>		
	1	Involving the local communities by the authorities in dealing with forest fires is an established issue.	Researcher made
	2	Cooperation between local communities and natural resource personnel in forest protection is common.	
	3	Forest dwellers are used to providing the necessary information about forest fires to others.	
	4	Informed local people advise others on new methods of forest conservation and exploitation.	Yeboah & Kaplowitz [41]
	5	Cooperation among forest dwellers, especially during fire, is a well-established culture.	Researcher made
<b>Environmental belief (EB)</b>	<b>EB: (<math>\alpha=0.871</math>), Semantic interpretation<sup>a</sup>: Good</b>		
	1	I believe that creating "people's organizations" is a good way to protect the forest from fire.	Souza-Alonso et al. [26]
	2	I believe that people's unwillingness to cooperate with the promoters of natural resources is one of the reasons for non-participation in protecting the forest from the risk of fire.	Researcher made <sup>b</sup>
	3	I believe that the new methods of collective participation in forest protection are effective in preventing fires.	Kimengsi & Ngu [2]
	4	I believe that without people's participation in firefighting programs, forest protection projects will not be effective.	Researcher made
	5	I believe that preventing, controlling, controlling and compensating fire damage requires collective cooperation and interaction.	
<b>Awareness of rules and regulations (ARR)</b>	<b>ARR: (<math>\alpha=0.918</math>), Semantic interpretation: Perfect</b>		
	1	I know how to deal with a person or people who light a fire in the forest.	Researcher made
	2	I know what is the punishment for intentional fire in the forest and where should I inform if I see a violation.	
	3	I have sufficient knowledge of how natural resource officers monitor and deal with forest fire offenders.	Araiesh [38]
	4	The amount of deterrence of the punishment considered for the deliberate fire of the forest is appropriate.	Sagala et al. [10]

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Table 2 (continued)

Var.	No.	Items	References
	5	When tourists enter the forest, I know what information to provide them to prevent forest fire.	Araiesh [38]
	6	I have enough information about the conditions and methods of obtaining equipment and the type of access to the relevant bodies to reduce fire damage in the forest.	
<b>Social capital (SC)</b>	<b>SC: (<math>\alpha=0.711</math>), Semantic interpretation: Acceptable</b>		
	1	Participation Local people are involved in decisions regarding forest fire related planning.	Researcher made
	2	Residents of forest areas tend to participate in protecting the forest from the risk of fire.	
	3	Local people tend to participate in activities related to forest fires.	Walle & Nayak [27]
	4	Local people are trying to implement group activities in order to help prevent fire in the forest.	
	5	Social trust Management institutions play a big role in gaining people's trust and participation in fighting forest fires.	
	6	Local communities trust each other for forest conservation activities.	Woo et al. [32]
	7	Officials related to forest protection are accepted by local people.	
	8	Local people trust the programs provided by the authorities to protect the forests from fire.	Researcher made
	9	Social solidarity Social cohesion is necessary for people's active participation in forest fires.	Kimengsi & Ngu [2]
	10	It is necessary to promote social capital in the development of awareness of the dimensions of fire.	Woo et al. [32]
	11	Increasing social awareness promotes the cohesion of local people regarding participation.	Kimengsi & Ngu [2]
	12	The continuous activity of the local community in forest fire prevention is an important prerequisite.	Researcher made
	13	Participatory management measures to prevent forest fires are an important prerequisite.	

<sup>a</sup> Source: Habibpour & Safari [42]:  $0.90 \leq \alpha$ : Perfect;  $0.80 \leq \alpha < 0.90$ : Good;  $0.70 \leq \alpha < 0.80$ : Acceptable;  $0.60 \leq \alpha < 0.70$ : With hesitation;  $0.50 \leq \alpha < 0.60$ : Weak;  $\alpha < 0.50$ : Not acceptable.

<sup>b</sup> Prior to and during the pilot study, data gathered from interviews with local residents and observations made by researchers are presented under the heading "researcher made".



**Table 3**  
The results of correlation analysis between research variables.

	CPFFM	QES	PEA	PA	SN	EB	ARR	SC
<b>CPFFM</b>	1							
<b>QES</b>	0.680**	1						
<b>PEA</b>	0.691**	0.766**	1					
<b>PA</b>	0.053	0.083	0.009	1				
<b>SN</b>	0.197**	0.034	0.143**	0.606**	1			
<b>EB</b>	0.238**	0.070	0.184**	0.585**	0.748**	1		
<b>ARR</b>	0.476**	0.439**	0.360**	0.010	0.068	0.055	1	
<b>SC</b>	0.524**	0.523**	0.534**	0.114**	0.125**	0.167**	0.248**	1

**Abbreviations:** Community participation in forest fire management (CPFFM), Quality of extension educational services (QES), Pro-environmentalist attitude (PEA), Place attachment (PA), Social norm (SN), Environmental belief (EB), Awareness of rules and regulations (ARR), Social capital (SC).

\*. Sig. level: 0.05 error.

\*\* . Sig. level: 0.01 error.

obtained from the correlation test between the variables (Table 3) also confirm this issue. For the path analysis of this causal chain, multiple linear regression was used with the ENTER method. This method has been used in several studies (i.e., [24,25,43,44]). It was found that the presented causal model explains a significant part of the variance changes of CPFFM. In this regard, in the first step, the direct effect of three variables QES, SN and ARR on CPFFM was measured ( $R^2_{Adj} = 0.510$ ). Then, in the second step, the effect of PA and EB on SN was examined ( $R^2_{Adj} = 0.609$ ). In the third step, the effect of the SC variable on PEA ( $R^2_{Adj} = 0.338$ ) and in the fourth step, the effect of PA and PEA on EB ( $R^2_{Adj} = 0.446$ ) was analyzed (Table 4). To obtain the indirect effects, the multiplication of the direct effects of the mediating variables was used (Table 5).

According to the obtained results, QES demonstrated the highest direct effect ( $\beta = 0.552$ ) and ARR showed the lowest direct effect

**Table 4**  
Calculation of direct and indirect effects of CPFFM causal chain variables.

Direct effect on:	Independent variables	B	Beta ( $\beta$ )	t	Sig. t
<b>CPFFM</b>	<b>QES</b>	1.428	0.552	4.992	0.000
	<b>SN</b>	0.392	0.156	3.321	0.032
	<b>ARR</b>	0.262	0.134	3.832	0.000
	<b>F= 43.228</b>		<b><math>R^2_{Adj} = 0.510</math></b>	<b>Sig. F = 0.000</b>	
<b>SN</b>	<b>PA</b>	0.452	0.161	5.383	0.000
	<b>EB</b>	1.306	0.532	3.348	0.000
	<b>F= 38.489</b>		<b><math>R^2_{Adj} = 0.609</math></b>	<b>Sig. F = 0.000</b>	
<b>EB</b>	<b>PEA</b>	0.408	0.177	3.838	0.018
	<b>F= 18.019</b>		<b><math>R^2_{Adj} = 0.338</math></b>	<b>Sig. F = 0.029</b>	
<b>PEA</b>	<b>SC</b>	0.822	0.434	3.766	0.000
	<b>F= 7.608</b>		<b><math>R^2_{Adj} = 0.446</math></b>	<b>Sig. F = 0.0000</b>	

**Abbreviations:** Community participation in forest fire management (CPFFM), Quality of extension educational services (QES), Pro-environmentalist attitude (PEA), Place attachment (PA), Social norm (SN), Environmental belief (EB), Awareness of rules and regulations (ARR), Social capital (SC).

**Table 5**  
Causal effects (direct and indirect effects) of the causal chain in CPFFM analysis.

Variable	Direct effect	Indirect effect	Total causal effect	Correlation coefficient	Non-causal effect	Model compliance with the theoretical framework
<b>QES</b>	0.552	-	0.552	0.680	0.128	✓
<b>SN</b>	0.156	-	0.156	0.197	0.041	✓
<b>ARR</b>	0.134	-	0.134	0.476	0.342	✓
<b>PA</b>	-	$[(0.161 \times 0.156) + (0.484 \times 0.532 \times 0.156)] = 0.025$	0.001	0.053	0.052	✓
<b>EB</b>	-	$(0.532 \times 0.156) = 0.083$	0.083	0.238	0.155	✓
<b>PEA</b>	-	$(0.177 \times 0.532 \times 0.156) = 0.014$	0.014	0.691	0.677	✓
<b>SC</b>	-	$(0.434 \times 0.177 \times 0.532 \times 0.156) = 0.014$	0.006	0.524	0.518	✓

✓ Match the theoretical framework.

× Mismatch with the theoretical framework.

**Abbreviations:** Community participation in forest fire management (CPFFM), Quality of extension educational services (QES), Pro-environmentalist attitude (PEA), Place attachment (PA), Social norm (SN), Environmental belief (EB), Awareness of rules and regulations (ARR), Social capital (SC).

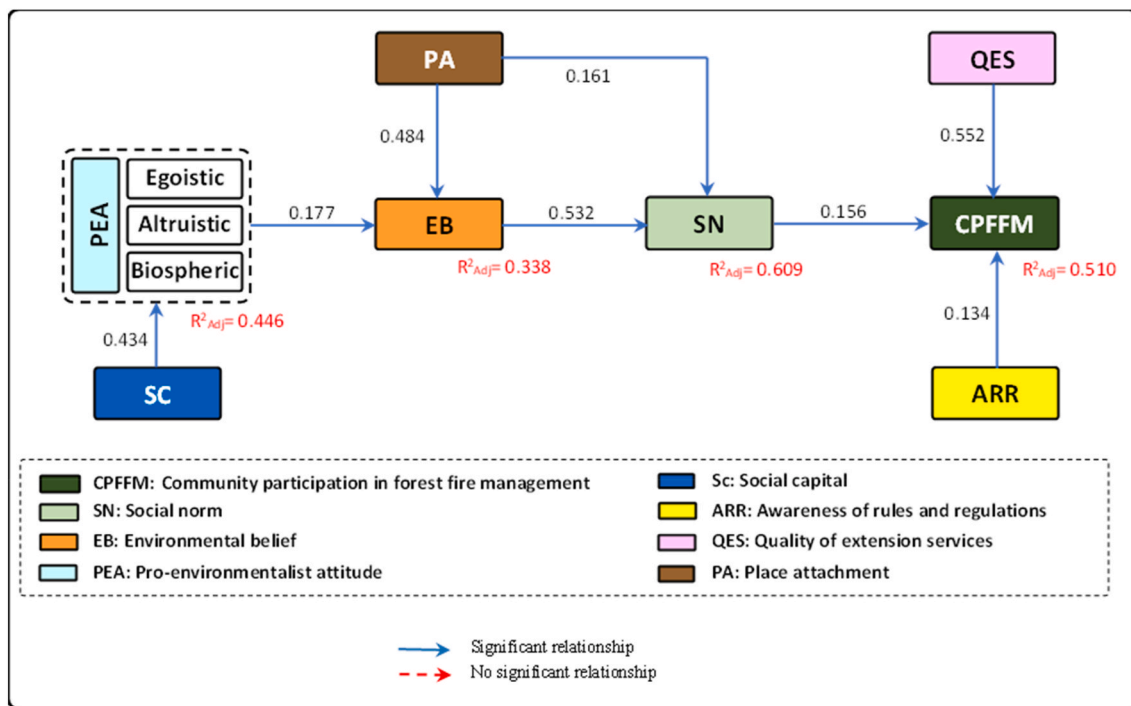


Fig. 3. The resulting causal model for CPFFM analysis.

( $\beta = 0.134$ ) on CPFFM (Table 4). Finally, the resulting causal model is illustrated in Fig. 3.

### 5. Conclusion

The present study aimed at the analysis to analyze the determinants of CPFFM in Nowshahr township. In this regard, from the point of view of human ecology and environmental psychology, the effect of seven independent variables QES, ARR, SN, PA, EB, PEA and SC on CPFFM was investigated using a survey with a quantitative approach (Fig. 2). The main core of this causal chain was based on the ethical approach and the use of VBN theory (e.g., PEA, EB, SN and CPFFM variables). The results of this causal analysis are consistent with the results of the studies reviewed in the theoretical literature section (e.g., [23–26,43–46]).

The results show that the variables presented in the mentioned causal chain have a significant impact on CPFFM in both direct and indirect methods, one of which is SC. Given the economic conditions of local communities living in forest areas and their influence on the income and livelihood, the downward trend of SC is evident in recent years, which has decreased the participation of local communities in environmental issues, including CPFFM. In this regard, the weakness of management in organizing the economic situation of local communities, especially on the part of the government, has the greatest impact on this process. Indeed, based on the low income of households and the low level of livelihood, the amount of forest exploitation has increased and this causes further reduction and destruction of vegetation and will reduce its conservation in case of fire. In Iran, the main management and macro-planning in the field of natural resources is the responsibility of the government, despite the laws enacted in order to protect the forest, due to economic needs and pressures and the lack of proper attention to their solution, the low participation of local communities is inevitable. In this case, PEA has a descending trend, and environmental attitudes will be inclined to egoistic attitudes instead of biospheric and altruistic views, which will be exacerbated by the weak SC support. As in a domino effect, these processes influence EB and then SN. However, the mediating variable of PA can have a significant effect on EB and SN. Attachment to a place and surrounding environment is a crucial factor that can compensate for weakness in other variables. The lack of investment to maintain and strengthen this variable has caused forest residents, especially the youth in rural communities, to be interested in migrating to more susceptible areas with better economic conditions. Besides the negative effect on PA, this process will decrease SC. The limitation created by the government regarding the exploitation of the forest (not using forest by-products, preventing the entry of livestock, etc.) and the laws issued without the interference of local communities, causes PA. This issue is mostly influenced by incorrect planning in the field of high centralization, not prioritizing natural resources, including forests, in macro-economic plans that have been dependent on oil. Indeed, the most important strategy here, “the shift from governmentality to appropriate governance” is the main and most important solution.

Under the current circumstances, QES and ARR are two effective variables on CPFFM. Presenting practical extension training and increasing the awareness of local communities about existing laws and regulations on forest fire and its consequences can lead to a significant increase in CPFFM. The most important factor in providing educational programs and the establishment of fire protection laws and regulations are the local communities living in the forest, who should be present and participate from the beginning to the end

(design to implementation and evaluation).

Local participation emerges at the convergence of community needs and individual aspirations. It entails active engagement and dialogue to establish common objectives and empower community members. Such involvement is crucial for sustainable development and inclusive decision-making. To foster community engagement effectively, it should encompass all stages, from initial planning to delegation, ongoing support and ultimately, program evaluation and impact assessment. Taking some measurements to delegate management of natural resources to local communities and participating these people in planning will attract maximum participation. In this regard, it is necessary to increase the SC of rural households, help to increase income, provide laws to facilitate the use of forest by-products and guide and support these people towards some activities such as wood farming, provide banking facilities to start workshops for the processing of forest by-products, and help the residents for better integration and expansion of activities in the country and international markets to increase income. Thus, education is a key element that should be prioritized to strengthen the desired PEA in forest residents.

The current study has the following limitations: Part of the data collection time coincided with the COVID-19 pandemic, which created challenges to optimal data collection. Another limitation is that there are many other variables (for example, personal, professional, sociological, managerial, political, etc.) for the CPFFM analysis that can be influential. Another limitation was the lack of statistics and information about fires, their causes and historical trends in the region. As no research can cover all the dimensions of a subject, the present study focused only on the variables used in the theoretical framework of the research. In fact, CPFFM can be examined with logical or ethical approaches, different theories and suitable for each region in future studies. Despite the mentioned limitations, the findings obtained in this study can be useful in the conceptualization and understanding of CPFFM and can play a role in future planning and decision-making and help prevent and control fires in forest areas.

### CRedit authorship contribution statement

**Mohamad Hassan Ansari:** Data curation, Formal analysis, Investigation, Resources, Software, Writing – original draft. **Masoud Bijani:** Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Enayat Abbasi:** Conceptualization, Project administration, Supervision, Writing – review & editing. **Imaneh Goli:** Conceptualization, Validation, Writing – review & editing.

### Declaration of competing interest

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

### Data availability

Data will be made available on request.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijdr.2024.104478>.

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