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Identifying the factors affecting the willingness of villagers to participate in forest firefighting in Iran's Zagros forests

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Abstract

One of the environmental factors affecting the forest ecosystem is fire. Local volunteer firefighters are often those who first respond to forest fires. This study was conducted aimed to determine the factors affecting their willingness to participate in firefighting in the northern Zagros forests of Iran (Sardasht County). For this purpose, after extracting Sardasht fire statistics during a 14-year period (2006-2019), the villages with the highest frequency of fires in the above period were selected. Organizing, facilities and equipment, indigenous knowledge and education for firefighting were selected as factors affecting the willingness to participate in firefighting. The research tools were a questionnaire and face-to-face interview. The statistical population included 649 households. According to Morgan's Table, the number of samples required for the distribution of questionnaires was $n=242$. The questionnaire questions were designed openly and closed with scores based on the Likert scale and the factors affecting villagers' willingness to participate in firefighting were investigated by face-to-face interviews. The results of statistical analysis of data showed that organizing, knowledge and facilities had a significant effect on the participation of respondents. This study showed that for the villagers, organizing was the most effective factor and facilities was the last factor affecting their willingness to participate. Also, a positive and significant relationship was found between the participation and the level of education. Therefore, it is necessary for the promotion department of the Iran's Forests, Range and Watershed management Organization (FRWO), along with the protection unit of the organization, to provide special programs and policies for the organizing of the public, rural and volunteer firefighting forces before the fire spreads to control it in principle.

1. Introduction

According to the statistics published by the Iran's Forests, Rangelands and Watershed management Organization (FRWO), hundreds of fires occur annually in different parts of Iran, which ranks fourth among the countries of the Middle East and North Africa in terms of the amount of forest destruction due to fires (Beygi Heidarlou et al., 2014).

The participation of local people is one of the main factors of the final decision-making and acceptance of ecosystem management practices. Firefighters are the basis of any forest fire prevention and control system in which volunteer firefighters and members of non-governmental organizations play an important role. The success of fire fighting plans or mechanical stress reduction programmes may be influenced by how local societies think.

The Zagros forests with an area of about 4,749,000 hectares (Roozitalab et al., 2018) have a special place and importance among the vegetation areas of western Iran. Fires in Zagros are devastating, amounting to 6,500 hectares per year, which mostly are caused by human beings. In order to manage the fire crisis in this vegetation area, it is necessary to know the factors affecting the participation of people and local societies in the fight against fire and how they change in terms of time and place. Specifically in this study, we seek to answer the following question:

- What are the most important factors affecting the willingness of local societies in Sardasht to participate in firefighting in the Zagros forests?

2. Methods & Materials

2.1. Study area

Sardasht with an area of 138,000 hectares in northwestern Iran has been selected as the study area in this study (Figure 1). According to the latest official statistics (2016), the population of Sardasht is 118,849 people. Sardasht is located between 45°13'48'' to 45°42'00'' E longitude and 35°37'36'' to 36°28'12'' N latitude. The average height above sea level is 1515 m (Beygi Heidarlou et al., 2020). This area is often covered with dense forests with trees such as *Quercus infectoria* Oliv, *Q. libani*, *Q. brantii*, *Vitis vinifera* L., *Ficus carica* and *Pyrus glabra*. Sardasht forests cover an area of 83,000 hectares (Beygi Heidarlou et al., 2019), Important causes of deforestation in recent decades include cutting down of trees for fuel, frequent fires, pruning to provide fodder, clear-cutting of forests and ploughing of forest soil to agricultural activities and vineyards and the constant presence of livestock, especially goats, in the forests.

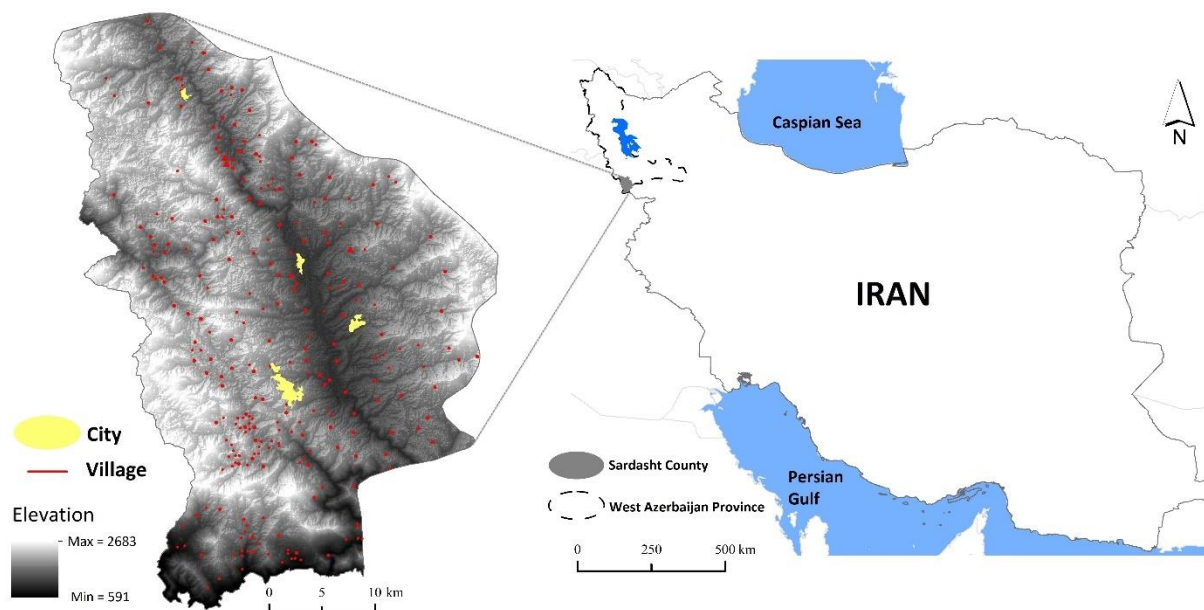


Figure 1. Geographical location of study area.

2.2. Research methodology

14 villages with the highest frequency of fires (2006-2019) in their customary system were selected. the present study was conducted by descriptive-survey research method. The study population included 242 residents of the villages who were selected using the Krejcie-Morgan sample size table in 2020 (Table 1).

Table 1. List of villages, number of households and number of measured samples in the study.

Row	Villages name	N of households	Population	N of samples households
1	Molasheikh	56	219	21
2	Gurangan	22	85	8
3	Baskedu	2	6	2
4	Banavile-Hajimine	16	64	6
5	Shalmash	57	201	21
6	Shivashan	9	25	3
7	Niskabad	16	68	6
8	Aghlan	80	307	30
9	Belav	12	61	4
10	Shendre	20	69	7
11	Bizile	39	137	15
12	Torshian	6	19	2
13	Cheku	107	400	40
14	Dolatu	207	834	77
Total	-	649	2505	242

Data were collected using a researcher-made questionnaire. In addition to individual, professional and sociological questions, this questionnaire contained 35 items representing willingness to participate, organizing, facilities and equipment, indigenous knowledge and firefighting training (education) factors provided by literature and Interviews with experts and specialists. The respondents were then asked to determine the effect of each of these factors on their willingness to participate in firefighting on a 5-point Likert scale. The validity of the questionnaire was confirmed using the knowledge of experts and university professors. Cronbach's alpha test was used to investigate the reliability with a coefficient of 0.899, which in social research indicates the appropriate reliability of the measurement tool.

2.3. Statistical analysis

The data obtained from the questionnaires were analyzed by SPSS Windows (version 25). Confirmatory factor analysis (CFA) was used to confirm the classification of factors affecting the willingness to participate in firefighting. The value of Kaiser-Mayer-Olkin (KMO) statistic was 0.867 and the value of Bartlett's Test of Sphericity was 1787.58 (at 0.0001 level), which indicate the appropriateness of the data for factor analysis. Also, in order to increase the interpretability of the items related to the attitude of the respondents, the Varimax method was used and a total of five factors (organizing, willingness to participate, education, indigenous knowledge, and facilities and equipment) were extracted based on eigenvalues and the previous factor criteria. At the next stage, stepwise regression was used to determine the factors affecting the willingness of villagers to participate in firefighting.

3. Results

3.1. Characteristics of the statistical population

The demographic information is presented in Table 2.

Table 2. Results of demographic characteristics of the studied community

Characteristic	Class	Frequency (%)	Characteristic	Class	Frequency (%)	
Gender	Female	0.83	Education	Illiterate	18.75	
	Male	99.17		High school diploma	47.08	
Age (year)	15-20	3.31		Diploma	16.25	
	21-30	35.12		Associate degree	3.33	
	31-40	33.47		Bachelor's degree and higher	14.58	
	41-50	14.05		Number of livestock available (livestock)	< 25	39.39
	51-60	8.26			26-50	23.23
	61-71	5.79			51-100	17.17
Number of household members (persons)	1-2	8.3			101-150	12.12
	3-4	46.06			> 151	8.08
	5-6	34.44	Marital status		Single	24.79
	7-8	9.54		Married	75.21	
	9-10	1.66	Job	Unemployed	4.13	
Type of livestock	Goats and sheep	52		Employee	5.49	
	Cow	47		Beekeeper, farmer and rancher	45.04	
	Other	1		self-employment	45.04	
Average monthly income (\$)	< \$ 55	27.59	Agricultural area (ha)	< 0.5	10.71	
	\$ 55-110	41.87		0.6-1	28.57	
	\$ 110-165	14.78		1.1-2	24.49	
	> \$ 165	15.76		2.1-5	28.57	
Participate in training classes	Yes	7.44		> 5	7.65	
	No	92.56				

3.2. Factor analysis results

The study result was a reduction in 22 indicators to five factors, which explained about 57% of the variance of participation and indicated the satisfactory factor analysis and indicators used to investigate the dimensions of willingness to participate in this study (Table 3).

Table 3. Variance and eigenvalue of factors of people willingness of participation in firefighting programs.

Component	Eigenvalue	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
		Eigenvalue	% of Variance	Cumulative %	Eigenvalue	% of Variance	Cumulative %
1	6.45	6.45	29.31	29.31	3.73	16.97	16.97
2	2.17	2.17	9.86	39.17	2.63	11.93	28.90
3	1.62	1.62	7.38	46.55	2.19	9.97	38.87
4	1.27	1.27	5.75	52.30	2.15	9.79	48.67
5	1.08	1.08	4.89	57.19	1.88	8.52	57.19

Extraction Method: Principal Component Analysis.

Finally, the last stage is to perform factor analysis, naming the factors that have already been named according to the nature and type of items and indicators of willingness to participate, and according to the expert point of view, the indicators have been named according to their nature. The first, second, third, fourth and fifth factors, which explained about 16.97, 11.93, 9.97, 9.79 and 8.52% of the variance related to factor analysis, respectively, according to the nature of the available variables were named as 1) organizing, 2) willingness to participate, 3) education, 4) indigenous knowledge and 5) facilities and equipment. Factors one to five consist of seven, four, three, four and three variables with the factor loads specified in Table 4, respectively. These variables play a greater role in the total variance of the variable. Also, during factor analysis, variables or questions that have less factor load or correlations i.e. their coefficient of determination (R^2) is less than 0.4, were not included in the analysis.

Table 4. Variables related to each factor and the amount of factor load obtained from the rotated matrix.

Factor	Measuring indices of participation	Factor Load
Organizing	Q6: I am ready to give the necessary training to the villagers in different seasons of the year to prevent fires.	0.572
	Q7: I am willing to participate in firefighting if I pass firefighting training courses and have the equipment.	0.6
	Q8: In the village, one or more responsible and knowledgeable people are needed for the volunteer forces to carry out the orders.	0.765
	Q9: As soon as a fire breaks out, I follow the instructions of the person in charge in the village.	0.75
	Q10: Provide the equipment needed to extinguish the fire before the fire occurs to the people or the village head.	0.566
	Q11: Organizing before putting out a fire will help succeed in putting out the fire.	0.689
	Q12: In organizing, a responsible person must be chosen.	0.56
	Q13: Each organization should be repeated manually in specific time periods.	0.572
Willingness to participate	Q1: I am willing to work with natural resources officers as a volunteer to fight fires.	0.775
	Q2: I am willing to accept responsibility for leading a public firefighting team.	0.542

	Q3: Until the firefighters arrive, we will put out the fire with the help of the villagers.	0.697
	Q5: In the event of a fire, I will try to put it out myself.	0.645
Education	Q29: Teaching how to use devices and equipment is effective in the success of firefighting.	0.72
	Q30: Teaching how to behave and move fire in pastures and forests has an important role in extinguishing fires.	0.822
	Q31: Training should be provided by natural resource experts.	0.597
Indigenous knowledge	Q20: To spread the fire to the top of the hill.	0.736
	Q21: In the event of a small fire, it must be attacked directly.	0.561
	Q23: The rate of fire spread in pastures is higher than in forests.	0.693
	Q24: Relative humidity has the highest correlation with the occurrence and extent of fire spread.	0.654
Facilities and equipment	Q15: Individual facilities and equipment play an important role in firefighting.	0.512
	Q16: Heavy facilities and equipment play an important role in fire fighting.	0.81
	Q17: Motor facilities and equipment play an important role in fire fighting.	0.755

3.3. Stepwise regression test results

The results of factor analysis using stepwise regression showed that organizing, knowledge and facilities factors had a significant effect on the willingness to participate in firefighting. According to the results, three of five predictors in the study were included in the model. The results of the stepwise regression model summary also showed that based on the value of the adjusted R-squared, the three selected predictors had the ability to explain about 45% of the scatter of the dependent variable (participation) (Table 5).

Table 5. Summary of stepwise regression model.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.638 ^a	0.407	0.405	2.51
2	0.666 ^b	0.443	0.439	2.43
3	0.673 ^c	0.453	0.446	2.42

a. Predictors: (Constant), Organizing

b. Predictors: (Constant), Organizing, Indigenous knowledge

c. Predictors: (Constant), Organizing, Indigenous knowledge, Facilities and equipment

Table 6 shows the coefficients of each factor. According to the study results, the factor of organizing with a coefficient of 0.549 played the most important role in participation, followed by knowledge (0.165) and facilities (0.11).

Table 6. Coefficients of stepwise regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	8.889	1.322		6.726	.000					
	Organizing	0.789	0.061	0.638	12.837	.000	0.638	0.638	0.638	1.000	1.000
2	(Constant)	5.943	1.484		4.003	.000					
	Organizing	0.725	0.062	0.586	11.720	.000	0.638	0.604	0.566	0.931	1.074
	Indigenous knowledge	0.263	0.067	0.197	3.947	.000	0.351	0.247	0.190	0.931	1.074
3	(Constant)	4.199	1.715		2.448	.015					
	Organizing	0.679	0.066	0.549	10.336	.000	0.638	0.557	0.496	0.816	1.226
	Indigenous knowledge	0.220	0.069	0.165	3.164	.002	0.351	0.201	0.152	0.843	1.187
	Facilities and equipment	0.129	0.065	0.110	1.994	.047	0.400	0.128	0.096	0.750	1.333

Dependent Variable: participation

The model presented by this regression fit will be as follows:

$$\text{Participation} = 4.199 + 0.549 (\text{Organizing}) + 0.165 (\text{Indigenous knowledge}) + 0.110 (\text{Facilities and equipment})$$

4. Discussion

The study results showed that the respondents in this study were willing to fight voluntarily with natural resources officers against fire. Voluntary activities are often carried out in the context of society, with different standards, norms, resources and institutions. By volunteering and willing to participate in solving problems in society, people respond to what they see as social problems in their society, and so social capital increases as encouraging civic and voluntary participation and social trust (creating communication and cooperation between members) (Putnam, 2020). The respondents were also satisfied with accepting responsibility for leading a firefighting team and willing to fight against the fire with the help of villagers until firefighters arrive. The willingness to fight against the fire voluntarily can be done individually or collectively. In collective voluntary activities, the head of groups inspire, and oversee the activities of others (Eckstein, 2001). In the last two decades, the willingness to participate in firefighting voluntarily has been investigated by several researchers (Perkins, 1989, 1990; Perkins and Metz, 1988). Thompson III and Bono (1993) found that the strongest motivation for volunteering as a firefighter was to help society, followed by the will to help contain the fire. Perkins and Metz (1988) argued that firefighting represented powerful sources of solidarity and identity of society.

The respondents believed that facilities and equipment for firefighting play an important role. In the face of forest fires, what is very important is the availability of firefighting equipment and infrastructure (Clément, 2001).

The study results in relation to the native knowledge of the respondents showed that they were relatively aware of the basic principles of firefighting. They believed that: direction of fire spread is to the top of the hill; in the occurrence of a small fire, must be directly attacked; the spread of fire in the rangelands is faster than forests; and Relative humidity has the highest correlation with the occurrence and extent of fire spread, which is

consistent with the results of the Forthofer (2007), Plucinski et al. (2017), Maffei and Menenti (2019) and Ertugrul et al. (2021) studies.

At the pre-fire stage, the human management and firefighting training courses are important for local and national forces (Karimi et al., 2014). The respondents in this study believed that firefighting training and how to use devices and equipment play an important role in firefighting and preventing its spread. Vadrevu et al. (2010) in their study in southern India showed that informing and training the public, publishing risk maps and regional recommendations to authorities have played an important role.

The results of factor analysis using stepwise regression showed that the factors of organizing, knowledge and facilities had a significant effect

($\alpha = 0.01$) on the participation of respondents (Table 6), indicating the importance of these factors. According to the study results, organizing factor had a greatest effect among the other two factors on the participation of respondents, which is contrary to the opinion of officials of the FRWO and Natural Resources Department, which is the main cause of failure due to the lack of facilities. This study showed that for the villagers, organizing was the most effective factor and facilities was the last effective factor on their willingness to participate.

5. Conclusion

The participation of local societies in recent decades as a rational and human necessity is the most important variable of development and protection. In general, in order to promote the willingness for participation of local societies and foresters, it is necessary to organize, train basic measures and use the indigenous knowledge of villagers for firefighting and increase firefighting facilities and equipment in forest areas and natural resources. This will not be possible without considering the various dimensions of the attitude and willingness of villagers and forest dwellers for firefighting and try to improve it. Therefore, the necessary measures to increase the willingness of villagers and foresters for firefighting should not be delayed under the pretext of limited resources to address other dimensions of forest management.

The study results introduced the factor of organizing and knowledge as the first and second factors in terms of importance and the factor of facilities as the third factor for explaining the variance of the willingness for firefighting. Given the current different and opposite attitude towards forest firefighting among most of the top managers in the country, according to the study results, their attitude can be improved.

High efficiency of firefighting, control in a short period of time, quick access to fire extinguishers, professional readiness of local societies to deal with fire, use of firefighting equipment, continuous training classes, constant presence of physical fire control and fighting forces on site and quick access to its location, familiarity with the fastest ways to access the site of the fire, quick and uninterrupted access to individual, collective and motor facilities and equipment, and the presence of one or more local officials to maintain order at times of crisis are very important using different methods of fire control. Therefore, the relevant organizations should organize and train the public forces so that they are ready for firefighting in the event of a fire.

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