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Degree modeling of pistachio farmers' resilience against climate change (Study subject: Rural areas of Rafsanjan and Anar counties, Iran)

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The counties of Rafsanjan and Anar are some of the main production centers of pistachio, an important strategic commodity of Iran that is recently facing major environmental problems such as climate change. Therefore, the present research has modeled the degree of resilience of Rafsanjan pistachio and pomegranate farmers against climate change. The study's statistical population was pistachio farmers in the rural areas of Rafsanjan and Anar, which were 27,860 people. To determine the sample size of the research, a sample size of 588 users was calculated using Cochran's formula, with an error level of 4%. Users were then randomly selected in each village as a proportional assignment. A questionnaire was used for data collection. A group of experts determined its validity, and Cronbach's alpha method was used to determine its reliability and internal consistency. The combined method of Vaikor-entropy was used to measure the resilience behavior of Rafsanjan pistachio and pomegranate farmers against climate change. Data processing was done using MATLAB 7.10, AMOSver24, SPSSver25, and Arc-GIS 10.5 software. The results show that the behavior of the studied farmers' resilience against climate change is at an average level. Also, after analysis, the studied villages were divided into six levels, ranging from lack of endurance to resilient. None of the villages fell into the lowest or highest level. There are 8 villages with a very weak resilience level and 22 villages in the weak resilience level. There are 26 villages at the relatively resistant level and 4 villages in the good resilience level. This finding indicates that the investigated pistachio growers are not in good shape in terms of climate change resilience, and they are unable to deal with larger climate change variations, which can have serious effects on the agricultural sector and the villages' livelihoods.

KEYWORDS
climate change, confirmatory factor analysis, resilience measurement, geographic information system, RCCR model, Vaikor-entropy method, weak resilience level

Introduction

When the theory of global warming was first proposed by Swedish scientist Arrhenius a century ago, few people imagined that this issue would so quickly become the most important concern of the international communityby first affecting and then changing the earth's climate (Qombar Ali et al., 2011). In other words, climate change is one of the biggest challenges that humanity is facing in the 21st century, severely affecting water resources, agriculture, energy, and tourism (Valiqolizadeh, 2018). Any relatively stable deviation in any of the climate elements or a deviation of the functioning climate factors and components from prevailing conditionswill result in climate change (Hoshmandanfar Moghadam Fard et al., 2019). Climate change can have a serious environmental, social, and economic impact on the employment and livelihood of all the planet's inhabitants, including farmers (Chisanga et al., 2017). Moreover, natural hazards such as climate change can turn into horrible and devastating accidents for human communities without risk reduction systems (Zhou et al., 2010). In this regard, societies must learn how to deal with climate change and its effects. Therefore, in the early stages, the main focus of actions was on reducing the risks caused by climate change. In the next stage, the work was directed at identifying direct responses to climate effects dealing with the resulting consequences, and adapting to these changes. Recently, the focus has shifted beyond identifying specific adaptations to resilience to ensure that individuals, communities, sectors, and nature have the necessary capacities to respond to any stress that arises (Schwarz et al., 2011).

Resilience is the third stage of response to crises and climate change (Gardner et al., 2019). The word resilience was introduced in the discussion of disaster management in 2005 at the Hugo conference. Since then, it has gradually gained a greater place in the theoretical and practical fields of disaster risk reduction. In recent years, concepts such as resilient societies, resilient livelihoods, and creating resilient societies have been commonly used in scientific articles (Manyena, 2006). Resilience as one of the types of socio-ecological systems can be interpreted in three cases: 1- the amount of disturbance that a system can absorb and remain in the same first state, 2- the limit, or the degree to which the system can organize itself and 3- the extent or degree in which the system can be built, or its capacity for learning and adaptation can be increased (Folke et al., 2004). Due to the dynamic nature of society's response to risks, resilience is a type of foresight that helps to expand policy choices in the face of uncertainty and change, which includes economic, social, environmental, and psychological dimensions (Berkes, 2007). Therefore, resilience against climate change is one of the characteristics of sustainable societies (Engle, 2011).

Climate change is a significant threat to farming communities' livelihoods (Campbell et al., 2011). The consequences of climate change and drought can lead to the instability of rural livelihoods (Speranza et al., 2008). Studies have also shown that households that depend on agriculture for livelihood are more exposed to the threats of climate change (Johnson, 2009). Therefore, rural and agricultural communities need to be more resilient against climate change because the livelihood of these communities depends on climatic conditions (Birkmann, 2011). However, the damages caused to farms and the consequences of climate change, such as periodic droughts, show farmers' lack of preparedness and resilience against this risk and its consequences. In other words, the first necessary step to deal with natural hazards such as climate change and adjust to its consequences is to know and understand the scope of people's vulnerability and their resistance to improving their tolerance and flexibility threshold (Sadeghlou and Sejasi Keidari, 2013).

Since problems and issues in rural areas differ according to the conditions of each region, it is necessary to pay special attention to regional and local planning to accurately determine the priorities in each region (Ranjbar, 2009). For this purpose, an accurate and comprehensive understanding of the existing situation, based on a systematic approach (Karimi et al., 2017). In this regard, knowledge of the spatial distribution and degree of resilience of farmers in rural areas against climate change is considered a prerequisite for development plans and programs in rural areas. Also, by evaluating and modeling the degree of resilience of farmers in rural areas against climate change using a significant share of the country's farming population, it is possible to formulate realistic plans to improve the resilience of farmers in rural areas to aid in climate change resilience efforts.

Pistachios are one of Iran's most important export products in the arid and semi-arid regions, including Kerman province (Bagheri et al., 2012). In addition to the economic aspect, pistachios play an essential rolein soil protection and sand control, especially in arid and semi-arid regions of Iran. In this province, Rafsanjan and Anar counties are considered the largest pistachio production centers in Iran, with around 80 thousand hectares of pistachio cultivation. The livelihood of most of the villagers in Rafsanjan and Anar counties is directly or indirectly dependent on pistachio production, and any disruption in pistachio production could endanger their income and, as a result, their livelihood (Hosseinifarhangi et al., 2020). As one of the main areas of pistachio production, Kerman province has faced climate change problems in recent years. Drought, cold, and untimely frosts are among the results of the phenomenon of climate change in Kerman province. Also, climate changes, drought, and indiscriminate harvesting have caused the income of the farmers to decrease (Meridenjad et al., 2014). This phenomenon has had many harmful effects on the farming and agricultural products of the region, especially pistachios, one of the primary sources of livelihood for farmers in Kerman province. During the past decade in Rafsanjan and Anar counties, the cold weather destroyed several farms and greatly reduced the productivity of others (reduced production by 70 and 85% in 2014 and 2018, respectively) (Jamalizade, 2014). Therefore, to recover their livelihood, rural households in Rafsanjan and Anar need to be able to withstand climate change and deal with crises that threaten their livelihood. Consequently, the question raised in this research is, what is the level of resilience of pistachio farmers in the rural areas of Rafsanjan and Anar cities?. And the most important dimension in measuring the resilience of pistachio farmers is the rural areas of Rafsanjan and Anar cities?.

Literature review

Globally, the dominant perspective has changed from focusing only on reducing vulnerability to increasing resilience against climate change and disasters (Cutter et al., 2008). Since being introduced at the Hugo conference in 2005, resilience has become increasingly important in the theoretical and practical fields of disaster risk reduction (Mayunga, 2007). Based on Folke's definition, resilience is the capacity to absorb disruption and organization (Folke et al., 2004). Many studies on resilience opposite sciences, and the idea of resilience is an interdisciplinary

TABLE 1 Definitions and concepts of resilience in different scientific fields.

Science	Definition	References
Ecological	The resilience of an ecosystem is the ability of that system to absorb changes and concepts against it and continue on its path.	Holling, 1973
Social	Social flexibility is the ability of groups and societies to deal with external tensions and disturbances resulting from social, political, and environmental changes.	Adger, 2000
Economy	Resilience is the distance to the threshold. This distance shows the volatility of stocks, where a level of stocks is equivalent to the flexibility of the system	Walker et al., 2010
Psychology	Having a good life despite hardships. Being exposed to hardship is significant; flexibility is the capacity and ability of people to move on their path and obtain psychological, social, and physical resources to ultimately maintain their health and comfort.	Ungar, 2011
Spatial resilience	Spatial resilience is the ability to maintain identity over time; maintenance of key components and relationships continuously over time, so that if flexibility is low, identity may decrease and vice versa.	Cumming, 2011

Source: Speranza et al., 2014.

concept proposed in the fields of ecology, psychology, social sciences, economics, and other sciences (Table 1).

One of the fundamental aspects of research related to resilience and resilient communities against natural hazards is finding the appropriate way to measure resilience. Since this research is related to natural hazards and disasters, researchers study ways to take steps toward practical and technological improvement to reduce the risk of accidents. Due to the multifaceted nature of resilience (including ecological, economic, institutional, and social dimensions), the transition from the theoretical framework concepts to reality is complicated and challenging to evaluate. Current resilience models examine the flexibility of societies to reduce vulnerability to the consequences of hazards; it is necessary to study and analyze these models to determine which is suitable in each case. For example, different researchers have proposed several models addressing specific aspects of resilience against flooding, while other models have been presented to measure resilience against accidents.

Many essential models are currently being used to analyze different types of resilience. Some of the most important and widely used models are mentioned below. Tobin's model has been proposed to evaluate the resilience of communities located in high-risk areas, he uses three models, risk reduction, recovery, and demographic structure, to show the sustainability and resilience of the community, and then the framework assesses which is more ecological (Tobin, 1999). Kumpfer's resilience framework is an exchange model of resilience and includes the structure of process and outcome. This model pays less attention to the cycle of destruction and reintegration and is somewhat oriented toward the interactive nature of environmental and internal content and internal resilience factors, as well as the consequences of reintegration (Kumpfer, 1999). Adger (2000) proposed a community-based disaster management model (CBDM), a bottom-up management approach that pays attention to people's participation in solving crises caused by natural disasters. Its purpose is to reduce the vulnerability of societies and strengthen people's abilities and participation to deal with the risks caused by natural disasters. The linear-time model of Davis and Izadkhah (2006) shows that society can improve its vulnerability over time in the form of a timeline in certain conditions following development. This model has three stages: 1. absorbing and tolerating stress and risk before the disaster, 2. returning to the balance after the disaster, and 3. changes in the communities to make them safe and resilient. Capital-based model (Mayunga, 2007) has been proposed as a framework for evaluating society's resilience against disasters based on types of capital (material, economic, physical, human, and natural). The spatial model or DROP (Cutter et al., 2008) is designed to clarify the relationship between resilience and vulnerability and provides a comparative assessment of disaster resilience at the local and community levels. This model defines resilience as a dynamic process dependent on previous conditions, the severity of accidents, the time between hazards, and the influence of exogenous factors. This model pays attention to the economic, social, ecological, and institutional dimensions. Jurjonas and Seekamp's RCCR model 2017 considers resilience as a range from vulnerable to flexible, where the capacity to adapt to society is scaled between opposite indicators. The drawn line shows the relative position of societies in this spectrum or at what level the whole system is placed.

Various studies have been proposed and conducted to measure the resilience of farmers in rural areas sample of domestic and foreign studies in this field is presented in Table 2.

After considering the different dimensions of resilience and the multiple definitions of this concept, this study used the RCCR model to measure resilience. The RCCR framework is designed to rapidly engage stakeholders with other stakeholders to assess local resilience needs (Jurjonas and Seekamp, 2017). Furthermore, this model considers resilience as a range from vulnerable to flexible, where the capacity of a society is scaled between opposite indicators. Therefore, this model aims to reduce the vulnerability of societies and strengthen people's abilities and participation to deal with the risks caused by natural disasters and accidents. In other words, RCCR integrates the idea that adverse changes affect societies, and high vulnerability can eventually lead to the collapse of the whole system (Jurjonas and Seekamp, 2017). Table 3 presents the conceptualization of the dimensions of the RCCR model.

Methods

The current research was conducted as a survey and used quantitative numerical data analysis in a descriptive-correlation method. The statistical population of the research was 27,860 pistachio farmers in rural areas of Rafsanjan and Anar counties (Figure 1). A stratified sampling method was used to select the studied villages with regard to the extent of the studied. Each village was first divided into four classes (north, south, west, and east). Villages

TABLE 2 Domestic and foreign studies in the field of resilience against climate change.

References	Subject	Result
Fang et al. reported that modifying the seasonal crop calendar, using resistant species and seeds, integrated crop production models, and diversifying income were among the most important adaptation strategies of farmers in response to climate change.	Knowing the capacity of smallholder farmers to respond to climate change in a central coastal Vietnam.	Phuong et al., 2018
Their results showed that 90% of farmers had understood climate change, and 85% of farmers are also trying to implement strategies such as crop adaptation, change to strengthen planting, management, and protection of water and soil, increasing the use of inputs, combining crop cultivation with animal breeding, and adapting their tree planting to it.	Examining the adaptation components of smallholder farmers to climate change in Ethiopia.	Belay et al., 2017
Their results showed that indicators such as diversity of skills in the labor force and employment, the performance of retailers and land efficiency, development of employment levels, flexibility, and financial facilities have an effect on the resilience of farmers against drought.	Analysis of economic resilience of farmers against drought in Fasa, Iran.	Jafari et al., 2020
They concluded that the resilience of the studied farmers is above average. Also, economic indicators and social capital have an effect on the resilience of farmers against drought.	Analyzing the resilience of farmers against drought with an emphasis on economic factors and social capital in rural areas (case study: Roniz village, Iran).	Akbarian Rounizi and Ramzanzadeh-Lesboi, 2019
Their results showed that rural households' food security and resilience against climate change are inadequate. They also showed that there is a positive and significant relationship between the index of resilience against climate change and the level of food security.	The role of resilience against climate change on the level of food security in rural households in the Menarid project in Yazd province, Iran.	Bagheri Fahroji et al., 2018
Their results showed that the resilience of the studied farmers is not suitable; some of the factors affecting the resilience of farmers against natural hazards include the development of agricultural products insurance, a monitoring and forecasting system, and indigenous knowledge.	Prioritization of effective factors for increasing the resilience of farmers against natural hazards in Abjerod, Iran.	Sadeghlou and Sejasi Keidari, 2013

Source: Author.

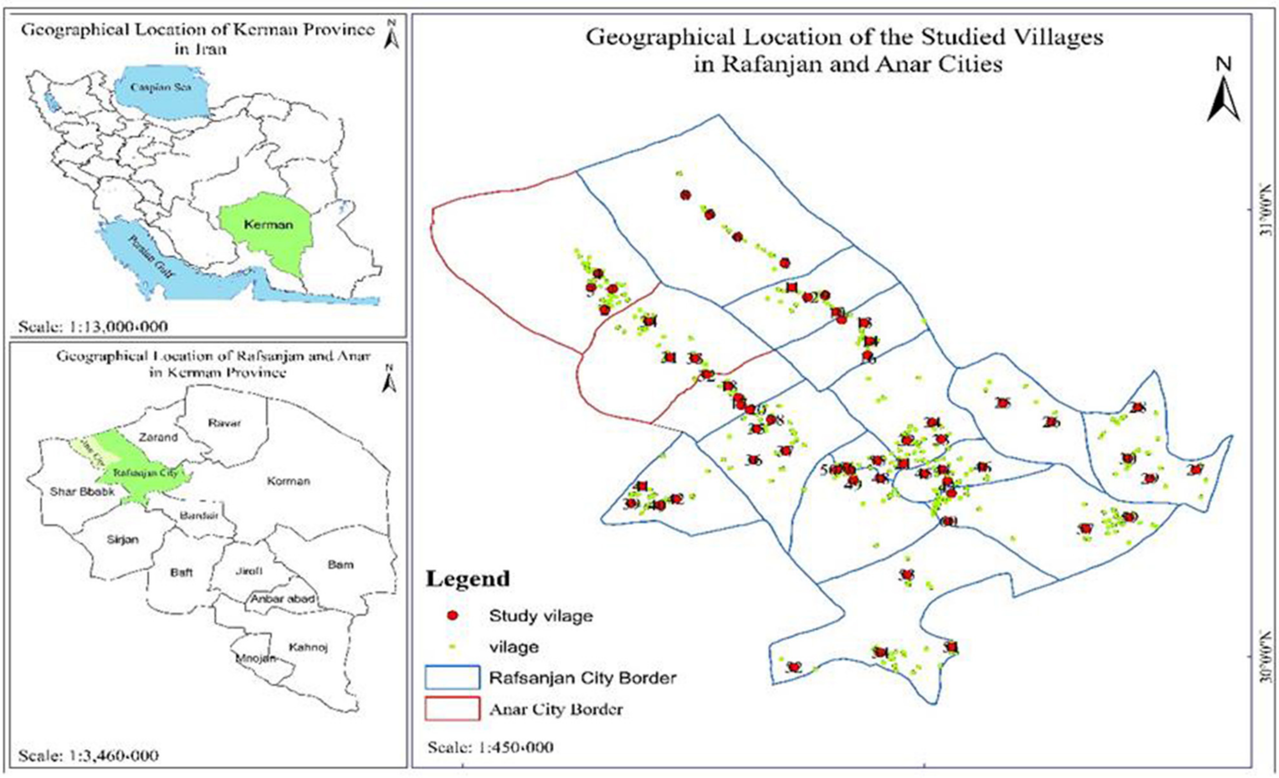

FIGURE 1
Spatial distribution of the selected villages (drawing by author).

were then randomly selected in each class (map 2). Next, Cochran's formula was used to determine the sample size of 588 users among the 27,860 users (pistachio farmers) in the study area, with an error level of 4%. Lastly, several beneficiaries were randomly selected in each village, a form of proportional assignment.

TABLE 3 Conceptualization of RCCR model dimensions.

References	Concepts	Dimensions
FAO (2019)	Livelihood diversification is one of the most effective risk management strategies for farmers facing climate change	Livelihood diversity
Frazier et al. (2010), Lane et al. (2013)	Wealth in a society facilitates the ability to develop solutions for environmental problems and maintain infrastructure. In addition, community wealth is a measure of local livelihood success that can strengthen long-term climate change preparedness planning	Health
Smith et al. (2012), Donatuto et al. (2014), Amundsen (2015)	Cohesive communities where people have a sense of belonging, happiness, and social events and full of opportunities to participate can create a stronger connection with the region and lead to planning to adapt to climate change	Social solidarity
Barbier et al. (2011)	Protecting ecosystem services through strategic and sustainable planning and development can reduce damage and disaster recovery costs while avoiding the need to create infrastructure to reduce risk	Sustainable development
Colombo and Byer (2012)	Flexible adaptation strategies by designing simultaneous adaptations with future climate change can help reduce the effects of uncertainty.	Flexibility

To collect the research data according to the research objectives, a multi-section questionnaire was designed with questions using a qualitative range of five options (completely disagree = 1, disagree = 2, have no opinion = 3, agree = 4, and completely agree = 5). The data collection process lasted three months, from May-July 2018, and data was collected from 60 villages in Rafsanjan and Anar. The RCCR resilience framework consisting of five components, livelihood diversity, wealth, sustainable development, social cohesion, and flexibility, was used to measure the structure of resilience against climate change (Jurjonas and Seekamp, 2017). The operational definitions of the variables used in this research are presented in Table 4.

The apparent validity method, using the opinions of professors and experts in several stages of modification and revision, was used to determine the validity of the questionnaire. To determine the reliability of the questionnaire, Cronbach's alpha coefficient for a pre-test (30 questionnaires) and the study questionnaire was calculated, 0.914 and 0.682, respectively, showing the validity of the designed questionnaire. To model the resilience behavior of the farmers in the studied rural areas against climate change (spatial analysis), the degree of resilience against climate change was first measured. From several methods presented for measurement and evaluation (such as numerical taxonomy, TOPSIS, weighted simple sum, Vaikor, etc.), the Vaikor method was found to be appropriate for this study (Karimi et al., 2017). Next, the entropy method was used to weigh the studied indicators. Then, the results obtained from the combined Vaikor-entropy model (in the range of zero and one) were entered as the input of the software of the Geography Information System and with the help of interpolation and the inverse weighted distance method. Finally, Inverse Distance Weighted (IDW) resilience behavior against climate changes was modeled in raster form. Data processing in this research was done using MATLAB 7.10, AMOSver24, SPSSver25, and ArcGIS 10.5 software.The utilized research methods are explained in more detail in the following paragraphs.

The Vaikor model

Vaikor is an applied multi-criteria decision-making method with high efficiency in solving discrete problems. This method is based on consensual planning, and in it, the consensual solution determines the justified solutions that are close to the ideal solution and is created in the form of an agreement through special credits of the decision-makers (Opricovic and Tzeng, 2004). In this method, the emphasis is on ranking and choosing from a set of options and determining a consensus solution for a problem with conflicting criteria (Chen and Wang, 2009). Presented by Buyukozkan and Ruan (2008) and by Opricovic and Tzeng (2004), the basis of consensual models was developed based on the LP metric method. The following steps are implemented to use this method (Opricovic and Tzeng, 2004).

Step 1: Formation of the spatial decision matrix.

Step 2: Determine the best and worst value for all criteria functions. If the criterion function indicates profit (positive) and cost (negative), the best and worst values are calculated based on relation 1.

$$f_i^- = \max f_{ij} \quad f_i^* = \min f_{ij} \quad f_i^* = \max f_{ij} \quad f_i^- = \min f_{ij} \tag{1}$$

Step 3: Determine the weight of the indicators. In this field, many methods, such as rank-order analysis, entropy, eigenvector, etc., can be used according to the need. The entropy method is used in this research.

Step 4: Calculate the values of the distance between the options and the ideal solution. In this step, the distance of each option from the positive ideal solution is calculated, and the calculated weights are included; then, its aggregation is calculated based on the following formulas.

$$R_j = \max \left\lfloor W_i \left(f_{ij}^* - f_{ij}\right) - \left(f_j^* - f_{ij}^-\right) \right\rfloor \text{ and}$$
$$S_j = \sum_{j=1}^{n} \frac{W_i \left(f_j^* - f_{ij}\right)}{f_j^* - f_j^-} \tag{2}$$

where f_{ij} is the index I in unit j, f_jth is the positive ideal of index I f_j- is the negative ideal of index I, W_i is the weight of the i-th index obtained from the fourth step, Sj is the distance from option I to the ideal solution, and Rj is the distance of option I from the negative ideal solution (worst combination)

Step 5: Calculate the value of Qi and Kor for i=1, 2, ..., m; The value of Qi is calculated based on the following equation.

TABLE 4 Indicators of resilience against climate change.

Objects, (R)	Dimensions
1. In the past few months, according to the existing potentials, society has been able to create jobs for people (R1) **2**. The variety of cultivation in the past has preserved my income against different conditions (R2) **3**. In the past few months, I could find another job if needed (R3)	Livelihood diversity dimension
1. In the past few months, my community has had enough resources for future planning (skilled planners, tax base, global income, tax aid) (R4) **2.** In the past few months, the local infrastructure of my communityhas been in good condition (R5) **3**. In the past few months, insurance support in the region has been acceptable (R6) **4.** In the past few months, resources, including money, information, technology, tools, raw materials, and services to solve problems in my society, have been available (R7) **5**. In the past few months, the government's macro policies to create employment, affordable housing, healthcare, and necessary facilities to support production have been successful (R8)	Wealth dimension
1. The new planned development programs have reduced the adverse effects of climate on the pistachio crop (R9) **2**. The government has used policies that have increased the welfare of the people (R10) **3.** Radio, television, and other social media have provided people with enough information about climate change(R11) **4.** Farmers have held group meetings to deal with the problems caused by climate change (R12)	Sustainable development dimension
1. In the past few months, the flexibility in the management systems has made it possible to adapt (R13) **2.** The sensitivity of the government to protect the environment and natural resources in the region has increased (R14) **3.** I have not used suitable models (planting harvesting) to cope with the effects of climate change (R15)	Flexibility dimension
1. Costs have been reduced through interactions and cooperation between farmers (R16) **2.** I have used the opinions of other farmers to solve farming problems(R17) **3.** I have worked with local non-governmental organizations regarding education dealing with climate change and I have cooperated to reduce the effects of climate change (R18) **4.** In the last few months, many NGOs have started working in the field of climate change (R19)	Social cohesion dimension

Source: Jurjonas and Seekamp, 2017.

$$Q_i = v\left[\frac{S_i - S^*}{S^- - S^*}\right] + (1 - v)\left[\frac{R_i - R^*}{R^- - R^*}\right] \quad (3)$$

Step 5: Calculate the value of Qi and Kor for i=1, 2, ..., m; The value of Qi is calculated based on the following equation. $Q_i = v\left[\frac{S_i-S^*}{S^- - S^*}\right] + (1-v)\left[\frac{R_i-R^*}{R^- - R^*}\right]$
where V is the weight of the strategy (the majority of criteria) or the maximum group favorability. (S_i-S^*)/(S^–S^*) shows the distance from the positive ideal solution of the i-th option. In other words, (R_i-R^*)/(R^–R^*) indicates the distance from the negative ideal solution for the i-th option. When v is >0.5, the Qi index has the maximum agreement. When V is smaller than 0.5, it indicates the maximum negative attitude.

Step 6: Ranking the options based on Qi values. Based on the values of Qicalculated in the fifth step for the options, the desired value can be reduced from one; thus, the village with the highest score (Qi-1) has priority in the selection.

The Entropy model

In information theory, entropy is a measure of uncertainty expressed by a certain probability distribution Pi (Hwang et al., 1981). The steps of the entropy method are described below (Karimi, 2013).

The first step is the calculation of normalized data: equation 4 is used for normalization.

$$P_{ij} = \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}} \qquad i = 1, 2, \ldots, m; \qquad j = 1, 2, \ldots, n \quad (4)$$

The second step is to calculate the entropy of the factor j (E_j) for E_j from the set of P_{ij} for each index using equation 5.

$$E_j = \left(\frac{-1}{\ln (M)}\right) \sum_{i=1}^{n} \left[P_{ij} \ln P_{ij}\right] \quad (5)$$

In the third step, the value of the degree of deviation, (dj)[1], is calculated, showing how much useful information the jam index provides to the decision maker, and is expressed in the form of equation 6:

$$d_j = 1 - E_j \quad (6)$$

The fourth step is to calculate the weight of existing indicators and factors (Wj):

$$W_j = \frac{d_j}{\sum_{i=1}^{n} d_j} \quad (7)$$

Results

Descriptive analysis of respondents' characteristics

The descriptive analysis of the respondent's characteristics shows that 92.85% of the studied subjects are men. The average age of the studied users (pistachio farmers) is 43.50 years, with a standard deviation of 8.56 years. The main occupation of 64.46% of the respondents is horticulture, and the average horticulture experience among the studied people is 14.41 years, with a standard deviation of 9.58 years. Results showed 51.02% of the studied people have elementary level literacy and below, which indicates the poor condition of the studied people in terms of education level. The household size of the studied subjects was, on average, 4.03 people, with a standard deviation of 1.48 people. The yield per hectare of pistachio among farmers studied was 1.86 tons per hectare, which is higher than the global average yield of pistachio of 1.43 tons per hectare (FAO, 2019). Also, the respondents stated their average monthly income was 12.15 million tomans,

1 Degree of Diversification

TABLE 5 Description of individual characteristics of pistachio farmers in the studied rural areas.

Middle	Maximum	Minimum	Standard deviation	Average	Individual characteristics of the respondents
43	85	20	8.56	43.05	Age (years)
14	60	2	9.85	14.41	Agricultural history (years)
4	9	1	1.48	4.03	Household dimension (person)
2	4	1	0.61	1.86	Average yield (tons per hectare)
13	45	3	2.43	12.15	Monthly income (million tomans)

Source: Research findings.

(283 dollars) with a standard deviation of 2.43 million tomans (56.60 dollars) (Table 5).

Evaluation of the variable measurement model of resilience behavior against climate change

Confirmatory factor analysis was used to evaluate the variable measurement model of resilience against climate change. The resulting measurement model of the research's latent variable (resilient behavior against climate change) incorporates the display of standardized factor loadings and the fit indices (Figure 2) and validity and reliability indices of the latent variable of climate change resilience in Table 5. As can be seen in the figure, the fit indices of the Chi-Square index on the degree of freedom [Chi-Square (X2/df)], the Comparative Fit Index (CFI), the standardized fit index, the unstandardized goodness of fit index, the goodness of fit index, the incremental fit index, the root mean square index of the estimation error, and the root mean square index of the residual are suitable; on the other hand, the chi-square value on the degree of freedom (67.2).

According to the results presented in Table 6, the path coefficients between the indicators and the hidden variable are significant, and the CR indexes and the average variance extracted for all these variables have a high and appropriate value. Therefore, it can be stated that indicators selected to measure the latent variable of resilience against climate change were correctly selected, and their validity and reliability are also confirmed. Based on the results presented in Table 6, in the dimension of livelihood diversity, the item "Cultivation diversity in the past has preserved my income against different conditions" has the highest standard coefficient (0.830) and is therefore considered the most important issue in the construction of the livelihood diversity component. Correspondingly, in the dimension of wealth, the item "In the past few months, the government's macro policies have been successful in creating employment, affordable housing, health and treatment, and necessary facilities to support production" has the highest standard coefficient (0.860). In the dimension of sustainable development, the item "new planned development programs have reduced the adverse effects of climate on pistachio crops" has the highest standard coefficient (0.816). In the dimension of flexibility, the item "the sensitivity of the government to protect the environment and natural resources in the region has increased" has the highest standard coefficient (0.861). Finally, in the dimension of social cohesion, the item "I have used the opinions of other farmers to solve garden problems" has the highest standard coefficient (0.826). Overall, the dimension of livelihood diversity had the highest standard coefficient (0.817), so it can be said to be the most critical dimension in measuring the resilience of pistachio farmers in the rural areas of Rafsanjan and Anar counties against climate change. Additional results are presented in Table 6.

Assessing the degree of resilience of pistachio farmers in rural areas of Rafsanjan and Anar counties against climate change

Based on the indicators used to measure the degree of resilience against climate change, a raw data matrix of each of the criteria in the studied villages was first collected through a field study, and then index-making was done. The result was the formation of a decision-making matrix (spatial matrix). Next, the obtained data were calculated through the combined Vaikor-entropy model, and finally, the scores related to the degree of resilience against climate change were obtained for each of the studied villages for the year 2021 (Table 7). The results of the degree of resilience against climate change study show that Gurbanabad village is the highest in the Hossein-Abad subdistricts with a coefficient of 0.771, and Deh Abbas village is the lowest in the Khunaman subdistricts with a coefficient of 0.186.

Table 8 also shows that the status of the studied indicators in the dimension of livelihood diversity is more favorable than other dimensions (mean 0.524 and standard deviation 0.160). Also, the status of indicators of the sustainable development dimension is unfavorable compared to other dimensions (mean sustainability 0.492, standard deviation 0.140). In addition, the resilience of the farmers in the studied rural areas to climate change was also calculated as average (0.5). As can be seen in Table 6, there is no significant difference in terms of the average resilience index (mean 0.476, standard deviation 0.128) against climate change and the average situation. Therefore, it can be acknowledged that the resilience of the farmers in the studied rural areas against climate change is in an average to low state, which is far from the ideal state.

However, the results of Table 9 show that, overall, the studied rural areas are not in the same situation in terms of resilience against climate change.

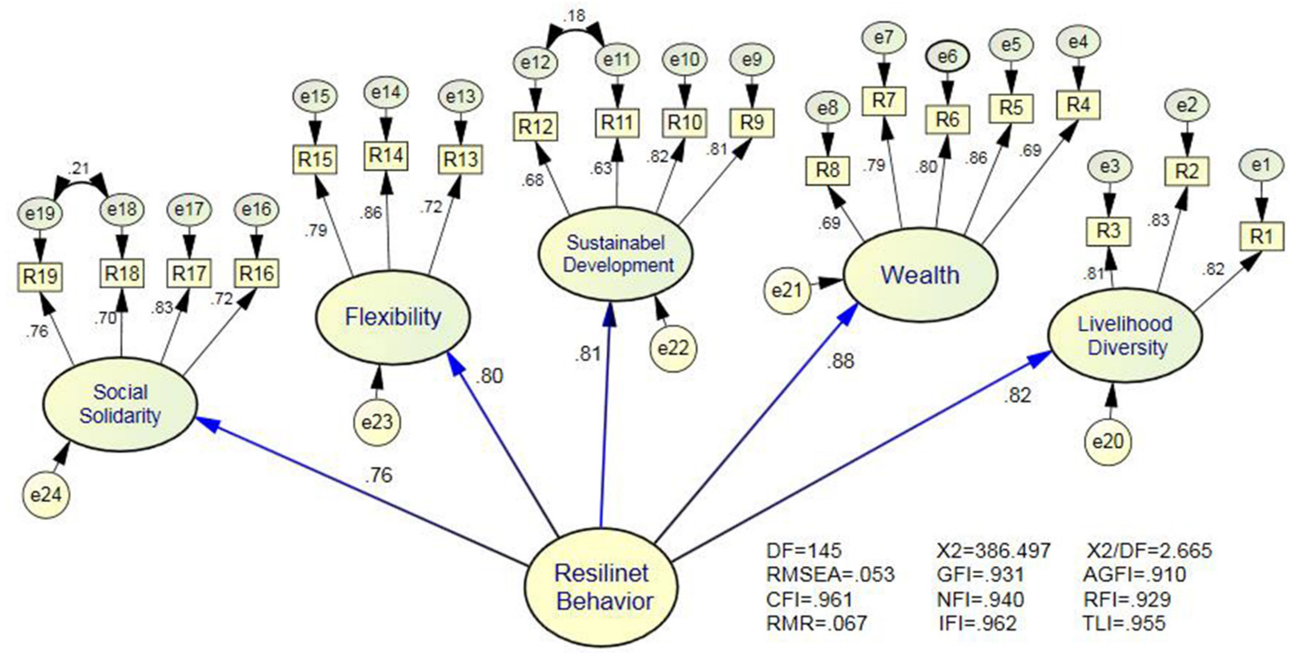

FIGURE 2
The confirmatory model of the latent variable (structure) of resilience against climate change with standardized factor loadings.

Modeling rural areas in terms of resilience against climate changes in Arc-GIS software

Arc-GIS 9.3 software was used to model the resilience levels of rural areas against climate changes (spatial analysis) to the land level and analyze the resulting situation. Therefore, according to the number of studied villages (60 villages) and the range of changes (between zero and one), the number of levels ($2K = 60$) is between $6 < K < 5$. Then, by placing the two values of K and R in relationship C, R/K or the length of the surfaces is $C5 = 1/5 = 0.20$, $C6 = 1/6 = 0.17$. Therefore, according to these calculations, the studied villages were divided into six levels, presented in Table 10.

Then, the resilience levels of the rural areas obtained from the model were used as the input in the geographic information system software. With the help of interpolation and the IDW method, the resulting levels were modeled in raster form. Table 8 and Figure 3 show that the villages' resilience level in the studied area was generally unfavorable. There are eight villages (13.30%) with a very weak resilience level and 22 villages (36.70 percent) at the weak resilience level. There are 26 villages (43/30) at the relatively resistant level and four villages (6.70 percent) at the good resilience level. While no villages were at the lowest lack of endurance level, there were also no villages at the highest completely resilient level.

Conclusion

The confirmatory factor analysis results showed that the path coefficients between the indicators and the hidden variable are significant, and the CR indexes and the average variance extracted for all these variables have high and appropriate values. Therefore, it can be stated that all the indicators selected to measure the latent variable of resilience against climate change were correctly selected, and their validity and reliability were also confirmed. In addition, the dimension of livelihood diversity had the highest standard coefficient; therefore, it can be said to be the most important dimension in measuring the resilience of pistachio farmers in the rural areas of Rafsanjan and Anar counties against climate change. Also, the results obtained from measuring the degree of resilience of pistachio farmers in rural Rafsanjan and Anar areas against climate change show that the current situation of the farmers in this field is at a medium to a low level. In the meantime, the village of Gurban-Abad in the Hossein-Abad sub-district had the highest degree of resilience, and the village of Deh Abbas in the sub-district of Khnaman sub-district had the lowest level of resilience. The results also indicated that the status of the indicators in the livelihood diversity dimension is in a more suitable situation than other dimensions. Moreover, the status of the indicators of the sustainable development dimension is in an unfavorable situation compared to other dimensions. Also, after analysis, the studied villages were divided into six levels, ranging from lack of endurance to resilient. None of the villages fell into the lowest or highest level. There are 8 villages at the very weak resilience level and 22 villages at the weak resilience level. There are 26 villages at the relatively resistant level and four villages at the level of good resilience. According to the successful results obtained from this model, this model can be used for future studies in other countries and provinces. This model can also be used to compare a product between two provinces with the same parameters.

TABLE 6 Summary of the information of the variable measurement model of resilience against climate change.

CR	AVE	P	Estimate	Indicator	Dimensions issues of resilience against climate change
0.918	0.672	**0.001**	**0.817**	-	**Livelihood diversity dimension**
		0.001	0.822	R1	In the past few months, according to the existing potential, it has been able to create jobs for people in the society
		0.001	0.830	R2	Crop diversification has sustained my income in the past against different conditions
		0.001	0.808	R3	In the past few months, I could find another job if needed in the society
0.926	**0.591**	**0.001**	**0.876**	-	**Dimension of fortune**
		0.001	0.691	R4	In the past few months, my community has had enough resources for future planning (skilled planners, tax base, global income, tax aid)
		0.001	0.860	R5	In the past few months, the government's macro policies to create employment, affordable housing, healthcare and necessary facilities to support production have been successful
		0.001	0.798	R6	In the past few months, resources including money, information, technology, tools, raw materials, and services have been created to solve the problems of society
		0.001	0.787	R7	In the past few months, insurance support in the region has been acceptable
		0.001	0.695	R8	In the past few months, the local infrastructure of my community has been in good condition
0.891	0.547	**0.001**	**0.814**	-	**Sustainable development dimension**
		0.001	0.811	R9	The government has used policies that have increased the welfare of the people
		0.001	0.816	R10	New planned development programs have reduced the adverse effects of climate on the pistachio crop
		0.001	0.634	R11	Radio and television and other social media have provided the people with enough information about climate change
		0.001	0.678	R12	Farmers have held group meetings to deal with the problems caused by climate change
0.899	0.627	**0.001**	**0.803**	-	**Flexibility dimension**
		0.001	0.718	R13	I have used appropriate patterns (planting, holding, and harvesting) to cope with the effects of climate change
		0.001	0.861	R14	The sensitivity of the government to protect the environment and natural resources in the region has increased
		0.001	0.788	R15	In the past few months, flexibility in management systems has provided the possibility for adaptation
0.901	0.569	**0.001**	**0.758**	-	**Social cohesion dimension**
		0.001	0.722	R16	Costs have been reduced through interactions and cooperation among farmers
		0.001	0.826	R17	I have used the opinions of other farmers to solve garden problems
		0.001	0.701	R18	I have collaborated with local non-governmental organizations on climate change education to reduce the effects of climate change
		0.001	0.755	R19	In the past few months, the solidarity of neighbors has increased in dealing with climate change

* Standardized coefficient.

Discussion

In recent years, climate change and drought as natural phenomena have created many challenges in different regions of Iran. Coping with climate change is important from different aspects, one of which is related to the performance of managers and another related to farmers. Therefore, an approach that will strengthen the resilience capabilities of farmers and also reduce their vulnerability will increase the resilience of rural settlements. However, the results showed that the resilience status of the farmers in the studied area is lower than the average (64.97% at the average to low level). This finding indicates that the studied pistachio farmersare not in good condition in terms of resilience and are unable to deal with wider climate changes or any fluctuations in climate changes (reduction of rainfall, frost, etc.) This inability could cause dire consequences in the agricultural sector of the region. Thus, plans to make the users more resilient against the effects of climate change and increase the tolerance threshold in the Rossinitai area should be prioritized.

It should be noted that the results obtained in the field of measuring resilience against climate change are in line with the findings of Bagheri Fahroji et al., 2018.

TABLE 7 The degree of resilience of pistachio farmers in rural areas of Anar and Rafsanjan cities against climate change.

Coefficient	S	Village	VC	Rural district	Coefficient	Sample	Village	VC	Rural district
0.34	20	Biaz	31	Biaz	0.577	29	Hossein Abad	1	Hossein Abad
0.351	16	Lotf abad	32		0.661	20	Gholshan	2	
0.364	5	Mehdi Abad	33		0.699	9	Dah Reies	3	
0.326	5	Mehr abad	34		0.771	5	Gorban Abad	4	
0.506	38	kashloiye	35	Kashkoiye	0.684	13	Javadie Abad	5	Behrman
0.535	14	Ahmed abad	36		0.697	7	Afog Abad	6	
0.575	6	Dife abad	37		0.528	5	Bahraman	7	
0.594	5	Hasan abad	38		0.497	5	Abas Abad Fallah	8	
0.510	5	Porkan	39	Raviz	0.627	17	Ferdosie	9	Ferdows
0.293	5	Hstaihoiye	40		0.504	12	Mehdi Abad	10	
0.367	5	Kohan razan	41		0.391	9	Raken Abad	11	
0.302	5	Mansor abad	42		0.285	5	Javad Abad	12	
0.543	15	Hamtabad olia	43	Gasem Abad	0.447	22	Esmayel Abad	13	Rezvan
0.559	15	Gasem abad	44		0.404	8	Shams Abad	14	
0.545	8	Heydar abad	45		0.331	8	Jahan Abad	15	
0.468	5	Zin abad	46		0.393	5	Kamal Abad	16	
0.396	20	Hormoz abad	47	Eslamiye	0.436	10	Sharif abad	17	Sharif Abad
0.362	5	Ahmed abad Razavi	48		0.463	11	Hosein Abad	18	
0.380	5	Dolat Abad	49		0.625	5	Amin Abad	19	
0.355	5	Neemat abad	50		0.586	5	Rahmat Abad	20	
0.425	5	Dah poshte	51	Sarcheshme	0.544	15	Karim abad	21	Azadghan
0.373	5	Mani satgd	52		0.443	9	Reza abad	22	
0.515	5	Dahoiee	53		0.564	5	Akbar Abad Hejry	23	
0.553	5	Magoiye	54		0.352	5	Mahmodie Bahrami	24	
0.612	20	Lahijan	55	Razm Avaran	0.508	20	Dhvaran	25	Duran Valley
0.608	5	Safi abad	56		0.288	5	Ali Abad	26	
0.633	22	Kabotar Kan	57	Kabotar khn	0.545	5	Deh Bala	27	Kanaman
0.578	14	Mahmod Abad meysam	58		0.186	5	Deh abbas	28	
0.532	5	Haji abad	59		0.241	5	Charook	29	
0.445	5	Sayid abad Shafiy Pour	60		0.340	7	Kanaman	30	

S, sample; VC, villagecode.

Suggestions

In the end, according to the findings of the research, suggestions are made to improve the resilient behavior of farmers against climate change.

- ✓ It is possible to increase the level of financial support, the level of information, the level of people's participation in meetings related to climate change, and the level of social cohesion by diversifying the skills and employment of agricultural operators and providing suitable agricultural infrastructure. With the appropriate actions, the resilient behavior of farmers can be improved.
- ✓ To confront the phenomena of climate change and drought, the government has put the development of agricultural product insurance on its agenda to help

TABLE 8 Comparison of the resilience of pistachio farmers in rural areas of Rafsanjan and Anar against moderate climate changes.

Significant level	Difference	df	T	Standard deviation	Average	Variable
0.255^{ns}	0.024	59	1.148	0.160	0.524	Livelihood diversity dimension
0.753^{ns}	0.006	59	0.316	0.150	0.506	Wealth dimension
0.638^{ns}	−0.009	59	−0.473	0.140	0.492	Sustainable development dimension
0.633^{ns}	0.009	59	0.480	0.142	0.509	Flexibility dimension
0.468^{ns}	0.013	59	0.730	0.142	0.513	Social cohesion dimension
0.158^{ns}	−0.024	59	−1.473	0.128	0.476	Total resilience behavior

Research findings: ns: $p > 0.05$; $^{**}p < 0.01$.

[a]The average range is zero (none) to one (completely) and the average number is 0.5.

TABLE 9 Comparison of resilience index of pistachio farmers in rural areas of Rafsanjan and Anar cities against climate change.

Significant level	F statistic	Average of squares	Degrees of freedom	Total boxes	Average	The dependent variable
0.0001**	4.673	0.116	59	6.849	between groups	Resilient behavior
		0.025	528	13.117	Intergroup	
		-	587	19.965	Total	

Source: Research findings.

$^{**}p < 0.01$.

TABLE 10 Zoning of rural areas in terms of the degree of resilience against climate change.

Percentage of villages	Number of villages	Range of levels	The condition of the surfaces
0	0	$0 \leq x < 0.1667$	Lack of endurance
13.30	8	$0.1667 \leq x < 0.3447$	Very poor endurance
36.70	22	$0.3447 \leq x < 0.5001$	Weak endurance
43.30	26	$0.5001 \leq x < 0.6668$	Relatively resilient
6.70	4	$0.6668 \leq x < 0.8335$	Good endurance
0	0	$0.8335 \leq x < 1$	Resilient

Source: Research findings.

farmers continue their productive activities and reduce the consequences of climate change, especiallyeconomic consequences to preventing migration of farmers to cities with the resulting consequences. And their attitude toward these changes and its management to a more rational direction.

- ✓ Create local credit funds and form a rural bank to increase the resilience of farmers in climate change conditions.
- ✓ Improve non-horticultural and complementary to horticulture and agriculture activities to create job creation capacities in climate change conditions.
- ✓ Create model gardens run by successful farmers who use modern horticulture methods using crop varieties and products resistant to climate change to show how to adapt to climate change conditions.
- ✓ Develop models of cooperation and various local organizations and organizations, especially in water management (through increasing social capital, it helps to promote this structure among farmers).
- ✓ Provide information and awareness to villagers and farmers about the importance of using modern gardening methods in drought and climate change conditions.
- ✓ Improve the insurance mechanism for horticultural and agricultural products, providing credit and facilities with suitable conditions for villagers to use. Establish emergency reserve funds among different classes of farmers simultaneously with government support to be used in crises such as drought.
- ✓ Build institutional development and capacity through quantitative and qualitative development of agricultural associations, financial funds, rural cooperatives, etc.
- ✓ Improve the economic capability of farmers by creating job opportunities and generating income in complementary non-agricultural sectors.
- ✓ Reduce production costs at the farm level and identify suitable inputs in the conditions of climatic changes and drought.
- ✓ Compile and revise policies and laws supporting the agricultural sector.

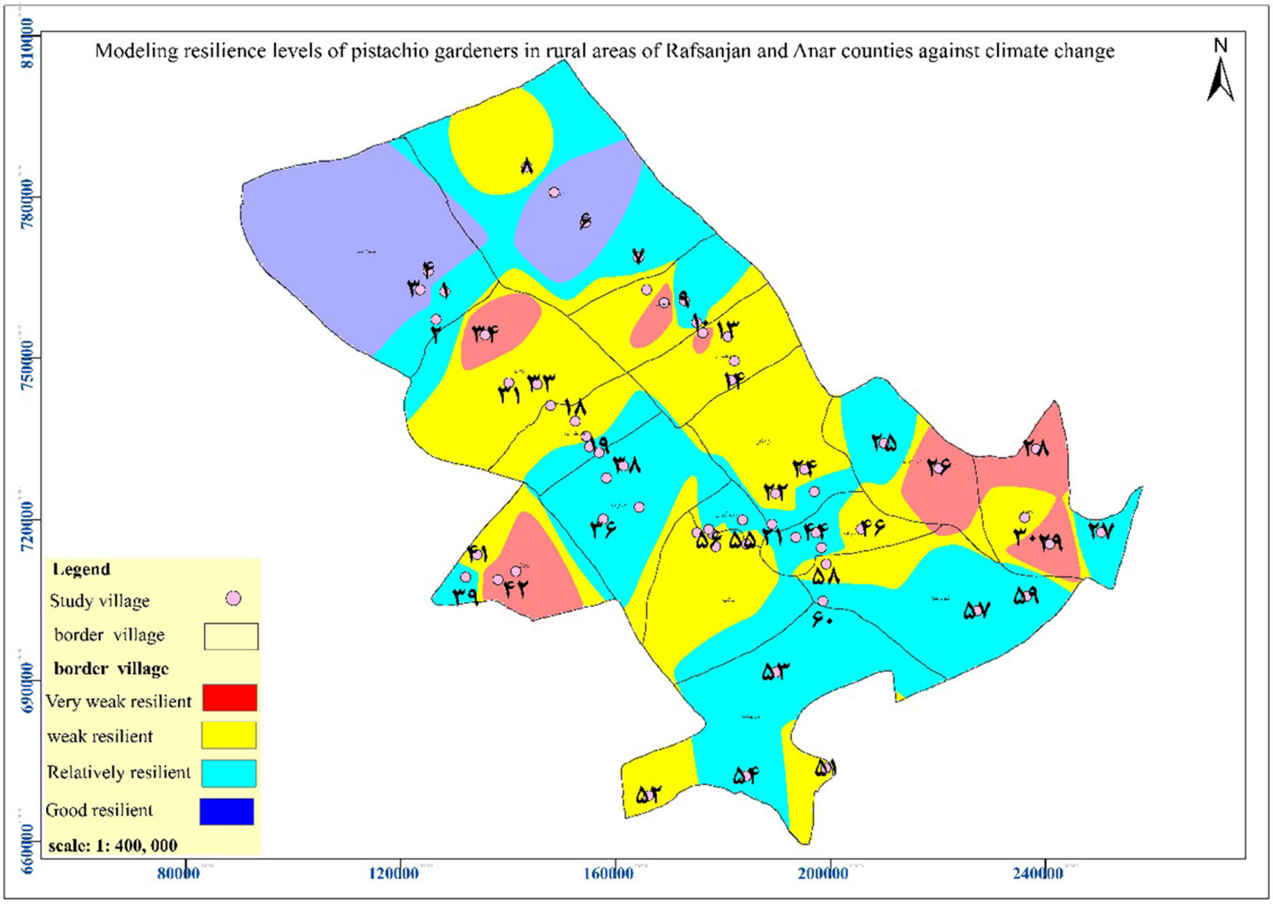

FIGURE 3
Modeling the levels of resilience of pistachio farmers in rural areas of Rafsanjan and Anar counties against climate change (drawing by author).

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

Study conception and design: AA, MO, and JF. Data collection and analysis and interpretation of results: AA and MO. Draft manuscript preparation: AA. All authors reviewed the results and approved the final version of the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Adger, W. N. (2000). Social and ecological resilience: are they related? *Prog. Hum. Geogr.* 24, 347–364. doi: 10.1191/030913200701540465

Akbarian Rounizi, S., and Ramzanzadeh-Lesboi, M. (2019). Farmers' resilience against drought with emphasis on economic factors and social capital in rural areas: (A case study of Roniz in Estehban county). *J. Rural Res.* 10, 230–243.

Amundsen, H. (2015). Place attachment as a driver of adaptation in coastal communities in Northern Norway. *Local Environ*. 20, 257–276. doi: 10.1080/13549839.2013.838751

Bagheri Fahroji, R., Gharechaie, H., and Savari, M. (2018). The role of resilience to climate change on the level of food security in villages households under the menarid project in Yazd Province. *Iranian J. Agric. Econ. Devel. Res*. 49, 347–359. doi: 10.22059/IJAEDR.2018.244244.668507

Bagheri, V., Shamshiri, M. H., Shirani, H., and Roosta, H. R. (2012). Nutrient uptake and distribution in mycorrhizal pistachio seedlings under drought stress. *J. Agricult. Sci. Technol. (JAST)*. 14, 1591–1604.

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., and Silliman, B. R. (2011). The value of estuarine and coastal ecosystem services. *Ecol. Monogr*. 81, 169–193. doi: 10.1890/10-1510.1

Belay, A., Recha, J., Woldeamanuel, T., and Morton, J. F. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the central rift valley Of Ethiopia. *Agric. Food Secur*. 6, 24. doi: 10.1186/s40066-017-0100-1

Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Nat. Hazards*. 41, 283–295 doi: 10.1007/s11069-006-9036-7

Birkmann, J. (2011). First- and second-order adaptation to natural hazards and extreme events in the context of climate change. *Nat. Hazards*. 68, 811–840. doi: 10.1007/s11069-011-9806-8

Buyukozkan, G., and Ruan, D. (2008). Evaluation of software development projects using a fuzzy multicriteria decision approach. *Math Comput Simul*. 77, 464–475. doi: 10.1016/j.matcom.2007.11.015

Campbell, D., Barker, D., and McGregor, D. (2011). Dealing with drought: small farmers and environmental hazards in Southern St. Elizabeth, Jamaica. *Appl. Geog.* 31, 146–158. doi: 10.1016/j.apgeog.2010.03.007

Chen, L. Y., and Wang, T. C. (2009). Optimizing partners choice in IS/IT outsourcing projects the strategic decision of fuzzy VIKOR international. *J. Production Econ* 120, 1. doi: 10.1016/j.ijpe.2008.07.022

Chisanga, K., Bosco Mvula, A., and Habibu, T. (2017). The role of indigenous knowledge in climate adaptation: experiences with farmer perceptions from climate H. *Int. J. Sci. Res. Publ.* 7, 94–101. Available online at: http://137.63.168.4/handle/20.500.12260/55

Colombo, A., and Byer, P. (2012). Adaptation, flexibility and project decision-making with climate change uncertainties. *Impact Assess. Proj. Apprais*. 30, 229–241. doi: 10.1080/14615517.2012.731189

Cumming, G. S. (2011). *Spatial Resilience in Social–Ecological Systems*. Dordrecht: Springer, Dordrecht. doi: 10.1007/978-94-007-0307-0

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., et al. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environ. Change*. 18, 598–606 doi: 10.1016/j.gloenvcha.2008.07.013

Davis, I., and Izadkhah, Y. (2006). Building resilient urban communities. *Articlefrom OHI*. 31, 11–2. doi: 10.1108/OHI-01-2006-B0002

Donatuto, J., Grossman, E. E., Konovsky, J., Grossman, S., and Campbell, L. W. (2014). Indigenous community health and climate change: integrating biophysical and social science indicators. *Coastal Manag.* 42, 355–373. doi: 10.1080/08920753.2014.923140

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environ. Change*. 21, 647–656. doi: 10.1016/j.gloenvcha.2011.01.019

FAO (2019). *Minimum Dietary Diversity for Women: A Guide for Measurement*. Rome: FAO. p. 82.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., et al. (2004). Regime shifts, resilience, and biodiversity in ecosystem management. *Annu. Rev. Ecol. Evol. Syst*. 35, 557–581. doi: 10.1146/annurev.ecolsys.35.021103.105711

Frazier, T. G., Wood, N., Yarnal, B., and Bauer, D. H. (2010). Influence of potential sea level rise on societal vulnerability to hurricane storm-surge hazards, Sarasota County, Florida. *Appl. Geog.* 30, 490–505. doi: 10.1016/j.apgeog.2010.05.005

Gardner, R. L., Cooper, E., Haskell, J., Harris, D. A., Poplau, S., Kroth, P. J., et al. (2019). Physician stress and burnout: the impact of health information technology. *J. Am. Med. Inform. Assoc*. 26, 106–114. doi: 10.1093/jamia/ocy145

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annu. Rev Ecol Evol Syst.* 4:1–23. doi: 10.1146/annurev.es.04.110173.000245

Hoshmandanfar Moghadam Fard, Z., Shams, A., Yacoubi, J., Saba, J., and Asakereh, H. (2019). Investigating the effective factors on the adaptation behavior of farmers to climate changes in Zanjan province. *J. Sustain. Agric. Sci.* 3, 251–231.

Hosseinifarhangi, S., Ferrario, V., Patassini, D., and Tornieri, S. (2020). "Agricultural transition and regional development in Rafsanjan," in *A Technology Driven Approach in a Drought Affected County (Venice: University IUAV of Venice)*. Available online at: https://hdl.handle.net/11578/287418

Hwang, C. L., Yoon, K., Hwang, C. L., and Yoon, K. (1981). "Basic concepts and foundations," in *Multiple Attribute Decision Making: Methods and Applications A State-of-the-Art Survey*. p. 16–57.

Jafari, M., Rezvani, M. R., Faraji Sokhbar, H., Qadiri Masoum, M., Darban Astana, A., et al. (2020). Analysis of economic resilience of farmers to drought impacts (Case Study: Rural Settlements of Fasa County). *J. Reg. Plan*. 10, 61–78.

Jamalizade, M. (2014). *Important Role of Climatic and Climatic Changes on Pistachio Trees*. Kerman: Iranian Pistachio Association.

Johnson, R. (2009). "Food security: the role of agricultural trade," in *International Food and Agricultural Trade Policy Council*. p. 10–13.

Jurjonas, M., and Seekamp, E. (2017). Rural coastal community resilience: Assessing a framework in eastern North Carolina. *Ocean Coastal Manag.* 162, 137–150 doi: 10.1016/j.ocecoaman.2017.10.010

Karimi, F. (2013). "Modeling the development levels of rural areas (the case study of the central part of Boyar Ahmad city)" in *Dissertation of master's course in rural development*. Yasuj, Iran: Yasouj University. p. 178.

Karimi, F., Ahmadvand, M., and Heydari, A. (2017). Research on methods of measuring land development levels based on experimental data. *Appl. Res. J. Geog. Sci*. 18, 151–164 doi: 10.29252/jgs.18.51.151

Kumpfer, K. L. (1999). "Factors and processes contributing to resilience," in *Resilience and development. Positive life adaptations*, Glantz, M. D., and Johnson, J. L. (eds). New York: Kluwer Academic/Plenum. p. 179–244.

Lane, D., Mercer Clarke, C., Forbes, D. L., and Watson, P. (2013). The gathering storm: managing adaptation to environmental change in coastal communities and small islands. *Sustainability Sci.* 8, 469–489. doi: 10.1007/s11625-013-0213-9

Manyena, S. B. (2006). The concept of resilience revisited. *Res. Assoc. Disaster Development Centre*. 30, 433–450. doi: 10.1111/j.0361-3666.2006.00331.x

Mayunga, J. S. (2007). "Understanding and applying the concept of community disaster resilience: a capital-based approach," in *A Draft Working Paper Prepared for the Summer Academy for Social Vulnerability and Resilience Building*. p. 22-28.

Meridenjad, A., Liaqat, A., and Nazari, B. (2014). "Analysis of the results of evaluation studies of changing the surface irrigation system to pressurized irrigation in the irrigation sub-networks of 550,000 hectares of Jihad Nasr Institute in Khuzestan province," in *The First National Conference to Examine the Technical, Economic, Social, and Environmental Aspects of the Restoration Plan of 555 Thousand Hectares of Khuzestan and Ilam Lands* (University Ahvaz).

Opricovic, S., and Tzeng, G. H. (2004). Decision aiding compromise solution by MCDM methods: a comparative analysis of VIKOR and TOPSIS. *Eur. J. Operat. Res*. 156, 445–455. doi: 10.1016/S0377-2217(03)00020-1

Phuong, L. T. H., Biesbroek, G. R., Sen, L. T. H., and Wals, A. E. (2018). Understanding smallholder farmers' capacity to respond to climate change in a coastal community in Central Vietnam. *Climate Dev*. 10, 701–716. doi: 10.1080/17565529.2017.1411240

Qombar Ali, Z., Pop-Zen, A., and Afsharzadeh, N. (2011). Investigating farmers' views on climate change and adaptation strategies (case study: Kermanshah city). *Rural Res*. 3, 192–213.

Ranjbar, A. (2009). *The Agricultural Sector and the Need to Pay Attention to Regional Planning*. Available online at: http://bovali.blogfa.com (accessed March).

Sadeghlou, T., and Sejasi Keidari, H. (2013). Prioritization of the effective factors on increasing the resilience of farmers against natural hazards (with emphasis on drought) in the study area: farmers in the villages of Eicherud city. *Geogr. Res. Q. J.* 10, 153–129.

Schwarz, B., Vanelle, C., and Gajewski, D. (2011). *The Recursive Stacking Operator (RSO) Part 2: Application to Heterogeneous Media. Annual WIT Report 2011*. University of Hamburg, Hamburg, Germany. p. 158–172.

Smith, J. W., Anderson, D. H., and Moore, R. L. (2012). Social capital, place meanings, and perceived resilience to climate change. *Rural Sociol.* 77, 380–394. doi: 10.1111/j.1549-0831.2012.00082.x

Speranza, C. I., Kiteme, B., and Wiesmann, U. (2008). Drought and famines: the underlying factors and the causallinks among agro-pastoral households in semi-arid Makueni District, Kenya. *Global Environm. Change*. 18, 220–233 doi: 10.1016/j.gloenvcha.2007.05.001

Speranza, C. I., Wiesmann, U., and Rist, S. (2014). An indicator framework for assessing livelihood resilience in the context of social–ecological dynamics. *Glob. Environ. Chang.* 28, 109–119. doi: 10.1016/j.gloenvcha.2014.06.005

Tobin, G. (1999). Sustainability and community resilience: the holy grail of hazards planning?. *Environ. Hazards.* 1, 13–25. doi: 10.3763/ehaz.1999.0103

Ungar, M. (2011). The social ecology of resilience: addressing contextual and cultural ambiguity of a nascent construct. *Am. J. Orthopsychiat.* 81, 1–17. doi: 10.1111/j.1939-0025.2010.01067.x

Valiqolizadeh, A. (2018). Explaining the economic effects of climate change on the life of human societies. *Geog. Space*. 19, 161–198. Available online at: http://geographical-space.iau-ahar.ac.ir/browse.php?a_id=3412&sid=1&slc_lang=en

Walker, B. H., Pearson, L., Harris, M., Maler, K. G., Chuan-Zhong, L., Biggs, R., et al. (2010). Incorporating resilience in the assessment of inclusive wealth: an example from South East Australia. *Environ. Resour. Econ. (Dordr*). 45, 183–202. doi: 10.1007/s10640-009-9311-7

Zhou, H., Wan, J., and Jia, H. (2010). Resilience to natural hazards: a geographic perspective. *Nat. Hazards.* 53, 21–41 doi: 10.1007/s11069-009-9407-y