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Explaining farmers' response to climate change-induced water stress through cognitive theory of stress: an Iranian perspective

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Abstract
This study investigates the underlying causes of farmers' adaptation responses in the face of the negative impacts of climate change on water resources in Iran. We applied the theory of cognitive stress to examine and clarify how farmers respond to climate change-induced water stress as an environmental stressor, using a multistage, clustered, random sampling method of farmers ($n=250$) in a survey conducted in southwestern Iran. Our analyses revealed that both demand appraisal and self-efficacy are significant predictors of problem-focused coping, which, in turn, influenced farmers' adaptation responses. The theory accounted for 31% of the variance in farmers' problem-focused coping behavior, which, in turn, accounts for around 39% of the variance in adaptation responses. We anticipate that the findings will result in recommendations for policymakers and advisors to extension organizations and that it will ultimately be used to inform strategies to encourage effective adaptation responses to water scarcity among Iranian farmers.

Keywords Adaptation behavior · Water stress · Climate change · Theory of cognitive stress · Iran

1 Introduction

Iran is located in an arid and semiarid region of the Middle East and is considered one of the most water-stressed regions in the world. This country has a long history of exposure to frequent and severe droughts, and two-thirds of its land area comprises desert land. Furthermore, it has mean annual precipitation of 250 mm–less than one-third of the global average (Abadi 2019; Abdoli et al. 2017; Sefati et al. 2019). Although there are huge uncertainties regarding the impacts of climate variability on water resources (Falloon and Betts 2010), scientific evidence suggests that projected climate change will significantly impact the hydrological cycle, water balance, and runoff characteristics. This will, in turn, cause water scarcity and insecurity (Issaka et al. 2018; Kahil et al.

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2015; IPCC 2007, 2014; Sowers et al. 2011;Yazdanpanah et al. 2013, 2011; Quinn et al. 2011; Tatar et al. 2019; Valizadeh et al., 2019; Pakmehr et al. 2020), thus further worsening the water situation and the management of this scarce resource in Iran by making the region both hotter and drier (Abbaspour et al. 2009; Hashemi et al. 2017; Zobeidi et al. 2016; Allahyari et al. 2016; Shojaei-Miandoragh et al. 2020; Pakmehr et al. 2020). This water scarcity has led to negative impacts on ecosystems, agriculture, livelihoods, and health in Iran (Yazdanpanah et al. 2014; Azadi et al. 2019a; Savari and Shokati Amghani 2020). For instance, as van Duinen et al. (2015) pointed out, reduced rainfall due to climate change will cause a decrease in soil moisture and an increase in salt concentrations and, as a result, both the quantity and quality of farm production will decrease, while costs will increase.

This situation poses serious problems for farmers, particularly smallholder ones (Wuepper et al. 2019) if they take no actions to deal with it (van Valkengoed and Steg 2019; Pakmehr et al. 2020). Therefore, farmers must constantly adapt to this variability and undertake continuous adjustments to their farming activities to handle this uncertain situation (Nguyen et al. 2016; Dono et al. 2013). The degree of adaptation and adjustment to this variability will undoubtedly depend on farmers' adaptation capacity (Wuepper et al. 2019). Adaptive capacity refers to the ability or potential capacity of individuals to respond properly to climate variability (Adger et al. 2009). It has been revealed that adaptive capacity depends on the economic and technological development, individuals' psychological characteristics (Klein and Smith 2003; Wuepper et al. 2019), or internal factors (Mertens et al. 2018; Pakmehr et al. 2020). These internal factors of adaptive responses are mostly related to individuals' perceptions of hazards. In other words, how they perceive the risks and the process of dealing with them has been shown to influence adaptation decision-making (Wolf et al. 2013). These internal factors have been introduced by researchers using a variety of different names (see Wuepper et al. 2020) and include various components such as perception, social norms, values, self-efficacy, the locus of control beliefs, and time preferences (Wuepper et al. 2019; Azadi et al. 2019b; Pakmehr et al. 2020).

Although these variables are used in assessing farmers' behavior concerning climate change adaptation, their use is limited. Thus, recognition of these factors is crucial to planning adaptation policies. Furthermore, they are of utmost importance when psychological variables vary between individuals (O'Brien et al. 2008), or more accurately these variables are "highly heterogeneous within a society or locality" (Adger et al. 2007, p. 729). Therefore, these factors must be investigated within particular contexts that are shaped by social–ecological systems and other important study areas within adaptation (Dang et al. 2019). Hence, recognizing these variables is indispensable due to the important role that individuals play in successful adaptation behavior. As such, there is a growing body of the literature highlighting the importance of these psychological traits in adaptation behavior (Wuepper et al. 2020; van Valkengoed and Steg 2019; Adger et al. 2009; Mertens et al. 2018; Wuepper and Sauer 2016; Wuepper and Drosten 2017; Schutte and Bhullar 2017; Niles et al. 2016; Pakmehr et al. 2020). However, few studies into psychosocial variables influencing the adoption of adaptation behavior have been conducted in Iran, and this would necessitate more work in this regard. Also, a deeper understanding of these variables underlying individual adaptation to climate change in developing countries is needed (Truelove et al. 2015; Smith 2018; Pakmehr et al. 2020). The gap exists due to the neglect of psychological factors and their influence on people's decisions and adaptive behavior. Therefore, this paper aims to fill this literature gap by determining the internal factors affecting farmers' adaptation to climate change-induced water stress among farmers in Iran, where water availability is a significant contributor to agricultural production.

This is in line with recent trends in (behavioral) economics toward decision-making under risk, emphasizing the importance of internal as well as external constraints such as access to resources and technologies (Dalton et al. 2016; Wuepper and Lybbert 2017). Although it is increasingly acknowledged that internal constraints, including coping appraisal and self-efficacy, play a crucial role in decision-making under risk, the literature on such constraints is still emerging (Wuepper and Lybbert 2017). Therefore, this study aims to assess which internal factors directly or indirectly prevent vulnerable individuals from taking preventive measures against climate change-induced water stress. Inspired by these backgrounds, we seek to realize which psychological characteristics can lead adaptation responses into water scarcity due to climate change as a stressful factor. To achieve this, we adopted the theory of cognitive stress (TCS) (Lazarus 1966, 1991; Lazarus and Folkman 1984) to analyze and explain how farmers respond to climate change-induced water stress as an environmental stressor. Apart from its value for scientific research and policymaking, farmers' responses to climate change-induced water stress are not well understood and have not received much attention in the literature. In other words, although there is a huge body of research in the existing literature that mostly focuses on farmers' responses to climate change, there is still a dearth of research that specifically focuses on adaptation to climate change-induced water stress. In this regard, Quinn et al. (2011) pointed out that the effect of water insecurity has emerged as a significant stressor at all levels, including at the settlement, local municipality, and district levels. This is a major limiting factor that affects both agroecological and individual resilience. As such, gaining a better understanding of farmers' awareness and behavior toward addressing increasing climate variability-induced water stress is of great importance to policymakers hoping to establish sustainable agriculture practices, guarantee food security, and reduce poverty. Therefore, the goal of the current study is to accumulate empirical confirmation about how growers respond to water scarcity under climate climate variability. We believe that the outcomes of the present study will deliver a significant cognition base for creating a robust policy that will considerably increase their adaptation between Iranian growers and ultimately address problems related to water scarcity. This approach is also very important due to the seldom examined and very infrequently referenced psychological forms of adaptation in terms of coping with climate variability in the existing literature (Clayton et al. 2015; Swim et al. 2011). Furthermore, the application of a western model in a non-western culture adds another nuance and novelty to this study. It is important to note that, in addition to this theory, there are other theories such as the protection motivation theory, the health beliefs model, the theory of planned behavior, the social cognitive theory, and the theory of interpersonal behavior which can be used as sound theoretical reasoning in studying farmers' adaptation behavior. These theories have been extensively used in the Iranian context so far (see Tajeri Moghadam et al. 2020; Keshavarz and Karami 2016; Delfiyan et al. 2020; Mohammadinezhad and Ahmadvand 2020; Boazar et al. 2019, 2020; Rezaei et al. 2018; Kazemi et al. 2018; Yazdanpanah et al. 2015, 2016; Monfared et al. 2015; Aliabadi et al. 2020; Sharifzadeh et al. 2019; Pakmehr et al. 2020). However, another contribution of this study is that to the best of our knowledge, this theory (TCS) is applied to farmers' responses to negative impacts of climate change for the first time. The rest of this paper is structured as follows. Section 2 presents the main mechanisms of the theory of cognitive stress. Section 3 provides detailed information about the research design, sampling, and data gathering. Section 4 presents the results, and Sect. 5 discusses the results, the implications, and the future outlook.

Therefore, the influence of climate variability on water resources raises major international concern, as it may cause severe stress on whole societies, particularly farmers, due to the huge negative impacts on agricultural production (Issaka et al. 2018; Quinn et al. 2011). As such, apart from many other stressors, climate variability has arisen as one of the major threats for farmers, which will impose new widely recognized challenges as an environmental stressor that has cognitive implications (Berkhout et al. 2006; Reser and Swim 2011; Tompkins and Eakin 2012; Nicholas and Durham 2012; Byrne et al. 2015; Roco et al. 2016; Acharibasam and Anuga 2018).

Regarding water scarcity and climate change, some studies (Roco et al. 2016) have illustrated that they are repeatedly considered as threats to farmers' property, livelihoods, as well as general well-being. Chemin et al. (2013) also argued that a decrease in annual precipitation and other weather-induced shocks to the income of farmers raise levels of perceived stress. As can be expected, farmers, as the most affected (and vulnerable) actors in this process, have been complacent about these changes. They use different ways to adjust to such a situation through a process called coping or adaptation. Thus, to understand and influence farmers' responses to climate change-induced water stress, gaining a better understanding of their current coping strategies is not only an academic challenge but also an essential requirement for the development of appropriate and effective policies and their implementation.

2 Theory of cognitive stress

The theory of cognitive stress (TCS) was designed based on environmental threats and stressors in human life. In other words, stressors form the core of the theory and emphasize the transactions that occur between individuals and their environments. Environmental stressors are the "physical and social-ecological situations that the typical individual would distinguish as really or possibly aggressive, destructive, hurtful, or depriving" (Lepore and Evans 1996, p. 350). The starting point is individual monitoring of the surrounding environment and then interpreting the situation through an appraisal process to determine whether or not the stressor threatening the subject's property (social or physical) is recognized and which coping process is used to respond to/mediate the situation. As such, based on TCS, the appraisal process will initiate problem-focused coping behavior that will cause protective behavior against the stressor (Homburg and Stolberg 2006).

In our research, climate change-induced water stress acts as a stressor that, following a process of demand and resource appraisal, leads to problem-focused coping behavior in farmers, which, in turn, causes adaptation behavior (Fig. 1). To date, TCS has been applied to recognize a range of environmental stressors (Homburg and Stolberg 2006; Homburg et al. 2007; Chen 2015). Appraisal processes are dynamic (Chen 2015) and comprise both demand and resource appraisal activities, which jointly can cause individuals to engage in protective action (Homburg and Stolberg 2006). Demand appraisal refers to a person's impression of the effects of a specific risk on their well-being (Lazarus 1991). In other words, well-being may be threatened if an individual judges that a situation can/will threaten her/his property, health, goals, or identity (Homburg and Stolberg 2006). This means that it is a conscious process through which people acquire knowledge and interpret their sensory impressions based on their interests, history, knowledge, experiences, and attitudes to ascribe meaning to their environment and behave accordingly (Robbins and Judge, 2012). In sum, demand appraisal can be classified as threat- and harm appraisal.

The second element of the appraisal process is resource appraisal. Lazarus (1991) stated that resource appraisal refers to an individual's perceptions regarding the ability to cope

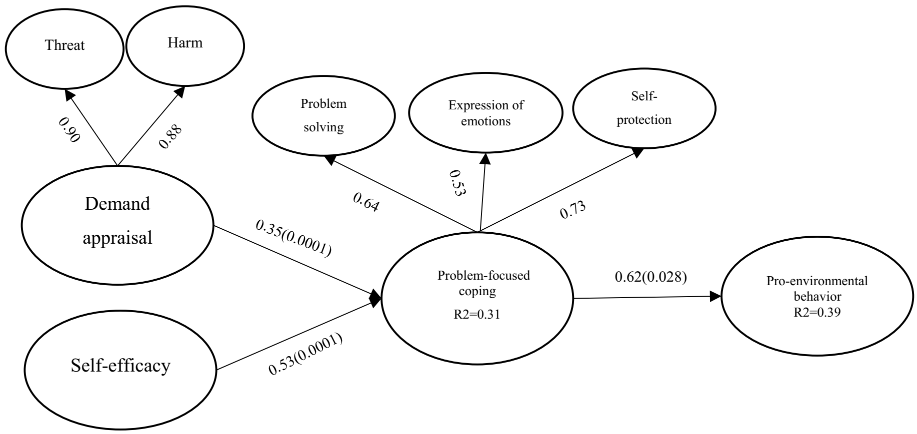

Fig. 1 Theoretical framework

with a stressor by any action to reduce risk, avoid or alleviate negative consequences, or cause additional drawbacks or benefits. According to Lazarus and Folkman (1984), control is ingrained in the notion of resource evaluation that motivates an individual to manage a particular threat. It seems that resource appraisal is synonymous with the concept of self-efficacy (Bandura 1997) or perceived behavior control (Ajzen 1991). In other words, the TCS assumes that whether a person will participate in pro-environmental behavior mostly relies on their assessment of risk and their ability to do so. This comprises the cognitive evaluation processes and refers to self-efficacy, which is an integral component of coping appraisal (Babcicky and Seebauer 2017).

Self-efficacy can be defined as the degree to which an individual feels that engaging or not engaging in a particular behavior is their choice and to whether it is easy or difficult for them to engage in that behavior (Bandura 1977, 1991). In this study, self-efficacy refers to farmers' confidence in their skills or abilities as it relates to adapting to water shortages. A bulk of study on climate variability and water scarcity adaptation worldwide (Grothmann and Reusswig 2006; Hornsey et al. 2015; Milfont 2012; Kellstedt et al. 2008) revealed that self-efficacy is an essential aspect in how individuals recognize the threat of climate change and how they respond to it. In this regard, Hornsey et al. (2015) pointed out that perceived self-efficacy could be an important psychological asset to mitigate or cushion threats and stimulate productive behavior.

In the same vein, Babcicky and Seebauer (2017) indicated that two factors could determine mitigation measures against flood disaster. The first is the perceived severity and probability of a flood event (demand appraisal), and the second is the perceived ability of an individual to respond to flood risk (resource appraisal). In line with the TCS, Boer et al. (2015) argued that the combination of two factors—perceived vulnerability and perceived efficacy—is the determinant of adaptation behavior, as confirmed by Grothmann and Patt (2005). They asserted that if farmers' perceptions of the risks associated with drought and their coping capacity (self-efficacy) are systematically biased, it could impede their ability to adapt successfully to these circumstances. Based on the assumptions of the TCS, the consequences of the appraisal processes mediate behavior through problem-focused coping. Lazarus and Folkman (1984) explained the concept of coping as "an individual's thought and behavioral struggles to achieve (reduce, minimize, master, or tolerate) the inner and outer demands of individual–environment dealings that are evaluated as challenging or more than that person's resources." Another definition describes it as a process-oriented phenomenon through which a stressful situation that causes distress can be managed and that includes intentional interpersonal efforts to change circumstances, as well as composed, sensible, and focused attempts to solve problems or diminish, avoid, or take taxing circumstances (Chen 2015). In this regard, Lazarus (1990) explained that in the relationship between human and the environment, when an actor recognizes a stressful situation through the appraisal process, a coping process will be activated to manage the risk associated with that stressful situation. According to two previous studies (Homburg and Stolberg 2006; Homburg et al. 2007), problem-focused coping consists of three dimensions: problem-solving strategies, expressive coping strategies, and self-protection strategies (Fig. 1).

Problem-solving strategies are devised to gain more clarity about a stressful situation and the possible response strategies to control it. It generally involves an individual gathering information about a stressor and possible social support. The second dimension of problem-focused coping is expressive coping strategies. This dimension concerns the expression of emotions and, of course, a proper subset of action-centered ways of coping (see Homburg and Stolberg 2006). While emotions are among the determinants of pro-environmental behavior, a considerable number of studies (Acharibasam and Anuga 2018; Wutich and Ragsdale 2008) reported emotional responses such as grief, worry, anger, anguish, and frustration over water shortages and scarcity. The final dimension of problem-focused coping is self-protection strategies that emphasize actions that can protect a person from a stressor.

Finally, at the last stages of the process, a combination of the three dimensions of problem-focused coping can determine environmental actions. In other words, as Homburg and Stolberg (2006) suggested, problem-focused coping can mediate the appraisal of environmental impacts and behavior or promote and adjust pro-environmental behavior due to environmental stressors. They propose that there is a difference between coping activities and pro-environmental behavior. While pro-environmental behavior clearly and directly intends to reduce or solve the stress, coping activities have no direct aim to reduce the problem. Instead, it is a process to acquire more information about the stressor (for more detail see Homburg and Stolberg 2006). Therefore, as Bell et al. (2001) argued, the adaptation behavior will occur in the case of a successful coping process. However, in the case of an unsuccessful coping process/strategy, the stress will intensify. In essence, based on the theory constructs discussed above, the hypotheses of the study can be presented as follows:

(1) Demand appraisal will positively affect problem-focused coping (H1).
(2) Self-efficacy will positively affect problem-focused coping (H2).
(3) Problem-focused coping will positively affect adaptation behavior (H3).

3 Method

3.1 Participants

The present study was carried out as a survey. The research population consisted of growers in the Shushtar county of Khuzestan Province in southwestern Iran (Fig. 2). The research sample included 250 growers who were nominated by a multistage clustered sampling

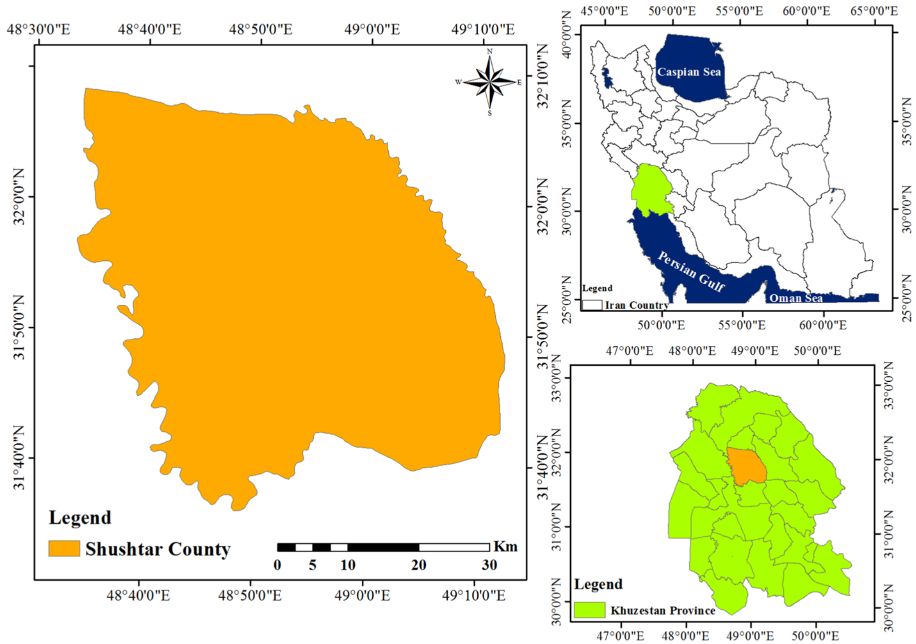

Fig. 2 Study site

technique. The surveys were directed throughout the winter of 2017. The questioner who filled out the questionnaires (the first author who was trained to gather quantitative and qualitative data) was from the county and was familiar with the language and customs of the research area. It took 30 to 40 min to complete the interviews. Farmers were not compensated to participate in the interview.

The participants were aged between 20 and 86 years, with an average value of 43.95 (S.D. = 13.65). The sample included 7 women (2.8%) and 244 men (97.2%). Around 43% of the growers had other jobs beside agriculture. The majority of the participants (39.8%) had a high school degree. Some (22.7%) had primary education, 7.6% had middle school education, 17.1% had a college degree, and 12.7% had no education.

3.2 Collection and analysis of data

To test the TSC quantitatively, an agricultural household survey methodology was conducted through questionnaires developed by researchers to understand farmers' behavior. The questionnaire included two sets of questions. The first set asked participants about demographic variables. The second set of questions focused on items that were used to represent the constructs of the TSC. To quantity the TSC constructs, we employed items that were closely modeled on the ones used to measure these constructs in previous studies (Homburg and Stolberg 2006; Homburg et al. 2007; Chen 2015). In designing the questionnaire, Likert-type scaling (five-point) was applied to the variables. Based on the nature of the items, the measuring scales included a five-point scale where five denoted very important/easy and one denoted not important/easy at all; or five denoted very much and one not at all; or five indicated strongly agree and one strongly disagree; or five denoted very likely and one very unlikely. Table 1 shows the items included in the survey questionnaire. A panel of experts approved the validity of the questionnaire. Furthermore, Cronbach's alpha reliability coefficients were investigated through a pilot study (40 farmers), and the results were then used to improve the items for the last questionnaire (Table 1).

Table 1 Survey items and reliability coefficients

Threat (α = 0.76)	4 items
I am worried about the consequences of climate change-induced water stress	
I am worried about my agriculture due to climate change-induced water stress	
I feel that I am threatened by climate change-induced water stress in my agriculture	
The thought of this climate change-induced water stress makes me uneasy	
Harm (α = 0.74)	4 items
So far, climate change-induced water stress has harmed me	
My water resources has become worse due to climate change	
My agriculture has become worse due to climate change-induced water stress	
I have lost hope, because climate change-induced water stress has just got worse and worse	
Self-efficacy (α = 0.73)	5 items
I know how to take precautions against climate change-induced water stress in my agricultural activities	
When faced with climate change-induced water stress, I find ways to deal with it	
When I hear about water shortages of this kind, I usually have various ideas on how to deal with it	
I believe I can manage unexpected climate change-induced water stress	
I know how to deal with new problems induced by climate change	
Problem Solving (α = 0.78)	4 items
I try to obtain a more exact picture of climate change-induced water stress	
I make sure I obtain more precise information about climate change-induced water stress	
I try to be informed about how this climate change-induced water stress can be reduced	
I am learning more about climate change-induced water stress	
Expression of Emotions (α = 0.72)	3 items
When I consider how much climate change-induced water stress there is in my agriculture, I feel depressed	
When I talk about climate change-induced water stress, I feel depressed	
When I think about how much climate change-induced water stress influences my agriculture, it makes me angry	
Self-protection (α = 0.65)	*2 items*
Because of climate change-induced water stress, I will put in more effort to protect the water	
Because of climate change-induced water stress, I try to behave more responsibly when it comes to water	
Adaptation behavior (α = 0.60)	5 items
I shift planting dates	
I shorten the length of the cultivation route or create plots that are shorter and narrower	
I use water and soil conservation methods (e.g., low tillage)	
I clean or cement the water canals	
I diversify into other crops	

4 Findings

4.1 Data analysis

Based on Table 2, the average values of the TSC constructs are fairly high and rather favorable (out of 5). However, the average values of self-efficacy were low at 2.31 out of 5. A Pearson correlation test was applied to examine the relationship between the TSC constructs (Table 2). The consequences revealed a significant relationship between adaptation behavior and threat, problem-focused coping, problem-solving, and self-protection. Furthermore, the results showed that demand appraisal, harm, self-efficacy, and expression of emotions did not have significant relationships with adaptation behavior (Table 2).

4.2 Descriptive statistics and correlation matrix of studied constructs

4.2.1 Main analysis

Structural equation modeling (SEM) was applied to investigate the TSC hypotheses with the maximum likelihood algorithm by applying the Amos software to reach the main goal of our study. This entailed ensuring the maximum explanatory power of the TSC to describe farmers' adaptation responses to climate change-induced water stress. SEM includes a confirmatory factor analysis (CFA) model that acts as the measurement model and the theoretical constructs test (Bagozzi, 1994). It is vital to guarantee that the measures that were theoretically claimed to be the indicators of each variable were adequately unidimensional. Based on scholars' arguments (for example, see Bentler 1989; Henry and Stone 1994), the CFA results must have acceptable conditions regarding empirical data (goodness of fit). In other words, certain indicators need to be at a good level or meet the necessities (Table 3). In our research model, the fit of the model depicted in Table 3 is rather good. The results indicate a satisfactory fit for the data. After the CFA, the TSC was examined. The outcomes of the SEM showed that the path coefficients specify the powers of interactions between the constructs. The outcomes of the SEM specified that the farmers' demand appraisal and self-efficacy had positive influences on their problem-focused coping, thus affecting their adaptation responses (Fig. 1). As demonstrated in Fig. 2, the model predicted 31% of the farmers' problem-focused coping and approximately 39% of their adaptation responses. The details of the results of the path coefficients indicated that self-efficacy ($\beta = 0.53$; $P < 0.0001$) is the strongest predictor of the farmers' problem-focused coping, followed by demand appraisal ($\beta = 0.35$; $P < 0.0001$). However, the path coefficients of problem-focused coping were ($\beta = 0.62$; $P < 0.028$) (Tables 4, 5).

5 Discussion and conclusion

The objective of this research was to investigate farmers' responses to negative impacts of climate variability on water resources through the TCS. The theory proposes that when individuals experience threats such as climate variability, their assessment procedure prompts them to engage in problem-focused coping behavior, which, in turn, leads them to take pro-environmental action (Homburg and Stolberg 2006).

The SEM analysis revealed that the TCS successfully accounted for the farmers' adaptation behavior, explaining 39% of the variation in the adaptation variable. To the

Table 2 Descriptive statistics and correlation matrix of studied constructs

Variables	Mean	Std. deviation	Demand appraisal	Threat	Harm	Self-efficacy	Problem-focused coping	Problem solving	Expression of emotions	Self-protection	Adaptation behavior
Demand appraisal	3.81	0.73	1								
Threat	4.06	0.71	0.86^{**}	1							
Harm	3.56	0.93	0.92^{**}	0.60^{**}	1						
Self-efficacy	2.31	0.70	-0.19^{**}	-0.13^{*}	-0.19^{**}	1					
Problem-focused coping	3.75	0.54	0.23^{**}	0.25^{**}	0.18^{**}	0.28^{**}	1				
Problem solving	3.32	1.23	0.05	0.07	0.03	0.34^{**}	0.82^{**}	1			
Expression of emotions	4.20	0.70	0.42^{**}	0.40^{**}	0.35^{**}	−0.01	0.59^{**}	0.14^{*}	1		
Self-protection	3.96	0.76	0.06	0.08	0.04	0.20^{**}	0.65^{**}	0.36^{**}	0.24^{**}	1	
Adaptation behavior	3.38	0.65	−0.08	-0.14^{*}	−0.02	0.064	0.24^{**}	0.26^{**}	0.01	0.20^{**}	1

* $P < 0.05$, ** $P < 0.01$

Table 3 Confirmatory factor analysis results model fit

Indexes	Model fit
Goodness-of-fit index (GFI)	0.86
GFI adjusted for degrees of freedom (AGFI)	0.84
Root mean square residual (RMR)	0.091
Chi-square	555.11
Chi-square *DF*	341
RMSEA estimate	0.05
Bentler's comparative fit index	0.87
χ^2/df	1.627
Bentler and Bonett's (1980) NFI	0.73

Table 4 Standardized loadings of indicators and convergent validity

Demand appraisal	Number of items	Loading
Demand appraisal	Threat (4 items)	0.87
	Harm (4 items)	0.91
Self-efficacy	5 items	0.51
		0.60
		0.68
		0.55
		0.56
Problem-focused coping	Problem solving (4 items)	0.64
	Expression of emotions (3 items)	0.53
	Self-protection (2 items)	0.73

Table 5 Results of structural equation modeling analysis

Causal Relationships	β	*P* value	Hypotheses
Demand appraisal → Problem-focused coping	0.35 ***	0.0001	Confirmed
Self-efficacy → Problem-focused coping	0.53***	0.0001	Confirmed
Problem-focused coping → Pro-environmental behavior	0.62*	0.028	Confirmed

* $P < 0.05$, ** $P < 0.01$

best of our knowledge, no research has used the TCS in Iran as a framework for farmers' response to hazards or in any other research domain. This circumstance makes it challenging to associate the results of this study with those of similar studies.

However, in comparison with other psychological studies in Iran and worldwide, the findings of our study suggest that the TCS framework is an effective tool for the study question. For example, a study of the theory of planned behavior (TPB) undertaken by Armitage and Conner (2001) discovered that this theory accounted for 27% of the variance in behavior in their study. This implies that the predicting power of the TCS in our study is also satisfactory. Furthermore, in comparison with the past literature in the domain of environmental psychology in Iran, the results of this study are also considered satisfactory. For example, Yazdanpanah et al. found that TPB (2014) and SCT (2015) could predict 33% and 40% of farmers' water conservation behavior, respectively. Moreover, our results were confirmed when we compared them with similar studies that used the TCS. For instance, Taiwanin sample, Chen (2015) found that the TCS could account for 52% of the variation in pro-environmental behavior in their sample, while multiple studies by Homburg and Stolberg (2006) revealed that the TCS could account for a variation ranging from 20 to 55% in pro-environmental behavior. As such, we can conclude that our study enhanced external validation by reexamining the TCS to understand farmers' environmental behavior in a new social and cultural setting that is quite different from the western world.

Our SEM analysis also discovered that self-efficacy ($\beta = 0.53$, $P < 0.0001$) was a strong predictor of farmers' problem-focused coping and self-reported adaptation behavior. In other words, based on our results, when compared to demand appraisal, self-efficacy contributes more to stimulating farmers' problem-focused coping behavior, which, in turn, triggers engagement in adaptation behavior. This result contradicts those of previous studies. In her study, Chen (2015) reported that self-efficacy (in the original TCS) was a stronger predictor than demand appraisal, but in another body of work covering four studies, Homburg and Stolberg (2006) found that demand appraisal was stronger than self-efficacy in the prediction of problem-focused coping and pro-environmental behavior. Self-efficacy has long been discussed as a reason for adaptation behavior. Other studies in the domain of adaptation to climate change confirmed that self-efficacy is a significant factor, and there is an extensive body of literature on the role of self-efficacy in adaptation behavior.

Kuruppu and Liverman (2011) conducted a study comparable to the present study, reporting similar findings for self-efficacy. They found that self-efficacy is an important driver of adaptation to climate change-induced water stress in the central Pacific islands of Kiribati. In other words, the current study provides more support for the view that self-efficacy is a resilient, positive predictor of adaptation responses, as suggested by previous studies (van Valkengoed and Steg 2019; Wuepper et al. 2019; Mertens et al. 2018; Grothmann and Patt 2005).

The concept of perceived self-efficacy denotes how individuals view their ability to engage in adaptive behavior (Le Dang et al. 2014; Wuepper and Lybbert 2017). Kellsted et al. (2008) and Wuepper et al. (2019) argued that individuals with higher perceived self-efficacy are more likely to act on risks. In a sample of Swedish landowners, Blennow and Persson (2009) found a significant connection between people who had failed to adapt to climate change and those who had insufficient knowledge on how to adapt, or lacked confidence in the effectiveness of certain adaptive strategies. Heath and Gifford (2006) argued that some individuals may believe that they cannot significantly ameliorate the negative consequences of climate change through their efforts, whereas others may think that they can make a difference. In their study on farmers' intention to adapt to climate change-induced water stress, Kuruppu and Liverman (2011) found that high levels of perceived self-efficacy were an important determinant of the intention of individuals to adapt. Besides, they found that an individual's belief in their self-efficacy might be more dependent on their past experiences with water stress than an in-depth understanding of the impacts associated with climate variability. Therefore, to enhance farmers' self-efficacy, the government and extension programs must encourage farmers to engage in adaptive behavior.

From a practical point of view, our findings suggest that strategies should be put in place to make it easier for farmers to engage in such behaviors. Extension programs that aim to increase adaptation behavior may also need to employ strategies focused on strengthening farmers' plans and objectives to engage in adaptation behavior. Educational programs that aim to increase farmers' confidence, thereby enabling them to overcome any perceived barriers and difficulties in engaging in adaptation behavior, for example, will improve the probability of their engagement in such behavior in the future. In other words, encouraging farmers to have self-confidence to be able to change their farming practices is crucial to actual adaptation measures. This can help them overcome a sense of powerlessness that may be particularly acute for collective action problems like climate change (Niles et al. 2016). Bandura (1982) pointed out that self-efficacy is enhanced by "enactive attainments," "vicarious experiences," "verbal persuasion," and "psychological state." In other words, enactive attainments and vicarious experiences (observing others) are most influential in determining self-efficacy. An extension agent targeting at fostering self-efficacy among farmers in a study region could consequently opt for demonstration plots and verbal persuasion of selected farmers to take adaptation measures and performance as successful example to farmers. Workshops and agricultural training in a study region could include an informing session for the farmers to help them develop their capacity and take adaptation measures to cope with water scarcity (see Wuepper and Lybbert 2017). Furthermore, providing farmers with information and materials concerning the efficiency and simplicity of particular adaptation measures may be crucial to inspiring them to protect themselves against water stress. As Wuepper et al. (2019) declared, in addition to fostering self-efficacy, the interventionist policies should be careful not to have a detrimental effect on it. In other words, although self-efficacy is related to positive feelings such as hope and self-confidence, interventions leading to disappointment should be avoided.

Demand appraisal is another determinant of problem-focused coping and adaptation behavior. Demand appraisal includes a combination of perceived probability (threat exposure expectation) and perceived severity (harm expectation). In much of the literature that examines individual adaptation responses to climate change, researchers presume that the perception of risk and dangers from climate variability are serious arbiters of either action or inaction between growers and other actors and positively correlate with adaptation behavior (Leiserowitz 2006; Spence et al. 2012; van der Linden 2015). In this regard, van Valkengoed and Steg (2019) argued that negative impacts of climate change may promote people's adaptation responses because it is an unpleasant state that disturbs their mental peace, encouraging them to solve it. They found that stronger negative effects were linked with more adaptation responses. In terms of policy implications, we think that the present study has significant practical implications. Interventions designed to encourage adaptation are undoubtedly more operative when they bull antecedent variables that were strong predictors, of adaptation responses here including self-efficacy and negative effects. In our study, demand appraisal and self-efficacy jointly predicted about 31% of problem-focused coping behavior, while problem-focused coping, in turn, considerably projected adaptation responses. We suggest that policymakers enhance farmers' knowledge and information about climate change and its negative impacts through extension and education programs (see Yazdanpanah and Feyzabad 2017). Indeed, a great number of recent studies have determined that increasing information about climate change and its negative impacts may help farmers realize and improve this issue, thereby influencing their actions (Semenza et al. 2008; Lorenzoni et al. 2007). This study partly clarified the adaptation issue and the motivational factors affecting it, including self-efficacy, among Iranian farmers. However, due to the importance of factors such as self-efficacy and outcome efficacy (Wuepper et al. 2019) in adaptation responses as well as insufficient research into such factors (van Valkengoed and Steg 2019; Adger et al. 2003; Wuepper et al. 2019), thus for future research, it would be especially fruitful to investigate, in more depth, the impacts of these motivational factors, particularly in developing countries that are highly vulnerable to climate change.

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