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# The Interactive Effect of Psychological Resilience and Temporal Perception of Drought on Farmers' Water-Saving Behavior in the Face of Compound Climate Shocks

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# Abstract

Compound climate shocks, particularly drought–extreme heat, pose a serious threat to water and food security in arid and semi-arid regions worldwide. This study aimed to investigate the interactive effect of psychological resilience and temporal perception of drought on the water-saving behavior of irrigated farmers in Kermanshah Province, western Iran, in the face of compound climate shocks. The research was applied in purpose and descriptive–correlational in method, using partial least squares structural equation modeling (PLS-SEM). The statistical population consisted of irrigated farmers in Kermanshah Province, from which 384 farmers were selected through stratified random sampling with proportional allocation. Data were collected using a 73 -item questionnaire and analyzed with SPSS 27 and SmartPLS 4. The findings showed that the experience of compound climate shocks had a positive and significant effect on psychological resilience (β = 0.386) and temporal perception of drought (β = 0.312). Psychological resilience (β = 0.352) and future-oriented temporal perception (β = 0.284) had positive and significant effects on water-saving behavior, while present-oriented (β = -0.156) and past-oriented (β = -0.132) temporal perception had negative and significant effects on it (β = -0.198). The interactive effect of psychological resilience × temporal perception of drought (β = 0.089, p = 0.156) and the moderating effect of compound climate shocks on the relationship between psychological resilience and water-saving behavior (β = -0.067, p = 0.238) were rejected. The research model explained 47% of the variance in water-saving behavior. Based on the results, promoting water-saving behavior requires a multidimensional approach that simultaneously considers psychological, temporal, and contextual dimensions. The findings indicate that in arid and semi-arid regions worldwide, policymakers can enhance water-saving behavior by simultaneously strengthening psychological resilience and future-oriented temporal perception, and by designing educational and supportive interventions in parallel.


# 1 Introduction

Climate change, one of the greatest challenges of the twenty-first century, has fundamentally altered temperature, precipitation, and extreme event patterns and intensified the vulnerability of agricultural systems worldwide (IPCC, 2022). In this context, compound climate shocks have emerged as one of the most complex and destructive forms of climate hazards, requiring analytical frameworks different from those for single-factor hazards. According to the IPCC definition, a compound event refers to conditions in which two or more extreme events occur simultaneously or successively, and their combined effects far exceed the sum of individual effects (Seneviratne et al., 2012). In agriculture, compound climate shocks typically manifest as drought–extreme heat, drought–low precipitation, or a combination of low precipitation and high temperature, and due to their synergistic effects, they systematically undermine the adaptive capacity of agricultural systems (Zscheischler et al., 2018).

The agricultural sector, as the largest consumer of fresh water worldwide, accounts for approximately 70% of global water withdrawals and is therefore both the primary driver of pressure on water resources and the most vulnerable sector to compound climate shocks (FAO, 2020). Compound climate shocks not only directly threaten food security but also endanger the socio-economic sustainability of rural

communities by reducing water productivity, increasing production costs, and decreasing farmers' incomes (Cissé et al., 2024).

Iran, located in the arid and semi-arid belt of the world, is particularly exposed to compound climate shocks. Studies have shown that the frequency of drought, extreme heat, and compound drought–extreme heat events in Iran has significantly intensified over the past 15 years, with new hotspots emerging in central Iran and the Zagros mountain range (Veysi & Nouri, 2026). More importantly, irrigation cannot fully serve as a protective shield against the synergistic pressure of compound drought–extreme heat events, as water productivity in irrigated areas decreases by 13.5% and in rainfed areas by 27.4% under these events (Veysi & Nouri, 2026).

Kermanshah Province in western Iran, as one of the important hubs of irrigated agriculture, is a clear example of vulnerability to compound climate shocks. Its irrigated land area exceeds 280,000 hectares, mainly allocated to water-intensive crops such as irrigated wheat, forage maize, alfalfa, and sugar beet (Kermanshah Province Agricultural Jihad Organization, 2024). Repeated droughts in recent years have significantly reduced groundwater levels and soil moisture and severely affected the yield of irrigated crops (Almasi et al., 2019). Provincial experts have declared a revision of cropping patterns and the adoption of modern irrigation methods as two unavoidable developmental necessities in the face of climate change and persistent droughts.

Recent research in this province has shown that psycho-social factors, including personal norms, perceived behavioral control, and environmental self-efficacy, play a determining role in explaining farmers' adaptation behavior to water scarcity (Azadi et al., 2024; Savari et al., 2025). However, psychological resilience and temporal perception, as two fundamental psychological constructs that can shape how farmers process and respond to compound climate shocks, have received less systematic attention.

Psychological resilience refers to the mental and emotional capacity of a farmer to cope with adversity and return to equilibrium after facing a crisis (Connor & Davidson, 2003). Studies have shown that repeated droughts have led to reduced life satisfaction, quality of life, and psychological resilience among Iranian farmers (Yazdanpanah et al., 2022). Meanwhile, temporal perception—the farmer's orientation toward the past, present, or future—acts as a cognitive framework that guides the prioritization and selection of risk management behaviors. Studies in Iran have shown that most farmers have a present-oriented perspective, and past-oriented farmers exhibit weaker drought risk management behavior compared to other groups (Neisi et al., 2020).

In a situation where compound climate shocks are increasingly pressuring agricultural systems in Iran and the world, and Kermanshah Province faces a combination of compound drought, severe groundwater depletion, and socio-economic constraints of smallholder farmers, identifying the psychological mechanisms affecting water-saving behavior is of critical importance. One-dimensional policymaking and exclusive focus on economic and technical tools, without attention to psychological dimensions, have been ineffective. Therefore, the present study investigates the interactive effect of

psychological resilience and temporal perception of drought on the water-saving behavior of farmers in Kermanshah Province in the face of compound climate shocks, in order to provide the empirical evidence necessary for designing more effective water-saving policies in arid and semi-arid regions.

# 2 Theoretical Foundations and Literature Review

*2 − 1. Theoretical Framework*

The present study integrates three theoretical frameworks: Hobfoll's Conservation of Resources (COR) theory for psychological resilience (Hobfoll, 1989), Zimbardo and Boyd's time perspective theory for temporal perception of drought (Zimbardo & Boyd, 1999), and Grothmann and Patt's cognitive–motivational adaptation theory for converting perception into water-saving behavior (Grothmann & Patt, 2005). Compound climate shocks simultaneously activate three psychological processes: (1) conservation of psychological resources, which determines whether an individual possesses the necessary resilience capacity (Hobfoll, 1989); (2) temporal processing, which determines how close, urgent, and relevant to one's future the threat is perceived to be (Zimbardo & Boyd, 1999); and (3) cognitive–motivational appraisal, which determines whether this perception translates into practical action (Grothmann & Patt, 2005).

# 2–2. Compound Climate Shocks

Compound climate shocks refer to events in which two or more climate hazards occur simultaneously, successively, or consecutively, and their combined effects far exceed the sum of individual effects (Zscheischler et al., 2018). In agriculture, the most common forms are drought–extreme heat, drought–low precipitation, and drought–hot wind, which undermine adaptive capacity by reducing soil moisture, increasing evapotranspiration, and decreasing crop yield (Seneviratne et al., 2012). Their synergistic nature operates through three pathways: physiological intensification (heat concurrent with drought increases transpiration and water demand), resource degradation (successive droughts reduce groundwater and soil recovery capacity), and capture of adaptive capacity (simultaneous threats deplete psychological, economic, and institutional capacity) (Cissé et al., 2024).

This synergy has important implications for farmers' perception and psychological response. Unlike single-factor hazards, compound shocks may create perceptual ambiguity and affect temporal perception and urgency. Moreover, repeated experience of these shocks can both strengthen psychological resilience (through active adaptation) and erode it (through resource depletion). In Iranian agriculture, compound climate shocks affect both the farmer's psychological capacity and their perception of the time and urgency of drought (Cissé et al., 2024). Accordingly:

**H1**

The experience of compound climate shocks has a positive and significant effect on farmers' psychological resilience.

**H2**

The experience of compound climate shocks has a significant effect on farmers' temporal perception of drought.

The Conservation of Resources (COR) theory (Hobfoll, 1989) explains human behavior in the face of stress and crisis. Individuals strive to preserve valued resources, compensate for loss, and acquire new resources. Stress occurs when resources are threatened, lost, or cannot be recovered. In agriculture, resources include water, land, capital, knowledge, and psychological resources such as self-efficacy, hope, and resilience. Psychological resilience, the central core of this theory, refers to an individual's capacity to return to equilibrium, maintain optimal functioning, and achieve positive growth in the face of adversity and chronic crises (Connor & Davidson, 2003). In agriculture, farmers' psychological resilience includes self-efficacy, hope, cognitive flexibility, emotion regulation, and active coping. Studies show that psychological resilience is significantly associated with adaptive behaviors under climate change (Marshall & Smajgl, 2013). In Iran, Shojaei-Miandoragh et al. (2020) confirmed that psychological resilience plays a key role in farmers' water conservation behavior. Tahernejad et al. (2025) also showed that psychological resilience, through self-efficacy and hope, strengthens farmers' motivation to adopt adaptive behaviors. Accordingly:

**H3**

Psychological resilience has a positive and significant effect on farmers' water-saving behavior.

## 2–3. Time Perspective Theory and Temporal Perception of Drought

Zimbardo and Boyd's (1999) time perspective theory states that individuals have different temporal orientations that shape their information processing, decision-making, and behavioral choices. Individuals may be past-oriented (focused on past experiences and traditions), present-oriented (focused on immediate pleasure and current problems), or future-oriented (focused on long-term goals and consequences). The Zimbardo Time Perspective Inventory (ZTPI) is the primary instrument for measuring this construct. In the context of drought, temporal perception refers to the farmer's perception, processing, and subjective evaluation of the temporal dimension of drought, which includes perceived temporal distance, perceived frequency, perceived urgency, and time orientation. Drought is a slow-onset phenomenon, and therefore the farmer's temporal perception of it shapes their response (Grothmann & Patt, 2005). Studies show that time perspective significantly affects environmental behavior and climate adaptation (Milfont et al., 2012). In Iran, Neisi et al. (2020) showed that most farmers have a present-oriented perspective, and past-oriented farmers exhibit weaker drought risk management behavior compared to other groups. Another study in Iran confirmed that dimensions of

psychological distance explain 72.2% of the variance in climate concerns (Yazdanpanah et al., 2024). Accordingly:

**H4**

Future-oriented temporal perception has a positive and significant effect on farmers' water-saving behavior.

**H5**

Present-oriented temporal perception has a negative and significant effect on farmers' water-saving behavior.

**H6**

Past-oriented temporal perception has a negative and significant effect on farmers' water-saving behavior.

## 2–4. Cognitive–Motivational Adaptation Theory and Water-Saving Behavior

Grothmann and Patt's (2005) cognitive–motivational adaptation theory explains the process of converting perception into adaptive behavior. Drawing on protection motivation theory (PMT), this theory developed the Model of Private Proactive Adaptation to Climate Change (MPPACC). Adaptive behavior results from two sequential processes: threat appraisal (risk perception and urgency perception) and adaptation appraisal (self-efficacy, outcome expectation, and action costs). In agriculture, water-saving behavior refers to operational, technical, and managerial actions that a farmer performs to reduce water consumption and increase efficiency (Keshavarz & Karami, 2014). These behaviors include technical, managerial, and institutional–social behaviors (Bijani et al., 2017). Studies show that self-efficacy is the main determinant of converting risk perception into practical action. In Iran, a study using the value–belief–norm framework showed that the model explained 68% of the total variance in water-saving behavior (Fouladi et al., 2026).

## 2–5. Interactive Effect of Psychological Resilience and Temporal Perception of Drought

The theoretical logic of this interaction is based on two arguments. First (facilitation): high psychological resilience allows the farmer to convert future-oriented and urgency-focused temporal perception of drought into practical action, because psychological capacity is a necessary condition for converting perception into behavior (Grothmann & Patt, 2005). Second (compensation): farmers with high psychological resilience, even with present-oriented or past-oriented temporal perception, may adopt

water-saving behaviors due to their psychological capacity (Hobfoll, 1989). However, empirical evidence in Iranian agriculture is limited. Joireman et al. (2012) showed that interactive effects between time orientation and psychological capacity typically have small effect sizes. Grothmann and Patt (2005) also emphasized that the moderating effect of self-efficacy varies depending on context and behavior type. Accordingly:

**H7**

The interactive effect of psychological resilience × temporal perception of drought on water-saving behavior is positive and significant.

**H8**

The experience of compound climate shocks moderates the relationship between psychological resilience and water-saving behavior.

## 2–6. Moderating Role of Compound Climate Shock Experience

According to cognitive–motivational adaptation theory, direct experience of climate events shapes information processing and threat appraisal (Grothmann & Patt, 2005). Studies show that repeated drought experience can both strengthen psychological resilience (through adaptation) and weaken it (through psychological erosion) (Omid et al., 2023). However, the direction and significance of this moderating effect in Iranian agriculture are not definitive. Galappaththi et al. (2023) showed that chronic exposure to drought can lead to resilience erosion, but this erosion does not necessarily lead to reduced water-saving behavior. Therefore, empirical testing appears necessary.

## 2–7. Dimensions of Research Constructs

**H9**

The five dimensions of self-efficacy, hope, cognitive flexibility, emotion regulation, and active coping significantly explain the second-order construct of psychological resilience.

**H10**

The six dimensions of perceived temporal distance, perceived frequency, perceived urgency, future-oriented, present-oriented, and past-oriented significantly explain the second-order construct of temporal perception of drought.

It is likely that psychological resilience and temporal perception of drought act not only as direct predictors but also as mediating mechanisms; that is, the experience of compound climate shocks first activates these psychological constructs, and they then indirectly shape water-saving behavior.

## 2-7-1. Mediating Role of Psychological Resilience

Grothmann and Patt's (2005) theory is the main framework for explaining the mediating role of psychological resilience. The adaptation process consists of two stages: threat appraisal and adaptation appraisal. Psychological resilience (including self-efficacy, hope, and active coping) acts as an intermediate psychological mechanism that links the experience of climate shock to practical action. The experience of climate shock alone is not sufficient for adopting water-saving behavior; rather, it must pass through the filter of the individual's psychological capacity. Shojaei-Miandoragh et al. (2020) showed that psychological resilience acts as a mediating mechanism between water scarcity experience and conservation behavior. Sadeghi et al. (2019) confirmed that self-efficacy has the highest total causal effect on water exploitation behavior, transmitted through other psychological variables. A study on smallholder farmers in India showed that psychological resilience acts as a full mediator between institutional support and climate adaptation. Azadi et al. (2026) also confirmed that psychological mechanisms mediate the relationship between contextual factors and water-saving behavior. Accordingly:

**H11**

The experience of compound climate shocks has a significant indirect effect on water-saving behavior through psychological resilience.

## 2-7-2. Mediating Role of Temporal Perception of Drought

Liberman and Trope's (2010) construal level theory (CLT) is the main framework for explaining the mediating role of temporal perception. Direct and repeated experience of an event reduces psychological distance and makes it perceived as close, urgent, and self-relevant. More urgent and future-oriented temporal perception converts the experience of climate shock into motivation and action for water saving. Valizadeh et al. (2018) showed that future-oriented time perspective has a positive effect on water conservation attitude and behavior, while present-oriented perspective has a negative effect; attitude acted as a mediator. Sadeghi et al. (2019) confirmed the mediating role of time perspective in water resource exploitation behavior. Yazdanpanah et al. (2024) showed that dimensions of psychological distance explain 72.2% of the variance in climate concerns, and these concerns act as a mediator. Corral-Verdugo et al. (2006) confirmed that future-oriented perspective has a positive relationship with water conservation behavior, mediated through cognitive–motivational variables. Accordingly:

**H12**

The experience of compound climate shocks has a significant indirect effect on water-saving behavior through temporal perception of drought.

## 2-7-3. Sequential Mediating Role of Psychological Resilience and Temporal Perception

Hypothesis H13 tests a sequential mediation in which the experience of climate shock first strengthens psychological resilience, then the strengthened resilience leads to a more urgent and future-oriented temporal perception, and finally this temporal perception guides water-saving behavior. The theoretical logic is derived from three theories: Hobfoll's (1989) COR theory, Zimbardo and Boyd's (1999) time perspective theory, and Grothmann and Patt's (2005) cognitive–motivational theory. Sadeghi et al. (2019) showed that self-efficacy has the highest total causal effect on water exploitation behavior, transmitted through time perspective, confirming the logic: self-efficacy → time perspective → behavior. Shojaei-Miandoragh et al. (2020) showed that both psychological resilience and temporal perception act as mediating mechanisms. A study on farmers in India confirmed a sequential psychological pathway (financial resilience → psychological resilience → climate adaptation). Yazdanpanah et al. (2024) showed that psychological distance affects adaptation behavior through climate concerns, which act as a sequential mediator. Accordingly:

**H13**

The experience of compound climate shocks has a significant indirect effect on water-saving behavior through the sequential chain of psychological resilience and temporal perception of drought.

A review of the literature shows that previous studies have predominantly examined either psychological resilience independently (Shojaei-Miandoragh et al., 2020; Tahernejad et al., 2025; Savari et al., 2025) or temporal perception as a separate construct (Neisi et al., 2020; Tahernejad et al., 2022; van Tilburg et al., 2025). In none of these studies has the interactive effect of these two constructs on farmers' water-saving behavior in the context of compound climate shocks been systematically tested.

This theoretical gap is of double importance, especially in Kermanshah Province, where farmers face a combination of compound drought, water poverty, and socio-economic constraints. Filling this gap is critically important for several reasons: first, if the two constructs act interactively, one-dimensional policymaking will be ineffective, and integrated interventions must be designed; second, if they act independently and in parallel, designing interventions becomes simpler and more cost-effective; third, identifying the psychological mechanisms can lead to more targeted adaptation policies and prevent the waste of resources; fourth, Kermanshah Province provides a suitable context for testing these relationships, and its findings can serve as a model for other arid and semi-arid regions; fifth, the findings can help policymakers move beyond a sole focus on economic and technical tools and pay serious attention to the determining role of psychological constructs.

Accordingly, the present study, using partial least squares structural equation modeling (PLS-SEM), investigates the interactive effect of psychological resilience and temporal perception of drought on the water-saving behavior of farmers in Kermanshah Province in the face of compound climate shocks, in

order to fill the existing theoretical gap and provide the empirical evidence necessary for designing more effective water-saving policies in arid and semi-arid regions.

## 2–8 Conceptual Framework of the Research

Based on the theoretical foundations and research literature, the conceptual framework of the present study is presented in Fig. 1. This framework is formed from the integration of three fundamental theories Conservation of Resources (COR) theory, time perspective theory, and cognitive–motivational adaptation theory and includes four main constructs (experience of compound climate shocks, psychological resilience, temporal perception of drought, and water-saving behavior) and one interactive construct (psychological resilience × temporal perception of drought).

Psychological resilience as a second-order construct consists of five dimensions: self-efficacy, hope, cognitive flexibility, emotion regulation, and active coping. Temporal perception of drought as a second-order construct also consists of four dimensions: perceived temporal distance, perceived frequency, perceived urgency, and time orientation (including three subcomponents: future-oriented, present-oriented, and past-oriented).

In this framework, the experience of compound climate shocks, as a contextual variable, affects both psychological resilience and temporal perception of drought. Psychological resilience and temporal perception of drought each independently affect water-saving behavior. In addition, the interactive effect of psychological resilience × temporal perception of drought on water-saving behavior is tested. Also, the experience of compound climate shocks is examined as a moderating variable on the relationship between psychological resilience and water-saving behavior.

# 3 Methods

*3 – 1 Study Area*

The present study was conducted in Kermanshah Province, located in western Iran (Fig. 2). With an area of approximately 25,000 square kilometers, this province is considered one of the important hubs of irrigated agriculture in the country. The irrigated land area of the province exceeds 280,000 hectares, mainly allocated to the cultivation of water-intensive crops such as irrigated wheat, forage maize, alfalfa, and sugar beet (Kermanshah Province Agricultural Jihad Organization, 2024). The agricultural water resources of this province include permanent rivers, springs, qanats, and deep and semi-deep wells, whose groundwater levels have noticeably declined in recent years due to repeated droughts and excessive extraction. The selection of this region was based on three criteria: the strong dependence of irrigated agriculture on endangered surface and groundwater resources, the repeated experience of severe droughts and compound climate shocks over the past two decades, and the strategic importance of the province in the production of irrigated crops in the country.

## 3 – 2 Statistical Population and Sampling Method

The statistical population consisted of all irrigated farmers in Kermanshah Province engaged in irrigated crop cultivation in the 2024–2025 crop years. Based on official statistics, the population size was approximately 45,000 irrigated beneficiaries. Using Cochran's formula with a 5% error level and 95% confidence level, 384 individuals were selected as the sample. To determine sample adequacy in PLS-SEM, the 10-times rule was used, requiring a minimum of 10 times the maximum number of structural paths leading to an endogenous construct (Hair et al., 2019). Since "water-saving behavior" had the highest number of incoming paths, the minimum required sample was 60 individuals. Also, G*Power analysis with 80% power, a medium effect size ($f^2 = 0.15$), and five predictors confirmed a minimum sample of 92 individuals (Faul et al., 2009).

Stratified random sampling with proportional allocation was used. Kermanshah Province was classified into main counties (Kermanshah, Sarpol-e Zahab, Sahneh, Harsin, Kangavar, Sonqor and Kolyai, and Paveh), and each county's share was determined by its ratio of irrigated beneficiaries to the total population. Inclusion criteria were: possessing irrigated agricultural land, active engagement in irrigated crop cultivation, using at least one irrigation system, and having at least three years of irrigated farming experience. Data were collected using a researcher-made questionnaire through face-to-face interviews.

## 3–3. Research Instrument

The main instrument was a researcher-made questionnaire, finally set with 73 items after examining content, face, and construct validity and removing overlapping items. It consists of five sections. All latent constructs were measured using a 5-point Likert scale, and composite scores were computed as the average of respective items.

Section One Demographic and Agricultural Characteristics: Included 12 questions about gender (1 = male, 2 = female), age (1 = less than 40, 2 = 40–59, 3 = more than 59), education level (1 = illiterate, 2 = elementary, 3 = secondary, 4 = university), farming experience (1 = less than 10 years, 2 = 10–25 years, 3 = more than 25 years), cultivated area (1 = less than 2 ha, 2 = 2–5 ha, 3 = 5–10 ha, 4 = more than 10 ha), type of irrigation system (1 = surface, 2 = sprinkler, 3 = drip, 4 = combined), main source of water supply (1 = private well, 2 = shared well, 3 = river, 4 = qanat and dam), type of land tenure (1 = owner, 2 = tenant, 3 = shared), main source of income (1 = only agriculture, 2 = agriculture + non-agriculture, 3 = non-agriculture), participation in water-related extension courses (1 = yes, 2 = no), and membership in water users' associations (1 = yes, 2 = no)

Section Two Experience of Compound Climate Shocks (CCS): Defined as the extent to which the farmer has experienced simultaneous or successive compound climate events (drought–extreme heat) over the past five years. It was measured with 5 items (CCS1–CCS5) on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), designed based on Zscheischler et al. (2018). A composite score was computed as the average of the five items, with higher scores indicating greater experience.

Section Three Psychological Resilience (PR): Defined as the farmer's mental and emotional capacity to cope with adversity and return to equilibrium after facing a crisis. It was measured with 20 items across five dimensions: self-efficacy (4 items), hope (4 items), cognitive flexibility (4 items), emotion regulation (4 items), and active coping (4 items), based on the Connor–Davidson Resilience Scale (Connor & Davidson, 2003) and Luthans et al. (2017). Responses were rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Composite scores were computed for each dimension and the overall PR score.

The five dimensions were defined as follows: Self-efficacy refers to the farmer's belief in their ability to successfully perform tasks and manage challenges related to water scarcity. Hope refers to the ability to generate multiple pathways and maintain motivation under water-scarce conditions. Cognitive flexibility refers to the ability to adapt thinking and behavior to new climatic conditions. Emotion regulation refers to the ability to manage and control negative emotions arising from drought. Active coping refers to the tendency to actively seek solutions, plan practically, and take initiative.

Section Four Temporal Perception of Drought (TPD): Defined as the farmer's perception, processing, and subjective evaluation of the temporal dimension of drought. It was measured with 21 items across four dimensions: perceived temporal distance (3 items), perceived frequency (3 items), perceived urgency (3 items), and time orientation (12 items, including 4 future-oriented, 4 present-oriented, and 4 past-oriented items), based on Zimbardo and Boyd's (1999) time perspective theory and the ZTPI. Responses were rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Composite scores were computed for each dimension and the overall TPD score.

The four dimensions were defined as follows: Perceived temporal distance refers to the perception of how close or distant a severe drought event is in time. Perceived frequency refers to the perception of how often droughts have occurred in recent years. Perceived urgency refers to the perception of the need for immediate action. Time orientation refers to the tendency to focus on the past, present, or future in agricultural decisions, comprising three sub-dimensions: future-oriented (long-term goals), present-oriented (immediate needs), and past-oriented (traditional methods and past experiences).

Section Five Water-Saving Behavior (WCB): Defined as the set of operational, technical, and managerial actions performed by the farmer to reduce water consumption and increase water use efficiency. It was measured with 15 items across three dimensions: technical behaviors (5 items), managerial behaviors (5 items), and institutional–social behaviors (5 items), based on Keshavarz and Karami (2014) and Bijani et al. (2017). Responses were rated on a 5-point Likert scale (1 = never to 5 = always). Composite scores were computed for each dimension and the overall WCB score

The three dimensions were defined as follows: Technical behaviors refer to the use of technical equipment and methods to reduce water consumption (e.g., drip irrigation, mulching, water meters). Managerial behaviors refer to managerial practices to optimize water use (e.g., adjusting irrigation intervals, changing cropping patterns). Institutional–social behaviors refer to participation in collective

and institutional activities related to water management (e.g., water users' associations, training courses)

Transformations applied: No reverse coding was applied, as all items were worded positively and directly. Mean centering was applied to the predictor (PR) and moderator (TPD) variables before creating the interaction term (PR × TPD) to reduce multicollinearity. Latent variable scores were standardized before computing the interaction term in the two-stage approach.

Before final distribution, the questionnaire was tested in a pilot study on 30 irrigated farmers outside the main sample to examine clarity and completion time. To prevent response bias, the purpose of the research was explained at the beginning, and confidentiality was emphasized.

## 3–4. Validity and Reliability of the Research Instrument

Content and Face Validity: Content validity was confirmed using CVR and CVI based on a 10-member panel of experts in agricultural extension, environmental psychology, and agricultural economics. All items obtained CVR values above 0.62 and CVI values above 0.79 (Lawshe, 1975). Face validity was confirmed by 15 irrigated farmers outside the sample.

Convergent Validity: Assessed using outer loadings, AVE, and CR. The acceptance criterion for loadings was 0.70 or higher, and items with loadings between 0.40 and 0.70 were removed if their removal improved AVE and CR values (Hair et al., 2019). AVE values should be at least 0.50 (Fornell & Larcker, 1981) (Supplementary Table S1).

Reliability: Assessed using Cronbach's alpha, CR, and indicator reliability. The minimum acceptable value for Cronbach's alpha was 0.70 (Cronbach, 1951). CR should be between 0.70 and 0.95 (Hair et al., 2019) (Supplementary Table S1).

Discriminant Validity: Assessed using cross-loadings, the Fornell–Larcker criterion, and HTMT. According to Fornell–Larcker, the square root of the AVE of each construct should be greater than its highest correlation with other constructs (Fornell & Larcker, 1981). For HTMT, values should be less than 0.85 (Henseler et al., 2015) (Table 8).

Common Method Bias: Harman's single-factor test and the full collinearity approach were used. In Harman's test, if the first factor explains less than 50% of the total variance, it indicates the absence of common method bias (Podsakoff et al., 2003). In the full collinearity approach, VIF values for all constructs should be less than 3.3 (Kock, 2015).

## 3–5 Data Analysis

Data analysis was performed in two stages. In the first stage, descriptive statistics and normality of data distribution were examined using SPSS version 27. In the second stage, hypothesis testing and

structural equation modeling were conducted using the partial least squares (PLS-SEM) approach with SmartPLS version 4.

Stage One: Measurement Model Assessment (Outer Model): Outer loadings of all indicators were examined. Indicators with loadings less than 0.50 were removed. Then, reliability was assessed with Cronbach's alpha and composite reliability, and convergent validity with AVE (Supplementary Table S1). Discriminant validity was also confirmed with the Fornell–Larcker criterion and HTMT. For second-order constructs (psychological resilience and temporal perception of drought), the repeated indicators approach was used (Tables 7 and 8). Stage Two: Structural Model Assessment (Inner Model): VIF values for all endogenous constructs were examined. The $R^2$ value for the endogenous construct "water-saving behavior" was reported. For each structural path, the $f^2$ value was calculated. Using the Blindfolding procedure (with an omission distance of 7), the $Q^2$ value was calculated. The significance of structural paths was assessed using the bootstrapping procedure with 5,000 subsamples and a two-tailed test at a 5% significance level ($t > 1.96$) (Hair et al., 2019).

Interaction Effect Test: To test hypothesis H7, the two-stage approach in SmartPLS was used. In the first stage, the main model without the interaction term was estimated and latent variable scores were saved. In the second stage, the latent variable scores of the predictor (psychological resilience) and the moderator (temporal perception of drought) were multiplied, and a single indicator was created for the interaction term. Then, the model was re-estimated with the inclusion of the interaction term (Becker et al., 2018).

Model Fit Indices: The fit of the measurement model was assessed using SRMR (acceptable value less than 0.08) and NFI (acceptable value greater than 0.90) (Tenenhaus & Esposito Vinzi, 2005) (Table 4).

# 4 Research Findings

*4 – 1 Demographic and Agricultural Characteristics of Respondents*

The data collected from 384 irrigated farmers (Table 1) show that 292 respondents (76.04%) were men and 92 (23.96%) were women. The highest frequency belonged to the 40–59 age group with 173 individuals (45.05%). In terms of education, 139 individuals (36.20%) had secondary and high school education. The largest group by farming experience was 10–25 years with 168 individuals (43.75%). Regarding cultivated area, the highest frequency was the 2–5-hectare category with 157 individuals (40.89%), followed by less than 2 hectares with 98 individuals (25.52%), 5–10 hectares with 86 individuals (22.40%), and more than 10 hectares with 43 individuals (11.20%). This indicates that most farmers are smallholders (less than 5 hectares), comprising 66.41% of the sample. Regarding irrigation systems, 147 individuals (38.28%) used surface (flood) irrigation, followed by sprinkler irrigation with 98 individuals (25.52%), drip irrigation with 82 individuals (21.35%), and combined systems with 57 individuals (14.84%). This shows that despite the promotion of modern methods, more than one-third of farmers still use traditional surface irrigation. In terms of cropping pattern, irrigated wheat was the most dominant crop with 158 individuals (41.15%). Half of the respondents (192 individuals, 50.00%) used a

private well, 210 individuals (54.69%) owned their land, and 258 individuals (67.19%) made a living solely from agriculture. Also, 206 individuals (53.65%) had participated in water-related extension courses, and 168 individuals (43.75%) were members of water users' associations.

Table 1
Demographic Characteristics of Farmers (n = 384)

| Variable | Category | Frequency (n = 384) | Percentage (%) |
|---|---|---|---|
| Gender | Female | 92 | 23.96 |
| | Male | 292 | 76.04 |
| Age (years) | Less than 40 | 118 | 30.73 |
| | Between 40–59 | 173 | 45.05 |
| | More than 59 | 93 | 24.22 |
| Education | Illiterate | 87 | 22.66 |
| | Elementary | 72 | 18.75 |
| | Secondary (Middle and High School) | 139 | 36.20 |
| | University | 86 | 22.40 |
| Farming Experience (years) | Less than 10 | 109 | 28.39 |
| | Between 10–25 | 168 | 43.75 |
| | More than 25 | 107 | 27.86 |
| Cultivated area | Less than 2 hectares | 98 | 25.52 |
| | 2–5 hectares | 157 | 40.89 |
| | 5–10 hectares | 86 | 22.40 |
| | More than 10 hectares | 43 | 11.20 |
| Type of irrigation system | Surface (flood) irrigation | 147 | 38.28 |
| | Sprinkler irrigation | 98 | 25.52 |
| | Drip irrigation | 82 | 21.35 |
| | Combined (more than one system) | 57 | 14.84 |
| Type of dominant crops cultivated | Irrigated wheat | 158 | 41.15 |
| | Irrigated barley | 112 | 29.17 |
| | Maize | 62 | 16.15 |
| | Other (alfalfa, sugar beet) | 52 | 13.54 |
| Main source of water supply | Private well | 192 | 50.00 |

| Variable | Category | Frequency (n = 384) | Percentage (%) |
|---|---|---|---|
| | Shared well | 106 | 27.60 |
| | River | 51 | 13.28 |
| | Qanat and dam | 35 | 9.11 |
| Type of land tenure | Owner | 210 | 54.69 |
| | Tenant | 104 | 27.08 |
| | Shared | 70 | 18.23 |
| Main Income Source | Only agriculture | 258 | 67.19 |
| | Agriculture + non-agriculture | 85 | 22.14 |
| | Non- agriculture | 41 | 10.68 |
| Participation in water-related extension courses | Yes | 206 | 53.65 |
| | No | 178 | 46.35 |
| Membership in water users' associations | Yes | 168 | 43.75 |
| | No | 216 | 56.25 |

## 4 – 2 Descriptive Statistics of the Main Research Constructs

An examination of the central tendency and dispersion indices of the research constructs in Table 2 shows that the experience of compound climate shocks has the highest mean among all constructs (M = 3.89, SD = 0.79). Among the dimensions of psychological resilience, self-efficacy has the highest mean (M = 3.81, SD = 0.84). Regarding temporal perception of drought, perceived frequency has the highest mean (M = 3.94, SD = 0.76). Water-saving behavior, with a mean of 3.46 (SD = 0.89), is at a moderate level.

Table 2
Descriptive Statistics of the Main Research Constructs

| Variable | Mean (out of 5) | Standard Deviation |
|---|---|---|
| Experience of Compound Climate Shocks (CCS) | 3.89 | 0.79 |
| Psychological Resilience (PR) | 3. 68 | 0.82 |
| Self-Efficacy (SE) | 3.81 | 0.84 |
| Hope (HO) | 3.76 | 0.80 |
| Cognitive Flexibility (CF) | 3.64 | 0.86 |
| Emotion Regulation (ER) | 3.52 | 0.88 |
| Active Coping (AC) | 3.67 | 0.83 |
| Temporal Perception of Drought (TPD) | 3.58 | 0.85 |
| Perceived Temporal Distance (TD) | 3.42 | 0.91 |
| Perceived Frequency (PF) | 3.94 | 0.76 |
| Perceived Urgency (PU) | 3.61 | 0.87 |
| Future-Oriented (FUT) | 3.74 | 0.82 |
| Present-Oriented (PRES) | 3.25 | 0.90 |
| Past-Oriented (PAST) | 3.40 | 0.88 |
| Water-Saving Behavior (WCB) | 3.46 | 0.89 |
| Technical Behaviors (TB) | 3.58 | 0.92 |
| Managerial Behaviors (MB) | 3.41 | 0.90 |
| Institutional–Social Behaviors (IB) | 3.38 | 0.94 |

## 4 – 3 Assessment of Common Method Bias and Collinearity

Prior to testing the structural model, common method bias and collinearity were examined using two approaches. First, Harman's single-factor test showed that the first factor explained only 31.42% of the total variance, which is below the 50% threshold, and therefore common method bias is not a concern in this study (Podsakoff et al., 2003). Second, Kock's (2015) full collinearity approach showed that all VIF values ranged from 1.38 to 2.04, which is well below the threshold of 3.3, confirming the absence of multicollinearity (Kock, 2015). Tolerance values also ranged from 0.49 to 0.72, which exceeds the 0.20 threshold and indicates the absence of collinearity (Hair et al., 2019) (Table 3).

Table 3
Common method bias and multicollinearity assessment (Full collinearity VIF)

| Tolerance | VIF | Constructs |
|---|---|---|
| Experience of Compound Climate Shocks (CCS) | 1.58 | 0.63 |
| Psychological Resilience (PR) | 1.86 | 0.54 |
| Self-Efficacy (SE) | 2.04 | 0.57 |
| Hope (HO) | 1.92 | 0.52 |
| Cognitive Flexibility (CF) | 1.78 | 0.56 |
| Emotion Regulation (ER) | 1.66 | 0.60 |
| Active Coping (AC) | 1.71 | 0.58 |
| Temporal Perception of Drought (TPD) | 1.74 | 0.57 |
| Perceived Temporal Distance (TD) | 1.54 | 0.65 |
| Perceived Frequency (PF) | 1.48 | 0.68 |
| Perceived Urgency (PU) | 1.62 | 0.62 |
| Future-Oriented (FUT) | 1.59 | 0.63 |
| Present-Oriented (PRES) | 1.65 | 0.61 |
| Past-Oriented (PAST) | 1.60 | 0.63 |
| Water-Saving Behavior (WCB) | 1.38 | 0.72 |
| Technical Behaviors (TB) | 1.75 | 0.57 |
| Managerial Behaviors (MB) | 1.80 | 0.56 |
| Institutional–Social Behaviors (IB) | 1.70 | 0.59 |

## 4–4 Measurement Model Assessment

Model Fit Indices: The SRMR value was 0.062, NFI was 0.93, RMS-theta was 0.074, d_ULS was 0.42, and d_G was 0.39, all of which are within acceptable ranges (Hu & Bentler, 1999) (Table 4).

Table 4
Summary of goodness of fit indices for the measurement model

| Fit index | SRMR | D_ULS | D-G | NFI | RMS-theta |
|---|---|---|---|---|---|
| Suggested value | < 0.08 | > 0.05 | > 0.05 | > 0.90 | ≤ 0.12 |
| Estimated value | 0.062 | 0.42 | 0.39 | 0.93 | 0.074 |

Convergent validity and reliability: Standardized factor loadings for all items were above 0.50 and significant at $p < 0.001$. Cronbach's alpha values ranged from 0.82 to 0.91, composite reliability from 0.88 to 0.93, rho_A from 0.84 to 0.92, and AVE from 0.57 to 0.64 (Fornell & Larcker, 1981; Hair et al., 2019) (see Supplementary Table S1).

Table 6 presents the second-order confirmatory factor analysis for Psychological Resilience (PR) and Temporal Perception of Drought (TPD), reporting factor loadings, t-values, significance levels, and dimension rankings.

For PR, all five dimensions had factor loadings above 0.70 and were significant at $p < 0.001$. Self-efficacy ($\beta = 0.824$) had the highest loading, followed by hope ($\beta = 0.798$) and active coping ($\beta = 0.789$), while emotion regulation ($\beta = 0.712$) had the lowest. This indicates that self-efficacy forms the central core of psychological resilience among irrigated farmers, and educational interventions should focus on strengthening this dimension.

For TPD, all six dimensions had factor loadings above 0.68 and were significant at $p < 0.001$. Perceived frequency ($\beta = 0.812$) had the highest loading, followed by future-oriented ($\beta = 0.791$), perceived urgency ($\beta = 0.768$), and perceived temporal distance ($\beta = 0.734$), while past-oriented ($\beta = 0.689$) had the lowest. This indicates that the perception of drought frequency is the strongest component in defining temporal perception of drought among irrigated farmers.

Table 6
Factor Loadings of Dimensions on Second-Order Constructs

| Second-Order Construct | Dimension | Factor Loading (β) | t | p | Result | Rank |
|---|---|---|---|---|---|---|
| Psychological Resilience (PR) | Self-Efficacy (SE) | 0.824 | 18.560 | 0.000 | Confirmed | 1 |
| | Hope (HO) | 0.798 | 16.230 | 0.000 | Confirmed | 2 |
| | Active Coping (AC) | 0.789 | 15.670 | 0.000 | Confirmed | 3 |
| | Cognitive Flexibility (CF) | 0.756 | 13.890 | 0.000 | Confirmed | 4 |
| | Emotion Regulation (ER) | 0.712 | 11.450 | 0.000 | Confirmed | 5 |
| Temporal Perception of Drought (TPD) | Perceived Frequency (PF) | 0.812 | 17.890 | 0.000 | Confirmed | 6 |
| | Future-Oriented (FUT) | 0.791 | 16.230 | 0.000 | Confirmed | 7 |
| | Perceived Urgency (PU) | 0.768 | 14.560 | 0.000 | Confirmed | 8 |
| | Perceived Temporal Distance (TD) | 0.734 | 12.230 | 0.000 | Confirmed | 9 |
| | Present-Oriented (PRES) | 0.708 | 11.890 | 0.000 | Confirmed | 10 |
| | Past-Oriented (PAST) | 0.689 | 10.560 | 0.000 | Confirmed | 11 |

Discriminant validity: According to Table 7, the square root of the AVE of each construct is greater than its highest correlation with other constructs (Fornell & Larcker, 1981). The HTMT values are also reported in Table 8, all of which are below the threshold of 0.85 (Henseler et al., 2015).

Table 7
Discriminant Validity (Fornell–Larcker Criterion)

| Construct | CCS | PR | TPD | WCB |
|---|---|---|---|---|
| CCS | 0.755 | | | |
| PR | 0.42** | 0.781 | | |
| TPD | 0.38** | 0.46** | 0.768 | |
| WCB | 0.35** | 0.53** | 0.49** | 0.800 |

Table 8
Heterotrait–Monotrait (HTMT) Ratio

| Construct | CCS | PR | TPD | WCB |
|---|---|---|---|---|
| CCS | - | | | |
| PR | 0.51 | - | | |
| TPD | 0.46 | 0.58 | - | |
| WCB | 0.42 | 0.64 | 0.59 | - |

## 4–5 Structural Model Assessment

After confirming the measurement model, the structural model was assessed using the bootstrapping method with 5,000 subsamples. The proposed model was able to explain 47% of the variance in water-saving behavior ($R^2 = 0.47$). The model also explained 31% of the variance in psychological resilience ($R^2 = 0.31$) and 26% of the variance in temporal perception of drought ($R^2 = 0.26$) (Fig. 3). Of the 10 research hypotheses, 8 were confirmed and 2 (H7 and H8) were rejected (Fig. 4, Table 9).

Table 9
Results of research structural models

| Hypothesis | Path | β | t-value | p-value | 95% CI (LL, UL) | $f^2$ | $R^2$ | Result |
|---|---|---|---|---|---|---|---|---|
| H1 | CCS → PR | 0.386 | 6.840 | 0.000 | ]0.28, 0.49[ | 0.17 | 0.31 | Confirm |
| H2 | CCS → TPD | 0.312 | 5.230 | 0.000 | ]0.20, 0.42[ | 0.11 | 0.26 | Confirm |
| H3 | PR → WCB | 0.352 | 5.980 | 0.000 | ]0.24, 0.46[ | 0.18 | 0.47 | Confirm |
| H4 | FUT → WCB | 0.284 | 4.760 | 0.000 | ]0.17, 0.39[ | 0.13 | 0.47 | Confirm |
| H5 | PRES → WCB | -0.156 | 2.840 | 0.005 | ]-0.26, -0.05[ | 0.05 | 0.47 | Confirm |
| H6 | PAST → WCB | -0.132 | 2.310 | 0.021 | ]-0. 24,-0.02 [ | 0.04 | 0.47 | Confirm |
| H7 | PR × TPD → WCB | -0.089 | 1.420 | 0.156 | ]-0.20, 0.03[ | 0.01 | 0.47 | Reject |
| H8 | CCS × PR → WCB (moderation) | -0.067 | 1.180 | 0.238 | ]-0.18, 0.05[ | 0.00 | 0.47 | Reject |
| H9a | SE→PR | 0.824 | 18.560 | 0.000 | ]0.76, 0.88[ | - | 0.31 | Confirm |
| H9b | HO→PR | 0.798 | 16.230 | 0.000 | ]0.73, 0.86[ | - | 0.31 | Confirm |
| H9c | AC→PR | 0.789 | 15.670 | 0.000 | ]0.72, 0.85[ | - | 0.31 | Confirm |
| H9d | CF→PR | 0.756 | 13.890 | 0.000 | ]0.68, 0.83[ | - | 0.31 | Confirm |
| H9e | ER→PR | 0.712 | 11.450 | 0.000 | ]0.63, 0.79[ | - | 0.31 | Confirm |
| H10a | PF→TPD | 0.812 | 17.890 | 0.000 | ]0.74, 0.87[ | 0.42 | 0.26 | Confirm |
| H10b | FUT→ TPD | 0.791 | 16.230 | 0.000 | ]0.72, 0.86[ | 0.38 | 0.26 | Confirm |
| H10c | PU→ TPD | 0.768 | 14.560 | 0.000 | ]0.69, 0.83[ | 0.35 | 0.26 | Confirm |

Note: β = standardized path coefficient; LL = lower limit; UL = upper limit; CI = confidence interval; $f^2$ = effect size (Cohen, 1988)

| Hypothesis | Path | β | t-value | p-value | 95% CI (LL, UL) | $f^2$ | $R^2$ | Result |
|---|---|---|---|---|---|---|---|---|
| H10d | TD→ TPD | 0.734 | 12.230 | 0.000 | ]0.66, 0.80[ | 0.30 | 0.26 | Confirm |
| H10e | PRES→ TPD | 0.708 | 11.890 | 0.000 | ]0.63, 0.78[ | 0.27 | 0.26 | Confirm |
| H10f | PAST→ TPD | 0.689 | 10.560 | 0.000 | ]0.61, 0.76[ | 0.24 | 0.26 | Confirm |

Note: β = standardized path coefficient; LL = lower limit; UL = upper limit; CI = confidence interval; $f^2$ = effect size (Cohen, 1988)

## 4–6. Mediation Analysis

The results of the mediation analysis showed that psychological resilience and temporal perception of drought play a partial mediating role in the relationship between compound climate shocks and water-saving behavior (Table 10).

Table 10
Mediation Analysis Results

| Hypothesis | Path | β | t-value | p-value | 95% CI (LL, UL) | Mediation Type | Result |
|---|---|---|---|---|---|---|---|
| H11 | CCS → PR→ WCB | 0.136 | 3.890 | 0.000 | ]0.21, 0.07[ | Partial | Confirm |
| H12 | CCS → TPD→ WCB | 0.089 | 2.940 | 0.003 | ]0.03, 0.15[ | Partial | Confirm |
| H13 | CCS → PR →TPD→ WCB | 0.052 | 2.360 | 0.018 | ]0.01, 0.10[ | Sequential | Confirm |

## 4–7 Predictive Power Assessment of the Model

The predictive relevance was assessed using Stone–Geisser's $Q^2$ criterion through blindfolding. The $Q^2$ values for psychological resilience (0.22), temporal perception (0.18), and water-saving behavior (0.31) were all greater than zero (Hair et al., 2019) (Table 11).

Table 11
Predictive Power Indices

| Endogenous Construct | $R^2$ | $Q^2$ | RMSE | Predictive Power |
|---|---|---|---|---|
| Psychological Resilience (PR) | 0.31 | 0.22 | 0.74 | Moderate |
| Temporal Perception of Drought (TPD) | 0.26 | 0.18 | 0.79 | Moderate |
| Water-Saving Behavior (WCB) | 0.47 | 0.31 | 0.68 | Strong |

# 5. Discussion and Interpretation of Findings

*5 – 1 Effect of Compound Climate Shocks on Psychological Resilience and Temporal Perception*

The findings showed that the experience of compound climate shocks has a positive and significant effect on farmers' psychological resilience (β = 0.386, p < 0.001). This is consistent with Sousa et al. (2022), who showed that farmers in areas affected by severe drought develop higher psychological capacity, and with Tahernejad et al. (2025), who confirmed that direct experience of drought facilitates psychological resilience through cognitive and emotional processes. Theoretically, this finding aligns with Hobfoll's (1989) COR theory, as individuals facing resource loss strive to acquire new psychological resources, enhancing resilience. Accordingly, training programs on emotion management, problem-solving, and active coping should be designed and implemented as weekly workshops in cooperation with agricultural jihad service centers to strengthen farmers' psychological capacity before facing more severe shocks.

Also, compound climate shocks had a significant effect on temporal perception of drought (β = 0.312, p < 0.001). This is consistent with van Tilburg et al. (2025), who showed that farmers with repeated drought experience report higher urgency, and with Yazdanpanah et al. (2024), who confirmed that dimensions of psychological distance explain 72.2% of the variance in climate concerns. Therefore, the lived experiences of farmers who have experienced compound shocks should be used as success narratives in extension programs to strengthen the perception of drought urgency in other farmers.

## 5 – 2. Effect of Temporal Perception of Drought on Water-Saving Behavior

Future-oriented temporal perception had a positive and significant effect on water-saving behavior (β = 0.284, p < 0.001), consistent with Corral-Verdugo et al. (2006) and Milfont et al. (2012), who confirmed that future-oriented perspective is a strong predictor of sustainable environmental behaviors. In contrast, present-oriented (β = -0.156, p = 0.005) and past-oriented (β = -0.132, p = 0.021) temporal perception had negative and significant effects, consistent with Neisi et al. (2020), who showed that most farmers have a present-oriented perspective and past-oriented farmers exhibit weaker drought risk management

behavior. Theoretically, this aligns with Zimbardo and Boyd's (1999) time perspective theory, which considers past, present, and future as three independent dimensions.

Accordingly, awareness campaigns should display future scenarios, present successful experiences of farmers who reduced water consumption through future-oriented thinking, and highlight intergenerational consequences of water shortage. Practical exercises such as "drawing the future timeline" and "calculating the long-term cost–benefit of low-water-demand cultivation" should be included in extension programs.

## 5 – 3. Effect of Psychological Resilience on Water-Saving Behavio

Psychological resilience had a positive and significant effect on water-saving behavior ($\beta = 0.352$, $p < 0.001$), explaining 18% of the variance. This is consistent with Shojaei-Miandoragh et al. (2020) and Buikstra et al. (2010), who showed that farmers with higher resilience adopt more diverse adaptation strategies. In Iran, Azadi et al. (2024) showed that environmental self-efficacy significantly affects adaptation behavior, and Savari et al. (2025) confirmed that self-efficacy and personal norms are significant predictors. Theoretically, this aligns with Hobfoll's (1989) COR theory and Grothmann and Patt's (2005) argument that psychological capacity is the main determinant of converting risk perception into action. Accordingly, extension programs should focus on strengthening self-efficacy and hope and use role models of successful farmers. Workshops on problem-solving and stress management should also be held.

## 5 – 4. Rejection of the Interactive Effect of Psychological Resilience × Temporal Perception of Drought

The interactive effect of psychological resilience × temporal perception of drought on water-saving behavior was not significant ($\beta = -0.089$, $t = 1.420$, $p = 0.156$), and H7 was rejected. The effect size ($f^2 = 0.01$) was very small. This is consistent with Joireman et al. (2012), who showed that interactive effects between time orientation and psychological capacity are typically weak and unstable, and with Grothmann and Patt (2005), who emphasized that the moderating effect of self-efficacy varies by context. Methodologically, interactive effects in PLS-SEM require larger sample sizes and stronger effect sizes (Hair et al., 2019). Theoretically, it is possible that the two constructs affect water-saving behavior in a parallel and independent manner rather than interactively, meaning both have independent contributions but their combination does not create an added effect. This is consistent with van Tilburg et al. (2025), who showed that farmers with high risk perception and high self-efficacy exhibit adaptive behaviors similar to those with low self-efficacy. Accordingly, educational programs should strengthen each construct independently rather than focusing on their interaction.

## 5–5. Rejection of the Moderating Effect of Compound Climate Shocks

The moderating effect of compound climate shocks on the relationship between psychological resilience and water-saving behavior was not significant (β = -0.067, t = 1.180, p = 0.238), and H8 was rejected. This is consistent with Galappaththi et al. (2023), who showed that chronic exposure to drought can lead to resilience erosion, but this erosion does not necessarily reduce water-saving behavior, and with Veysi and Nouri (2026), who showed that compound events create synergistic pressure that may affect other constructs rather than the resilience–behavior relationship. The rejection may mean that psychological resilience, as a relatively stable trait, does not change under compound shocks and maintains its effect. This is somewhat in tension with Hobfoll's (1989) COR theory, which predicts that chronic resource loss depletes psychological capacity. However, irrigated farmers in Kermanshah Province may not have yet reached complete psychological erosion, and their resilience acts as a protective shield. Accordingly, policymakers should design economic support programs (crop insurance, low-interest loans) alongside strengthening psychological resilience, and a system should be designed to identify vulnerable farmers and provide psychological and economic support during severe drought.

## 5–6. Mediation Analysis

The mediation analysis showed that psychological resilience and temporal perception of drought play a partial mediating role in the relationship between compound climate shocks and water-saving behavior. This is consistent with Grothmann and Patt (2005), who showed that the experience of climate events affects adaptive behavior through cognitive and motivational processes, and with Keshavarz and Karami (2014), who confirmed that farmers' decision-making is influenced by a combination of experience, perception, and psychological capacity. Accordingly, policymakers should design programs to strengthen psychological mechanisms (resilience and temporal perception) so that the experience of climate shocks is transformed into sustainable adaptive behavior, and integrated theoretical frameworks should be used in designing drought adaptation programs.

# 6 Research Implications

*6 − 1 Theoretical Implications*

This study, for the first time, tested the interactive effect of psychological resilience and temporal perception of drought on farmers' water-saving behavior in the context of compound climate shocks. Although the interactive effect hypothesis was rejected, this finding itself is considered an important scientific achievement because it shows that psychological resilience and temporal perception of drought affect water-saving behavior independently and in parallel, rather than interactively. This finding is a step beyond previous studies that examined each of these two constructs separately and shows that their combination does not create an added effect. Also, this study, by integrating three theories COR, time perspective, and cognitive–motivational adaptation has provided a more comprehensive

theoretical framework. The research model was able to explain 47% of the variance in water-saving behavior, which is higher than many previous studies in the context of Iranian agriculture.

## 6 – 2 Practical Implications

The findings of this study have several practical applications for policymakers, planners, and agricultural extension agents. For policymakers and water managers: the research model shows that to design effective water-saving policies, one cannot focus solely on economic or technical variables; rather, farmers' psychological dimensions must also be considered. Specifically, policies that strengthen farmers' future-oriented temporal perception can be used as a complement to water pricing policies and the development of modern irrigation technologies. For extension agents and educators, the findings show that extension programs should simultaneously focus on strengthening psychological resilience and shaping future-oriented temporal perception. For policymakers in compound shock conditions, the findings show that during periods of severe drought and concurrent heat, support programs should simultaneously strengthen psychological resilience and provide necessary economic and institutional support to prevent farmers' psychological erosion.

## 7 Conclusions

This study investigated the interactive effect of psychological resilience and temporal perception of drought on farmers' water-saving behavior under compound climate shocks. The integrated model based on Conservation of Resources theory, time perspective theory, and cognitive–motivational adaptation theory explained 47% of the variance in water-saving behavior, indicating the substantial explanatory power of the integrated framework.

A key finding is that psychological resilience and temporal perception of drought affect water-saving behavior independently and in parallel, with no significant interactive effect (H7 rejected). This indicates that each construct contributes independently to explaining water-saving behavior, but their combination does not create an additional incremental effect. Therefore, policymakers can focus on strengthening each construct independently.

Another result is that the experience of compound climate shocks, although leading to strengthened psychological resilience and urgent temporal perception of drought, does not significantly moderate the relationship between psychological resilience and water-saving behavior (H8 rejected). This suggests that psychological resilience, as a relatively stable psychological trait, appears to remain stable under compound climate shocks and maintains its effect on water-saving behavior.

Finally, promoting water-saving behavior in agriculture requires a multidimensional approach that simultaneously considers psychological, temporal, and contextual dimensions. Policymakers and water planners should move beyond a sole focus on economic and technical tools and pay greater attention to

the determining role of psychological constructs such as resilience and temporal perception in shaping farmers' behavior.

## 7 – 1 Limitations and Suggestions for Future Research

Despite its contributions, this study has several limitations. First, the data were collected cross-sectionally, and therefore it was not possible to examine long-term causal relationships between variables; to address this limitation, future studies can use multi-wave longitudinal designs to track changes in psychological resilience and temporal perception over time. Second, self-report instruments for measuring water-saving behavior may be subject to social desirability bias; it is recommended that future studies combine self-report data with objective data (such as water meter readings and irrigation equipment purchase records) to validate the findings. Third, the sample was limited to irrigated farmers only, and therefore the generalizability of the findings to other regions and agricultural systems warrants caution; future comparative studies can test similar patterns in different regions of Iran and with different agricultural systems. Fourth, the research model included only psychological variables, and institutional, economic, and infrastructural variables were not included as mediating or moderating variables; future studies can add institutional support, access to credit, and the quality of irrigation infrastructure as mediating or moderating variables to the model. Fifth, the rejection of hypotheses H7 and H8 may be due to methodological limitations such as sample size, small interaction effect size, or lack of control over contextual variables; future studies can re-test these relationships with larger sample sizes and more robust experimental designs.

## Declarations

# Declaration of Competing Interest

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

# Author Contribution

All authors contributed to the study conception and design. M.T. was responsible for conceptualization, methodology, investigation, data curation, formal analysis, software, visualization, and writing the original draft. A.H.A. was responsible for supervision, validation, writing review & editing, and resources. All authors commented on previous versions of the manuscript and approved the final version.

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# Data Availability

The datasets generated and analyzed during the current study are not publicly available due to confidentiality agreements with the participants and ethical restrictions imposed by the institutional ethics committee, as they contain sensitive information about participants' income, land ownership, and water use practices that could compromise their privacy. The raw datasets cannot be shared publicly to protect participant confidentiality. However, the datasets are available from the corresponding author on reasonable request for non-commercial academic purposes, subject to approval by the institutional ethics committee. The survey instrument (questionnaire) and variable definitions are provided as Supplementary Files to ensure transparency and reproducibility of the methodology.

# References

1. Azadi Y, Yaghoubi J, Gholamrezai S, Rahimi-Feyzabad F (2024) Farmers' adaptation behavior to water scarcity in Western Iran: Application of the values-identity-personal norms model. Agric Water Manage 306:109210. https://doi.org/10.1016/j.agwat.2024.109210
2. Azadi Y, Yaghoubi J, Gholamrezai S, Rahimi-Feyzabad F (2026) Awareness, trust, and perception as determinants of farmers’ incremental adaptation to water scarcity: a PLS-SEM approach in Western Iran. Humanit Soc Sci Commun. https://doi.org/10.1057/s41599-026-08466-4
3. Almasi H, Tavakkoli J (2019) The effectiveness of drought risk management strategies in western Iran. Int J Disaster Risk Reduct 40:101159. https://doi.org/10.1016/j.ijdrr.2019.101159
4. Becker J-M, Ringle CM, Sarstedt M (2018) Estimating moderating effects in PLS-SEM and PLSc-SEM: Interaction term generation × data treatment. J Appl Struct Equation Model 2(2):1–21. https://doi.org/10.47263/JASEM.2(2)01
5. Bijani M, Ghazani E, Valizadeh N, Fallah Haghighi N (2017) Pro-environmental analysis of farmers' concerns and behaviors towards soil conservation in central district of Sari County. Iran Int Soil Water Conserv Res 5(1):43–49. https://doi.org/10.1016/j.iswcr.2017.03.001
6. Buikstra E, Ross H, King CA, Baker PG, Hegney D, McLachlan K, Rogers-Clark C (2010) The components of resilience Perceptions of an Australian rural community. J Community Psychol 38(8):975–991. https://doi.org/10.1002/jcop.20409
7. Cisse JD, Hellmuth M, Khan Z (2024) Enhancing community resilience: Addressing compound and cascading climate shocks. Clim Risk Manage 45:100612. https://doi.org/10.1016/j.crm.2024.100612
8. Connor KM, Davidson JRT (2003) Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). Depress Anxiety 18:76–82. https://doi.org/10.1002/da.10113

9. Corral-Verdugo V, Fraijo-Sing B, Pinheiro JQ (2006) Sustainable behavior and time perspective: Present, past, and future orientations and their relationship with water conservation behavior
10. Candemìr S, Doğan HG, Edìrnelîgìl A, Bayramoğlu Z, Mìrza E, Ganìyusufoğlu A (2026) Water Saving Behaviors in Agriculture within the Framework of Norm Activation Model. Water Resour Manage 40:266. https://doi.org/10.1007/s11269-026-04598-z
11. Dogan HG, Edirneligil A (2024) Water saving behaviors in agriculture within the framework of Norm Activation Model. Interamerican J Psychol 40(2):139–147. https://doi.org/10.1016/j.erap.2005.09.002
12. FAO (2020) The State of Food and Agriculture 2020: Overcoming water challenges in agriculture. Food and Agriculture Organization of the United Nations. https://doi.org/10.4060/cb1447en
13. Faul F, Erdfelder E, Buchner A, Lang A-G (2009) Statistical power analyses using G Power 3.1: Tests for correlation and regression analyses. Behav Res Methods 41(4):1149–1160. https://doi.org/10.3758/BRM.41.4.1149
14. Fornell C, Larcker DF (1981) Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. J Mark Res 18(1):39–50. https://doi.org/10.2307/3151312
15. Fouladi H, Tarazkar M, Zibaei T (2026) The role of political interventions and personal beliefs in shaping water-saving behavior among farmers in the Dariun Plain, Iran. Environ Sustain Indic 32:101492. https://doi.org/10.1016/j.indic.2026.101491
16. Fred Luthans CM, Youssef-Morgan (2017) Psychological Capital: An Evidence-Based Positive Approach. Annual Rev Organizational Psychol Organizational Behav 4:339–366. https://doi.org/10.1146/annurev-orgpsych-032516-113324
17. Galappaththi EK, Schlingmann A (2023) The sustainability assessment of Indigenous and local knowledge-based climate adaptation responses in agricultural and aquatic food systems. Curr Opin Environ Sustain 62:101276. https://doi.org/10.1016/j.cosust.2023.101276
18. Grothmann T, Patt A (2005) Adaptive capacity and human cognition: The process of individual adaptation to climate change. Glob Environ Change 15(3):199–213. https://doi.org/10.1016/j.gloenvcha.2005.01.002
19. Gross JJ, John OP (2003) Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. J Personality Social Psychol *85* 2348–362. https://doi.org/10.1037/0022-3514.85.2.348
20. Hair JF, Risher JJ, Sarstedt M, Ringle CM (2019) When to use and how to report the results of PLS-SEM. Eur Bus Rev 31(1):2–24. https://doi.org/10.1108/EBR-11-2018-0203
21. Henseler J, Ringle CM, Sarstedt M (2015) A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Mark Sci 43(1):115–135. https://doi.org/10.1007/s11747-014-0403-8
22. Hobfoll SE (1989) Conservation of resources: A new attempt at conceptualizing stress. Am Psychol 44(3):513–524. https://doi.org/10.1037/0003-066X.44.3.513

23. Hu L, Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equation Modeling: Multidisciplinary J 6(1):1–55. https://doi.org/10.1080/10705519909540118
24. IPCC (2022) Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009325844
25. Joireman J, Shaffer MJ, Balliet D, Strathman A (2012) Promotion orientation explains why future-oriented people exercise and eat healthy: Evidence from the two-factor consideration of future consequences-14 scale. Pers Soc Psychol Bull 38(10):1272–1287. https://doi.org/10.1177/0146167212449362
26. Joshua JM, Massawe FA, Mwakalapuka AA (2020) Validation of the Cognitive Flexibility Scale (CFS) and its application in adoption of improved cassava technologies among cassava growers in Tanzania. IFE PsychologIA 28(1):1–15. https://doi.org/10.4314/ifep.v28i1.2
27. Keshavarz M, Karami E (2014) Farmers' decision-making process under drought. J Arid Environ 108:43–56. https://doi.org/10.1016/j.jaridenv.2014.03.006
28. Kock N (2015) Common method bias in PLS-SEM: A full collinearity assessment approach. Int J e-Collaboration 11(4):1–10. https://doi.org/10.4018/ijec.2015100101
29. Lawshe CH (1975) A quantitative approach to content validity. Pers Psychol 28(4):563–575. https://doi.org/10.1111/j.1744-6570.1975.tb01393.x
30. Liberman N, Trope Y (1998) The role of feasibility and desirability considerations in near and distant future decisions: A test of temporal construal theory. J Personal Soc Psychol 75(1):5–18. https://doi.org/10.1037/0022-3514.75.1.5
31. Martin MM, Rubin RB (1995) A new measure of cognitive flexibility. Psychol Rep 76(2):623–626. https://doi.org/10.2466/pr0.1995.76.2.623
32. Milfont TL, Wilson J, Diniz P (2012) Time perspective and environmental engagement: A meta-analysis. Int J Psychol 47(5):325–334. https://doi.org/10.1080/00207594.2011.647029
33. Marshall NA, Smajgl A (2013) Understanding variability in adaptive capacity on rangelands. Rangel Ecol Manage 66(1):88–94. https://doi.org/10.2111/REM-D-11-00176.1
34. Mohammadi M, Bijani M, Naeimi A, Valizadeh N, Setti A (2024) Extracting indicators of connectedness to nature to improve water conservation behavior in agriculture. Environ Sustain Indic 22:100338. https://doi.org/10.1016/j.indic.2024.100338
35. Neisi M, Bijani M, Abbasi E, Mahmoudi H (2020) The effect of farmers' time perspective on their drought risk management behavior in downstream of Karkheh Dam. Iran J Agricultural Econ Dev Res 51(1):133–148. https://doi.org/10.22059/ijaedr.2019.284604.668783
36. Omid M, Ghoochani M, Damaneh E, Damaneh HE, Ghanian H, M., Cotton M (2023) Why do farmers over-extract groundwater resources? Assessing (un)sustainable behaviors using an integrated agent-centered framework. Environments 10(12):216. https://doi.org/10.3390/environments10120216

37. Podsakoff PM, MacKenzie SB, Lee J-Y, Podsakoff NP (2003) Common method biases in behavioral research: A critical review of the literature and recommended remedies. J Appl Psychol 88(5):879–903. https://doi.org/10.1037/0021-9010.88.5.879
38. Savari M, Shokati Amghani M, Miladi H (2025) Sustainable rice production under water scarcity conditions using drip irrigation: Based on evidence among Iranian farmers. Results Eng 27:106443. https://doi.org/10.1016/j.rineng.2025.106443
39. Seneviratne SI, Nicholls N, Easterling D, Goodess CM, Kanae S, Kossin J, Luo Y, Marengo J, McInnes K, Rahimi M, Reichstein M, Sorteberg A, Vera C, Zhang X (2012) Changes in climate extremes and their impacts on the natural physical environment. In: Field CB et al (eds) Managing the risks of extreme events and disasters to advance climate change adaptation. Cambridge University Press, pp 109–230. https://doi.org/10.1017/CBO9781139177245.006.
40. Schwartz SH (1977) Normative influences on altruism. In L. Berkowitz (Ed.), Advances in Experimental Social Psychology, 10, 221–279. Academic Press. https://doi.org/10.1016/S0065-2601(08)60358-5
41. Shojaei-Miandoragh M, Bijani M, Abbasi E (2020) Farmers' resilience behaviour in the face of water scarcity in the eastern part of Lake Urmia, Iran: An environmental psychological analysis. Water Environ J 34(4):611–622. https://doi.org/10.1111/wej.12489
42. Sousa COM, Teixeira LV, Fouto NMMD (2022) Midterm impacts of a water drought experience: Evaluation of consumption changes in São Paulo, Brazil. Water Policy 24(1):179–191. https://doi.org/10.2166/wp.2021.120
43. Sadeghi A, Bijani M, Farhadian H (2019) The mediating role of farmers' time perspective in water resources exploitation behaviour in the eastern area of Lake Urmia, Iran: An environmental psychological analysis. Water Environ J 34(S1):106–120. https://doi.org/10.1111/wej.12508
44. Tenenhaus M, Esposito Vinzi V (2005) PLS path modeling. Comput Stat Data Anal 19(3):145–153. https://doi.org/10.1002/cem.917
45. Tahernejad A, Sohrabizadeh S, Mehrabi Y, Mashhadi A (2025) Investigating the conceptual model of the formation of psychological resilience in farmers affected by droughts in Iran using structural equation modeling. BMC Public Health 25:1883. https://doi.org/10.1186/s12889-025-23098-0
46. Veysi S, Nouri M (2026) Spatiotemporal dynamics of single and compound drought–heatwave extremes impact on water productivity. J Hydrology: Reg Stud 52:103370. https://doi.org/10.1016/j.ejrh.2026.103370
47. Valizadeh N, Bijani M, Abbasi E, Ganguly S (2018) The role of time perspective in predicting Iranian farmers' participatory-based water conservation attitude and behavior. J Hum Behav Social Environ 28(8):992–1010. https://doi.org/10.1080/10911359.2018.1485602
48. Mohammadi M, Bijani M, Naeimi A, Valizadeh N, Setti A (2024) Extracting indicators of connectedness to nature to improve water conservation behavior in agriculture. Environmental and Sustainability Indicators, 24, 100522. .org/10.1016/j.indic.2024.100522 Behavior in the Social Environment, 28(8), 992–1010. https://doi.org/10.1016/j.indic.2024.100338

49. Yazdanpanah M, Wheeler SA, Zuo A, Zobeidi T (2022) Understanding the influence of Iranian farmers' climate change beliefs on their adaptation strategies and mitigation intentions. Climate Dev 14(8):1–133. https://doi.org/10.1080/17565529.2022.2086524
50. Yazdanpanah M, Zobeidi T, Homayoon SB, Komendantova N, Lamm A (2024) Assessment of farmers' resilience to drought and its influencing components: The case of Fars Province, Iran. Climate Dev 16(7):572–586. https://doi.org/10.1080/17565529.2024.2414041
51. Zimbardo PG, Boyd JN (1999) Putting time in perspective: A valid, reliable individual-differences metric. J Personal Soc Psychol 77(6):1271–1288. https://doi.org/10.1037/0022-3514.77.6.1271
52. Zscheischler J, Westra S, Van Den Hurk BJJM, Seneviratne SI, Ward PJ, Pitman A, Aghakouchak A, Bresch DN, Leonard M, Wahl T, Zhang X (2018) Future climate risk from compound events. Nat Clim Change 8(6):469–477. https://doi.org/10.1038/s41558-018-0156-3

# Figures

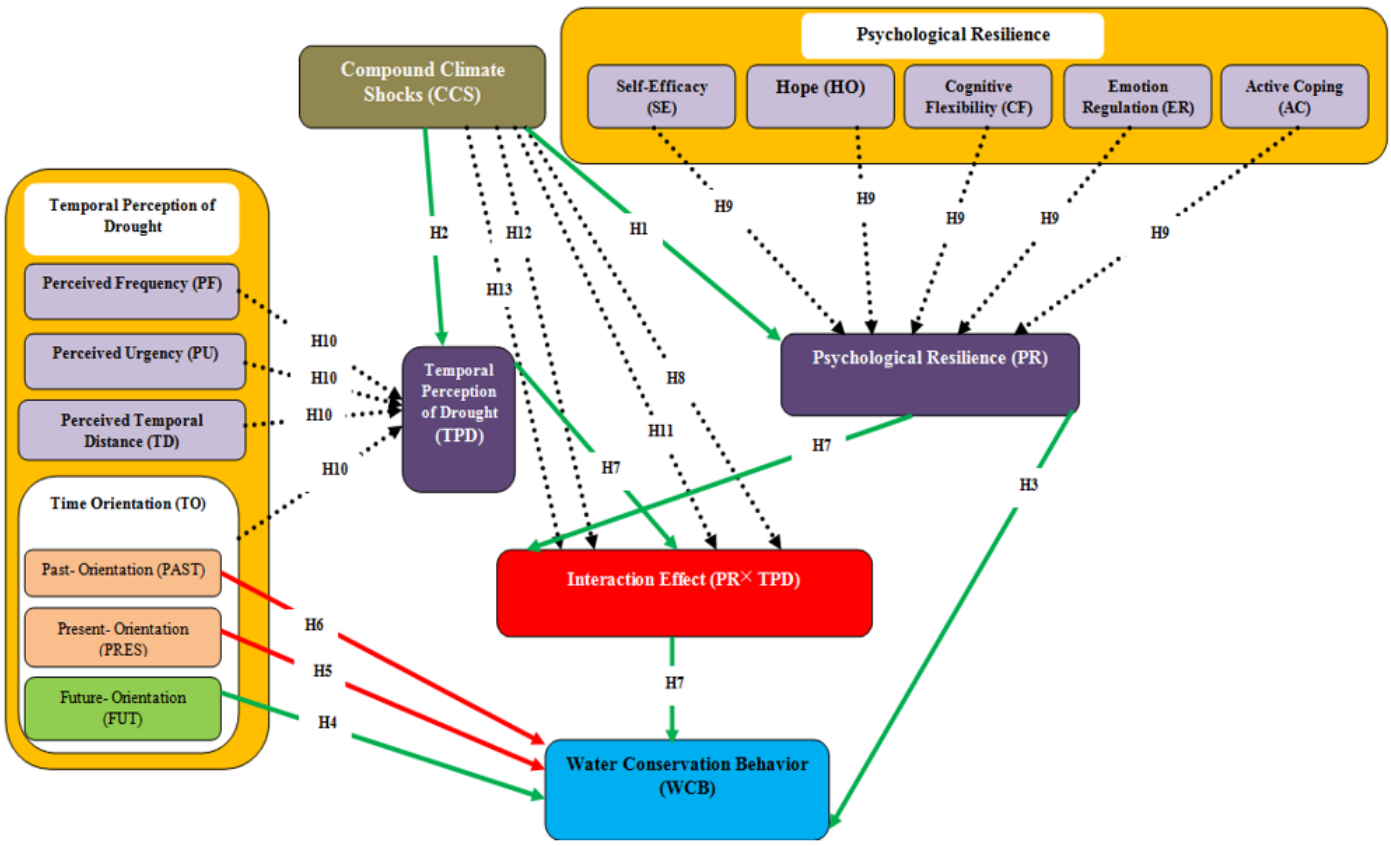



**Figure 1**

Conceptual Framework of the Research

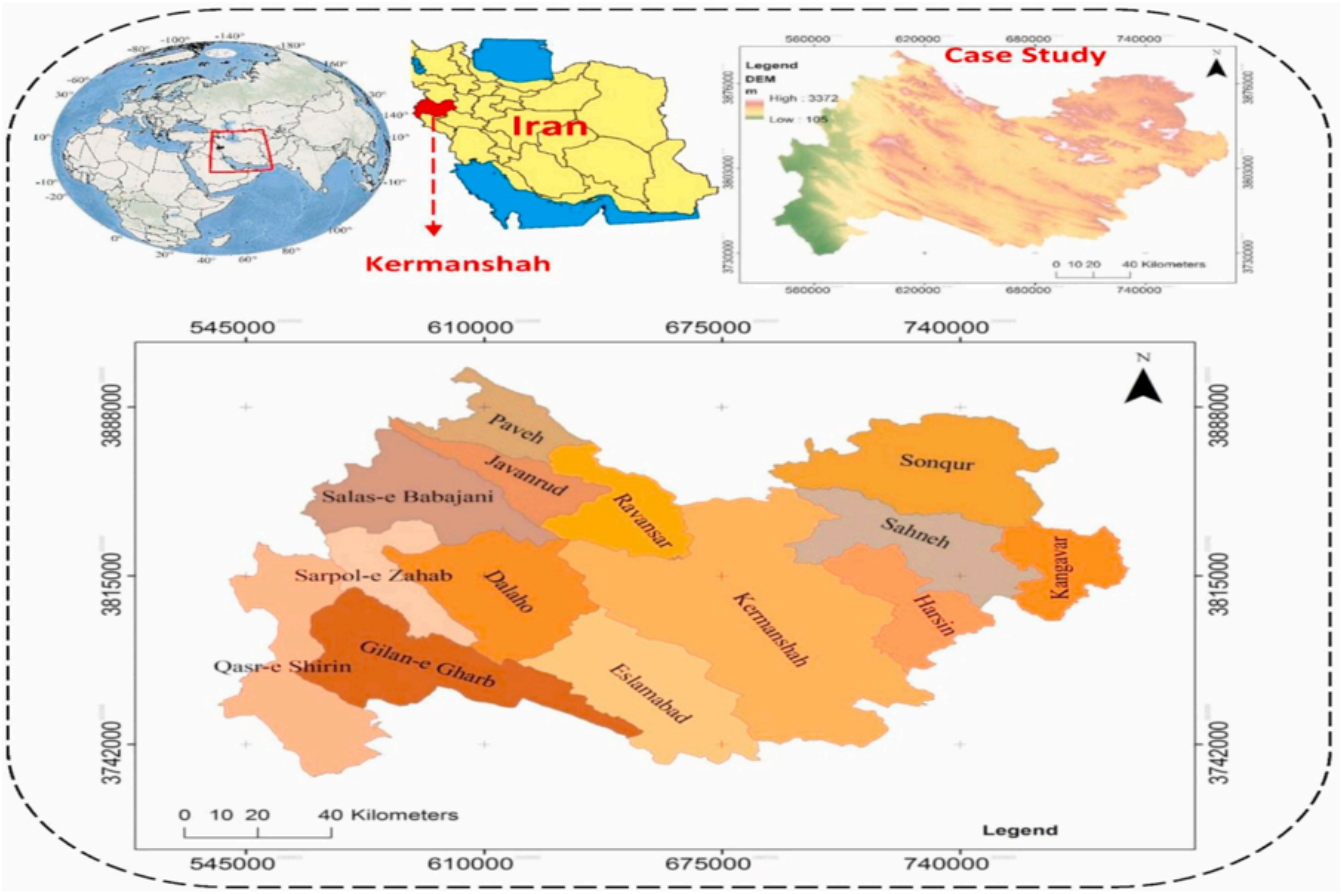



**Figure 2**

Geographic Location of the Study Area (Kermanshah Province, Iran)

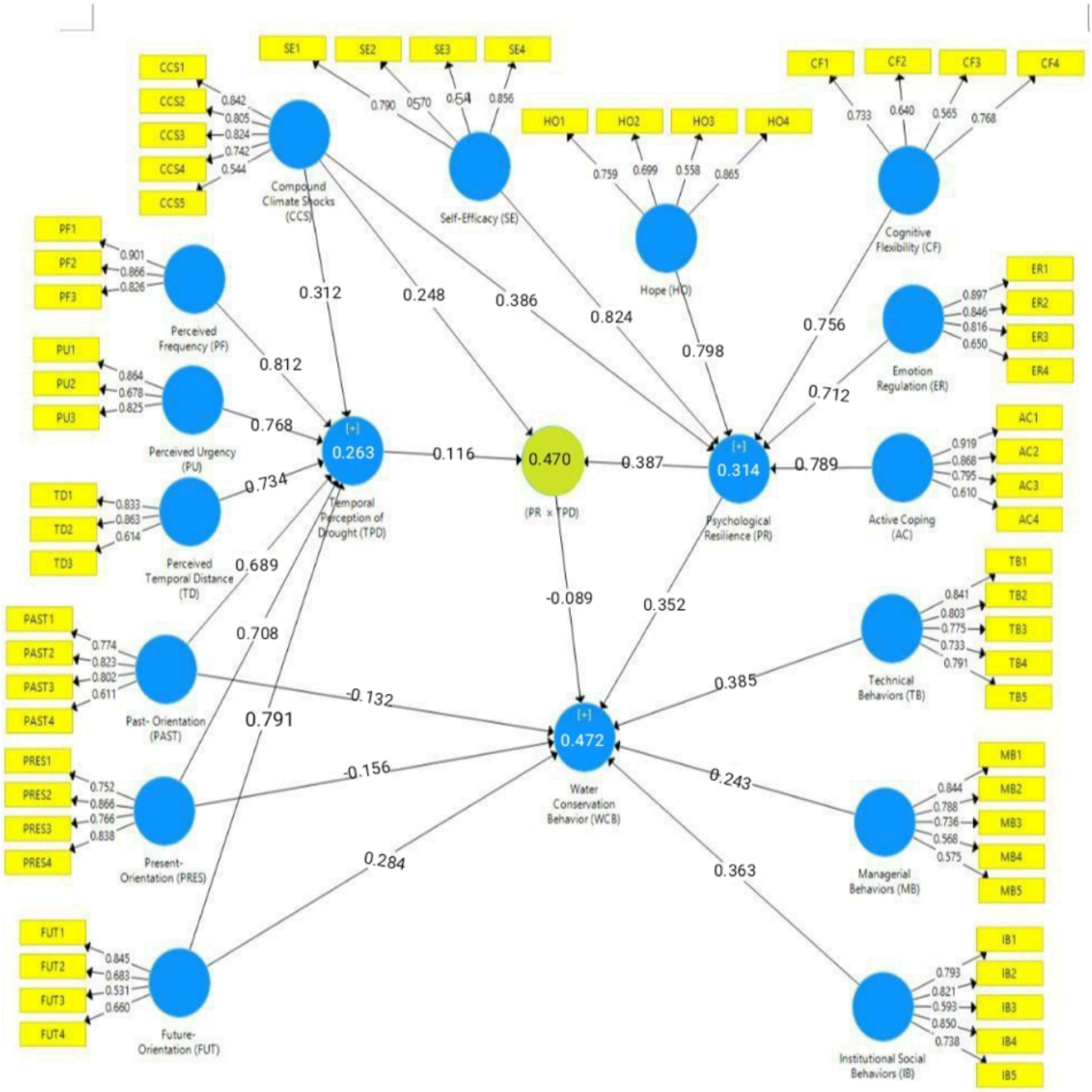



**Figure 3**

Path model with standardized factor loadings

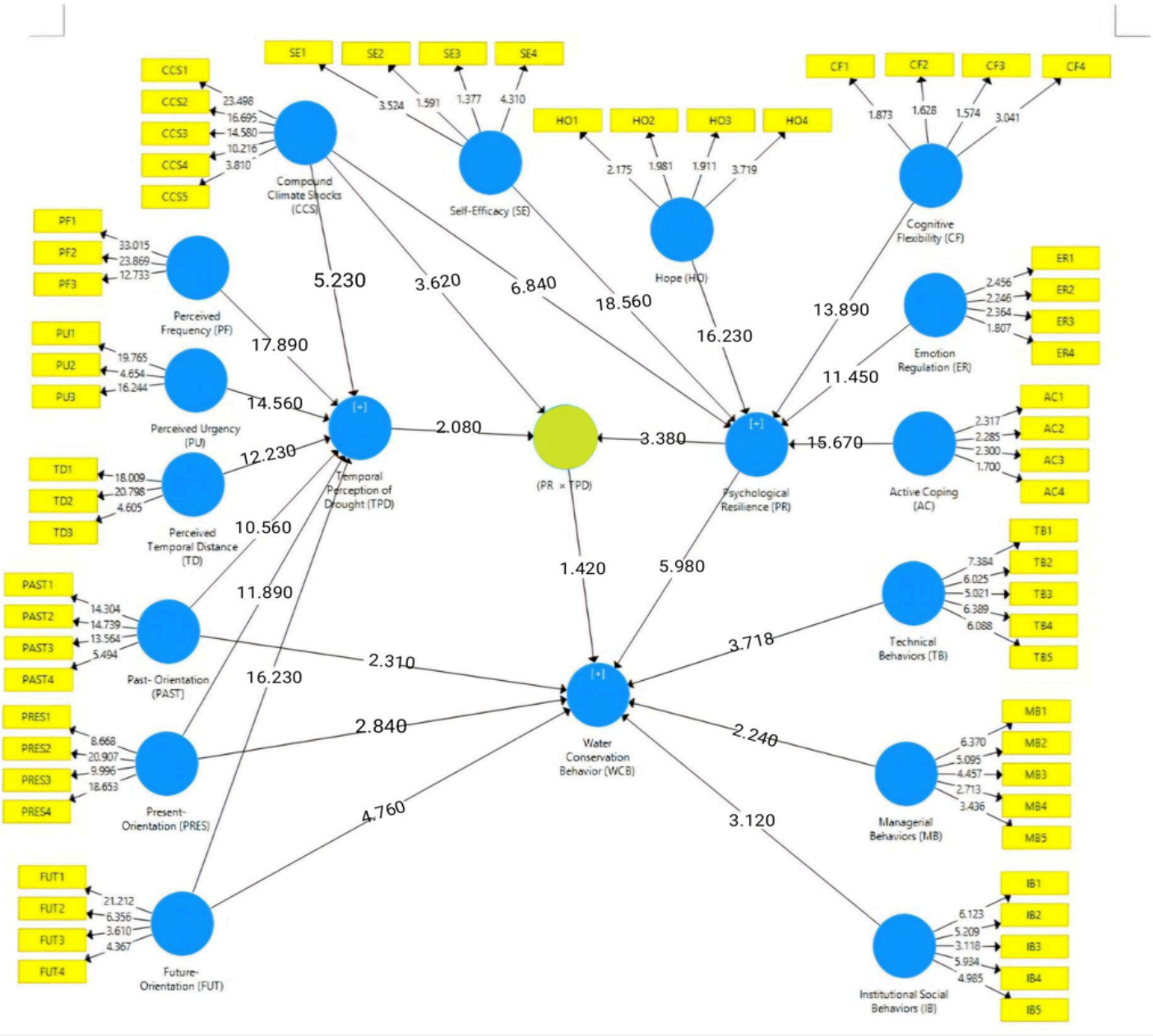



**Figure 4**

Path model with t-values