Predicting water conservation in communities around mountains:

Testing the Theory of Planned Behavior and past experience variables

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The full dataset is available on request from the first author.

This study was conducted in strict compliance with the ethical principles of the American Psychological Association (APA), the Declaration of Helsinki. All participants completed informed consent.

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Abstract

The theory of planned behavior (TPB) plus experience with extreme weather events (EWE) was used to predict water conservation intention and behavior in understudied communities living near glaciers. The sample included 2026 participants from communities in southern Peru. The results show that TBP + EWE explained 23.4% of the total variance of the intentions to conserve water (age, subjective norms, perceived behavioral control, EWE significant predictors). EWE significantly moderated the effect of attitude on intention, with attitudes only significantly predicting intention at moderate and higher levels of EWE. TBP + EWE explained 10.2% of the variance in self-reported water conservation behavior (gender, age, intentions, attitudes, subjective norms significant predictors). EWE did not significantly moderate the effects of any predictors on behavior. Implications of the findings on community water conservation intentions and behavior, as well as future lines of research, are discussed.

Keywords: conservation of water resources, behavioral intention, Theory of planned behavior

Introduction

The scarcity of water and water security constitute global challenges, particularly affecting vulnerable countries in South America, Africa, Asia, and Central America (IPCC, 2023). Indigenous communities bear the brunt of this issue due to their heightened vulnerability and limited resources to mitigate its effects (Gosling & Arnell, 2016; Liua, Fu, & Liu, 2023). Furthermore, it is well-established that climate change has inflicted irreversible damage on terrestrial freshwater, impacting nearly half of the global population, who now experience severe water scarcity due to climatic factors and the occurrence of adverse events (Qiu, Shen & Xie, 2023). Currently, water scarcity is increasing (He, Rosa, 2023; Liu, Liu, Yang, Ciais & Wada, 2022), underscoring the need to assess various sustainable and health-conscious approaches to water management and conservation (Wang et al., 2019).

The conservation of water is particularly crucial in the mountainous regions of Peru (Brügger, Tobias, Monge-Rodríguez & Alvarado-Yepez, 2021; Carey & Multon, 2023; Monge-Rodríguez, Huggel, & Vicuna, 2022). The Vilcanota-Urubamba basin of Peru, the focus of the current research, encompassing a glacier area of 141.7 km^2, relies on the water descending from the glacier as the primary sustenance for communities (Drenkhan et al., 2018). Additionally, this water resource plays a significant role in the local economy, agriculture, and energy generation (Taylor, Quincey, Smith, Potter, Castro & Fyffe, 2022).

Water conservation behaviors, such as rainwater harvesting, wastewater reuse, rationalization of water in agricultural systems and livelihoods, and efficient laundering of clothes and dishes, can contribute to the establishment of a sustainable water resources system (Kumar & Rajitha, 2019). The Autoridad Nacional del Agua (ANA) in Peru (2022) has formulated various guidelines for water conservation in indigenous communities, particularly those reliant on glaciers. However, due to a lack of resources and scientific evidence these measures have not yet been implemented, adversely affecting the most vulnerable communities, especially when exposed to extreme weather-related events such as droughts, avalanches, and floods.

The Theory of Planned Behavior (TPB; Ajzen 1985, 1988, 1991) is a widely utilized theory concerning the proximal determinants of behavior. It has been extensively applied in relation to various behaviors, including environmental protection behaviors (Gansser & Reich, 2023; Wang et al., 2019). The theory emphasizes the deliberative processing of available information in forming intentions, which is considered the key proximal determinant of action/behavior. Behavioral intention represents a person's motivation in the sense of her or his conscious plan, decision or self-instruction to exert effort to perform the target behavior. In the TPB, behavioral intentions are determined by attitudes toward the behavior, subjective norms, and perceived behavioral control (PBC). Attitudes are the individual's general evaluations of the behavior. Subjective norms consist of a person's beliefs about whether significant others think they should or should not perform the behavior. Perceived behavioral control (PBC; Ajzen, 1991) is an individual's perception of their degree of control over performing the behavior. PBC is considered a continuum with easily executable behaviors at one end (e.g., climbing stairs) and behavioral goals requiring resources, opportunities, and specialized skills (e.g., becoming a world-class athlete) at the other end. The relative importance of attitude, subjective norm, and PBC in predicting intention is expected to vary depending on behaviors, populations, and situations (Ajzen, 1991).

Meta-analyses indicate that the TPB predicts significant proportions of variance in both intentions and behavior, with attitudes and PBC being the strongest predictors of intentions (e.g., Armitage & Conner, 2001; MeEachan et al., 2011). In line with this, one review (Sur & Shapiro, 2022) determined that intention was the strongest predictor of behavior, while attitude and PBC were significant predictors of intention.

The TPB is regarded as a comprehensive theory in the sense that any other influence on behavior (i.e., external influences such as demographic variables, personality traits, or environmental influences) exerts their impact on behavior through existing components of the theory. However, the adequacy of the TPB has garnered considerable attention (see Conner & Armitage, 1998), with a number of additional variables being proposed. Ajzen (1991, p. 199) has indicated the openness of the TPB to such developments (see Ajzen, 2020). Such additional predictors might be posited to be direct predictors of intentions and/or behavior or as influencing the relationships between TPB variables or between TPB variables and behavior (i.e., moderators). A particular focus of research in recent years has been on moderator variables (Cooke & Sheeran, 2004 for a review of 44 studies of this kind), especially moderators of the intention-behavior relationship (Conner & Norman, 2022).

Although the TPB has been extensively employed across a range of behaviors, including environmental behaviors, the majority of studies focus on populations from developed countries based in urban areas. This extends to the limited number of studies using the TPB in relation to water conservation behaviors (e.g., Si, Duan, Zhang, Su & Wu, 2022). Confirming the value of the TPB in relation to populations based in rural areas of underdeveloped countries who are particularly susceptible to water scarcity was one important focus of the current research (IPCC, 2023). Such information might then usefully inform the development and implementation of low-cost interventions to tackle water scarcity.

Consistent with Ajzen (2020) a number of studies have explored the role of additional variables in the TPB to explain pro-environmental behaviors (Ateş, 2020) or water conservation behaviours (Gibson, Lamm, Lamm, & Holt, 2023). The current research focused on exploring the role of direct experience with extreme weather events (EWE). This variable has received considerable attention in the environmental domain (Sisco, 2021), although not in TPB studies. For example, Sisco (2021) reports that over 100 studies have examined the effects of weather experiences, with the focus mainly being on climate change attitudes and behaviors. The valence of effects observed is heterogeneous with studies reporting positive (Ogunbode et al., 2019; Sico et al., 2017), negative (Kohler et al., 2023; Wang et al., 2022) and null (Carmichael et al., 2017) effects on climate change attitudes and behaviors. Notably, Holland et al. (2019) reported that weather experiences were associated with negative effects on water conservation behaviors. Previous research has not explored the effects of EWE within the context of the TPB for environmental behaviors. In the current research, we explored whether EWE would predict intentions to engage in water conservation and the behavior of engaging in water conservation over and above TPB variables. Given the heterogeneity of the existing literature we did not make predictions about the direction of effects for EWE on intentions or behavior.

In addition, the current research explored whether EWE moderated relationships between TPB variables. In particular, we explored whether EWE moderated the relationship between attitude, subjective norms, PBC and intentions and whether EWE moderated relationships between attitude, subjective norms, PBC, intentions and behavior. To the best of our knowledge these tests are novel. Again given the heterogeneity of the existing literature on main effects for EWE, we did not make predictions about the direction of moderation effects, i.e., whether EWE would strengthen or weaken relationships or which relationships would be particularly affected.

In summary, the present research tested the power of the TPB in predicting the intention and behavior of water conservation in an understudied population. In addition, the role of EWE within the TPB was explored both as a main effect on intentions and behavior and also as a moderator of relationships between TPB variables and intentions plus TPB variables and behavior. The following hypotheses were tested.

1. Attitude, subjective norms and PBC would explain significant amounts of variance in intentions to engage in water conservation;
2. Intentions, attitude, subjective norms, and PBC would explain significant amounts of variance in engaging in water conservation;
3. EWE would explain additional variance in intentions over and above TPB variables;
4. EWE would explain additional variance in behavior over and above TPB variables;
5. EWE would moderate relationships between attitudes, subjective norms, PBC and intentions;
6. EWE would moderate relationships between intentions, attitudes, subjective norms, PBC and behavior.

Method

Study Area

The study was conducted in the communities of the Vilcanota basin located in the southern Andes of Peru. The region is characterised by steep slopes and elevations ranging from 2136m to 6301m above sea level. It has two distinct seasons, the rainy season from November to March and the dry season from April to October. Temperatures vary between an average high of 19-21°C and an average low of 0-6.5°C. The Vilcanota basin represents an important glacier area in Peru, the glacier area in 2016 was 255 km^2, which has decreased by 48% since 1962 (INAIGEM, 2017). The glaciers of the high Vilcanota are a source of water for the communities that live around them and sustain their agricultural and economic systems and serve as an energy source (Bello et al., 2023).

Participants and Procedure

Participants were recruited from twelve communities located around the mountains of the Vilcanota basin, Peru in May 2021. Seven interviewers (trained and monitored by a research assistant) collected data from individual participants on tablets using LimeSurvey. The approximate time per interview was 25 minutes. All participants provided informed consent before completing measures following the recommendations of the Declaration of Helsinki. A total of 2236 participants were recruited in this way. Of these 210 were removed from analyses due to incomplete responses on some questions. The 2026 participants who were retained for all analyses did not differ from those 210 eliminated in terms of gender (p = 0.506), education (p = 0.071) or income (p = 0.507). The final sample (N = 2026) contained slightly more women (N = 1072; 52.9%); mainly reported their religion to be Catholicism (N = 1363; 67.3%); had no (N = 76, 3.8%), primary (N = 292, 14.4%), secondary (N = 738, 36.4%), technical (N = 493, 24.3%) or university (N = 427, 21.1%) education; and had a modal income of less than 500 Peruvian soles (N = 794, 39.2%). Among the twelve locations surveyed, the highest response rates were in Sicuani (N = 789, 38.9%) and Combapata (N = 552, 27.2%).

Measures

Based on Gibson et al. (2021), scales were adapted to assess subjective norms, perceived behavioural control, intentions and behavior in relation to water conservation. For experiences with EWE we used the measure proposed by Van der Linden (2015). The estimated reliability of all scales was determined by ordinal alpha value which is based on the polychoric inter-item correlation matrix (Crutzen & Peters, 2017).

In addition to demographic measures (gender coded as 1=female, 2=male; education coded as 0= no studies, 1= primary, 2= secondary, 3= higher technical and 4= higher university), TPB components and were assessed in relation to water conservation behavior.

Intentions. Based on Gibson et al. (2021), intentions to save water were assessed with three items, e.g., "I want to participate every day in actions to save water in the house and garden in the next six months", strongly disagree-strongly agree, scored 1-7. The three items formed a reliable scale ($\alpha = 0.92$) and were therefore averaged so that higher scores indicated stronger intentions to save water.

Attitudes. These were assessed using 10 items adapted from Gibson et al. (2021), e.g., "More attention needs to be paid to water conservation" (0 = no, 1 = yes). The ten items formed a reliable scale ($\alpha = 0.81$) and were therefore averaged so that higher scores indicated more positive attitudes towards saving water.

Subjective Norms. These were measured by three items to tap social pressure to save water adapted from Gibson et al. (2021), e.g., "I feel there is social pressure to save water around the house and garden", strongly disagree-strongly agree; scored 1-7. The three items formed a reliable scale ($\alpha = .67$) and were therefore averaged such that higher scores indicate greater social pressure to save water.

Perceived Behavioral Control (PBC). This was assessed by two items to tap degree of perceived behavioral control based on Gibson et al. (2021), e.g., "If I save water around the house and garden or not, it is totally up to me", strongly disagree-strongly agree; scored 1-7. The two items formed a reliable scale ($\alpha = .63$) (Taber, 2018). Higher scores on PBC indicate greater perceived control over saving water.

Behavior. Based on Gibson et al. (2021) this was measured using 10 items (e.g., "I use the minimum amount of water for cleaning", no-yes; scored 0-1). The ten items formed a reliable scale (α = .81) and were therefore averaged such that higher scores indicate the behavior of saving more water.

Experience with weather extreme events (EWE). Based on Van der Linden (2015) and adapted from Monge-Rodríguez & Alvarado-Yepez, (2021), this was assessed using 4 items. The items asked about four types of extreme events (storms, droughts, landslides, and floods); e.g. "Considering the last 5 years or so, how often have you personally experienced severe storms or heavy rainfall leading to destruction in your local area?", (0 = Never, 1 = Once, 2 = Twice, 3 = Three times and 4 = More than three times). The four items formed a reliable scale (α = .71). Higher scores indicated greater experience of extreme events.

The full set of measures and dataset are available on request from the first author.

2.4. Analyses

Descriptive analyses and correlations among all measured variables were conducted first. Multicollinearity diagnosis was conducted following the recommendations of Cohen (1998). The main analyses used multiple hierarchical regressions to predict water conservation intentions and then behavior. For predictions of intentions, demographic variables (gender, income, education) were entered in Model 1. Model 2 added TPB variables (attitudes, subjective norms, PBC) as predictors. Model 3 added experiences with extreme events as predictors. In a final model, we tested the effects of adding each of three interactions one at a time: attitude x EWE, subjective norms x EWE, PBC x EWE. Variables in the interaction were mean-centred before calculating the interaction term to minimise collinearity problems (West et al., 1991). Where an interaction was significant, the nature of the interaction was decomposed using simple slopes analysis (West et al., 1991). The effect of any significant TPB variable on intention was calculated at low (Mean - 1SD), medium (Mean) and high (Mean + 1 SD) levels of EWE and these slopes plotted.

For predictions of behavior, demographic variables (gender, income, education) were entered in Model 1. Model 2 added intentions as a predictor. Model 3 added other TPB variables (attitudes, subjective norms, PBC) as predictors. Model 4 added experience with extreme weather events (EWE) to the model. In a final model, we tested the effects of adding each of four interactions one at a time: intentions x EWE, attitude x EWE, subjective norms x EWE, PBC x EWE. Any significant interactions were explored using the procedure of West et al. (1991) as detailed above.

All analyses were completed with R-Studio, using packages such as olsrr, psych, and tidyverse (Xie, Allaire, & Grolemund, 2018).

Results

Descriptive results

Table 1 reports descriptive data (Mean and Standard Deviation) and intercorrelations among all the measured variables. None of the variables were excessively skewed and all showed reasonable variation. Intentions to engage in water protection behaviors were significantly positively correlated with age, norms, and PBC, but significantly negatively correlated with EWE. PBC was the strongest correlate of intention. Similarly, water saving behavior was significantly positively correlated with intention, attitude and norms, but significantly negatively correlated with gender. Attitude was the strongest correlate of behavior.

Regressions to predict intentions

Results of the regression of intentions onto the other TPB variables and additional variables are shown in Table 2. Demographic variables were entered first (Model 1, Table 2) and explained a mere 0.4% of the variance in intentions, although this was significant ($F(3,2022) = 2.56$, $p < .05$). Only age was significant, with intentions to save water being stronger in those who were of greater age. Attitudes, subjective norms, and PBC were entered next (Model 2, Table 2) and explained a significant and substantial additional 22.8% of the variance in intentions ($F(3,2019) = 197.92$, $p < .001$). Norms and PBC were the only variables significant in Model 2. Stronger norms to conserve water and greater PBC over conserving water were independently associated with greater intentions to conserve water. Extreme events were entered next (Model 3, Table 2) and explained a significant additional 0.4% of the variance in intentions ($F(1,2018) = 10.33$, $p < .001$). Norms, PBC and EWE were the only variables significant in this model. Stronger norms to conserve water, greater PBC over conserving water and less experience of extreme events were independently associated with greater intentions to conserve water. A total of 23.1% of the variance in intentions to conserve water were explained in Model 3.

Adding the subjective norms x EWE (R^2 *change* = .0003; *Change in* $F(1,2017) = 0.91$, $p = .341$) or PBC x EWE (R^2 *change* = .0009; *Change in* $F(1,2017) = 2.45$, $p = .117$) to Model 3 did not explain a significant amount of additional variance in intentions and the interaction terms were not significant. However, entering the attitude x EWE did explain a significant amount of additional variance in intentions (R^2 *change* = .004; *Change in* $F(1,2017) = 9.38$, $p = .001$) and the interaction was significant (*Beta* = .23, $p = .01$). Simple slope analyses (West et al., 1991) showed that the effect of attitudes on intentions increased as EWE increased from low (M – 1 SD: $B = .092$, $SE = .097$, $p = .343$) to moderate (M: $B = .218$, $SE = .070$, $p = .002$) to high (M + 1SD: $B = .343$, $SE = .095$, $p < .001$). Notably the effect of attitude on intentions was positive and non-significant at low levels of EWE, but positive and significant at moderate and high levels of EWE. Figure 1 illustrates this significant interaction between attitude and EWE on intentions to conserve water.

Regressions to Predict Behavior

Results of the regression of behavior onto the other TPB variables and additional variables are shown in Table 3. Demographic variables were entered first (Model 1, Table 3) and explained a significant 1.0% of the variance in behavior ($F(3,2022) = 6.72$, $p < .001$). Sex and age were both significant, with the behavior of saving water being higher in women and older respondents. Intentions were entered next (Model 2, Table 3) and explained a significant additional 0.8% of the variance in behavior ($F(1,2021) = 18.30$, $p < .001$). Sex and intentions were significant correlates in this model with the behavior of saving water being higher in women and in those with stronger intentions to save water. Attitudes, subjective norms, and PBC were entered in the next model (Model 3, Table 3) and explained a significant additional 8.3% of the variance in behavior ($F(3,2018) = 61.96$, $p < .001$). Sex, intentions, attitudes and norms were the only variables significant in this model. Women, those with stronger intentions, more positive attitudes and stronger norms to conserve water were more likely to report conserving water. Extreme events were entered in the next model (Model 4, Table 3), but did not explain an additional increment in behavior (0.01%; $F(1,2017) = 2.18$, $p = .139$). Women, those with stronger intentions, more positive attitudes and stronger norms to conserve water were more likely to report conserving water. A total of 10.2% of the variance in conserving water behavior were explained in this final model with attitudes being the strongest predictor.

Adding the intentions x EWE (R^2 *change* = .000; *Change in* $F(1,2016) = 0.101$, $p = .750$), attitudes x EWE (R^2 *change* = .001; *Change in* $F(1,2016) = 2.486$, $p = .115$), subjective norms x EWE (R^2 change = .001; Change in F(1,2016) = 1.82, $p = .177$) or PBC x EWE (R^2 *change* = .000; *Change in* $F(1,2016) = 0.08$, $p = .776$) to Model 4 did not explain significant amounts of additional variance in behavior and in each case the interactions were not significant.

The reported models were similar in structural equation modelling. These additional analyses are available from the first author on request.

Discussion

Summary of results

The purpose of this study was to examine an extended TPB that included experience of extreme weather events (EWE) to predict water conservation in an understudied population. The TPB is an established prediction model that has been applied to various environmental behaviors including recycling (e.g., Bamberg & Moser, 2007; Rhodes et al., 2014) and water conservation (Thakur et al., 2022), although the majority of tests with the TPB have not been in rural, under-privileged populations. The results from the current research supported our first two hypotheses in that attitudes, subjective norms and PBC explained significant, but modest amounts of variance in intentions; while intentions, attitudes, subjective norms and PBC explained significant, but modest amounts of variance in water conservation behaviors. Specifically, subjective norms and PBC (along with age) were significant correlates of intention to conserve water, while intention, attitudes and subjective norms (plus gender) were significant correlates of water conservation behavior (Table 1). In addition, supporting hypothesis 3, EWE was significantly negatively correlated with intentions to conserve water, and remained a significant predictor when controlling for TPB variables and demographics. Hypothesis 4 was not supported as EWE did not show a significant correlation with water conservation behavior and was not a significant predictor when controlling for TPB variables and demographics. Hypothesis 5 was partially supported in that EWE moderated the effects of attitude (but not subjective norms or PBC) on intentions to conserve water. In contrast, hypothesis 6 was not supported in that EWE did not significantly moderate the effects of intentions, attitudes, subjective norms or PBC on water conservation behavior.

Regressions showed that subjective norms, PBC (consistent with Lam, 1999) and EWE were independent predictors of intention to conserve water, explaining 23.4% of the variance (Table 2). In addition, EWE moderated the effect of attitude on intention to conserve water. Regressions also showed that gender, intention, attitudes and subjective norms were independent predictors of water conservation behavior explaining 10.2% of the variance (Table 3). The effect for gender, reflecting greater water conservation behavior in women was consistent with a previous meta-analysis (Addo et al., 2018). On the other hand, age and education level had no effect. The lack of effects for other demographic variables (age, education) on either intention or behavior, after controlling for TPB variables was inconsistent with one previous study (Uralovich et al., 2023). However, the fact that TPB variables were the strongest predictors of intentions and behavior is consistent with other studies using the TPB to predict behavior in environmental contexts (Su & Fu, 2024). Attitude and subjective norms were the strongest predictors of behavior (Table 3). These results are consistent with those reported by Si et al. (2022) and provide strong evidence for the idea that if people believe that saving water is important and that their family and important others support saving water, they may be willing to act. It is notable that intention had a lower predictive weight, although studies such as Shahangian et al. (2021) and Canova and Manganelli (2020) did report that intention was an important component in predicting water conservation behavior. The stronger effects for subjective norms, particularly on intentions, is consistent with previous work on water conservation in South Africa (Thakur et al., 2022; see also Chaudhary et al., 2017). Overall, we can state that intention, attitude and norms are potentially useful targets for interventions aimed at increasing this behavior in this understudied population. These findings also support the value of using the TPB in understudied populations.

As noted earlier there are a considerable number of studies examining the direct effects of experience with extreme weather events (EWE) on climate change attitudes and behavior (Sisco, 2021). These studies indicate positive (Ogunbode et al., 2019; Sico et al., 2017), negative (Kohler et al., 2023; Wang et al., 2022) and null (Carmichael et al., 2017) effects on climate change attitudes and behaviors. The one study on water conservation behaviors (Holland et al., 2019) indicated that experiences with weather were associated with less water conservation behaviors (i.e., a negative effect). The current research also observed a negative effect, but only on intentions to engage in water conservation, with no observed effect on water conservation behavior (Table 1). This significant negative effect of EWE on intentions remained when controlling for TPB and demographic variables. It is not clear what factors might moderate the impact of EWE on intentions and behavior, although potential moderators are discussed by Sisco (2021). The current study indicates the need for further exploration of such moderators to explain differential effects on intentions versus behavior, making suggestions that sample differences explain the effects (Sisco, 2021) less tenable.

A novel aspect of the current research was the testing of EWE as a moderator of relationships between TPB variables as predictors and intentions or behavior as outcomes. While no significant moderation effects were observed for behavior as the outcome, the current research did observe a significant effect on the attitude-intention relationship. In particular, as levels of EWE increased the impact of attitudes on intentions also increased, such that attitudes were positive and significant predictors of intentions at moderate and high levels of EWE, while those with low levels of EWE had intentions that were unrelated to their attitudes. Such moderating effects of EWE might usefully be explored in future studies and could help explain the varying main effects of EWE observed. The current moderation effect should be confirmed in future studies before too much reliance is placed on it.

Nevertheless, the current finding might suggest the value of targeting attitudes towards water conservation, particularly in those with more experience of extreme weather events; the direct effect of attitudes on behavior independent of intentions would support this view. This might suggest the need for different interventions to increase water conservation intentions in those with and without experience of EWE (Page et al., 2020), particularly in Andean populations (Monge-Rodriguez et al., 2022). It is also worth noting the need for experimental tests to confirm any of these effects before too much reliance is placed on them.

Implications

In addition to providing insights into what to target in interventions designed to promote water conservation in a key impacted population the current research provides evidence of the value in using the TPB with less well served populations. This is important because of criticisms that models like the TPB are only useful in highly educated Western populations. The current research shows that the TPB can also provide insights in less educated populations/communities based in developing countries. It would be useful for future research to show that the insights provided by TPB studies like this one also translates into the effectiveness of interventions changing the target behaviors in these populations. In the current case, that would mean showing that interventions that changed TPB variables in relation to promoting water conservations in similar populations also resulted in behavior change in these groups (Steinmetz et al., 2016). In particular, it would involve showing that interventions targeting norms and PBC in all groups and attitudes in those with moderate or high experience of extreme weather events produces change in intentions and that changing intentions, attitudes and norms produces changes in water conservation behavior.

Limitations

The current study benefitted from a large sample from an understudied population in relation to a relatively novel behavior. Nevertheless, the study also had a number of weaknesses. A first weakness was that we employed a self-report measure of water conservation. Such measures may provide bias and be subject to social desirability effects. However, self-report measures of other environmental protection behaviors such as recycling have shown validity when compared to direct observation (Lingard, Gilbert, & Graham, 2001; Nigbur et al., 2010). It might be argued that water conservation is a more complex behavior although the impact on the validity of self-report measures is unknown. Nevertheless validation of our findings with observed behavior in a further study would be prudent.

A second weakness of the current research was the use of measures for different constructs based on varying numbers of response categories. For example, intentions, subjective norms, and PBC used items with 7-point response formats, while attitude and behavior had 2-point response formats, and EWE had 5-point response formats. Although a greater number of response categories may generate more information, this was countered by the fact that multiple items were used to tap each construct. In addition, each set of items formed a reliable scale. Nevertheless, confirming this pattern of findings using more similar measures for each construct could be useful. Examining whether this leads to a greater proportion of variance in intentions and behavior being explained would also be useful.

A third weakness of the current research was the use of a cross-sectional design, with the measure of behavior being taken at the same time as the other predictor measures. This potentially raises issues of causal direction and over-estimation of effect sizes, although to the extent that water conservation behavior is relatively stable over time then these biases may be modest. Future research could usefully employ a longitudinal design to assess these effects when controlling for effects of past behavior. Controlling for the effects of past behavior can be considered as switching the focus from predicting behavior to predicting behavior change. A recent review (Conner & Norman, 2026) summarized the size of effects for attitude and intention on behavior change and noted that while attenuated these effects remained substantial.

A fourth weakness of the current research was that the sample of participants was limited to self-selected respondents who were prepared to participate, although rates of refusal were low. This is a common problem for volunteer studies in that we do not know if those who refuse to participate differ from those who consent in systematic ways that might bias the findings.

A fifth and final weakness of the current research was the relatively modest amounts of explained variance in both intentions and behavior compared to many TPB studies (Armitage & Conner, 2001). Whether this is attributable to the population, the behavior, some weakness in the measures used, or the failure to identify other key predictors of water conservation intentions and behavior is unclear. These issues might be usefully explored in future research.

Conclusions

In summary, in an understudied population, on a relatively novel behavior we tested the effects of TPB variables plus experience of EWE. Subjective norms, PBC and EWE were shown to be predictive of intentions to engage in water conservation. In addition, EWE moderated the effects of attitudes on intentions: only when EWE was moderate or high were attitudes predictive of intentions to engage in water conservation. Furthermore, intentions, attitude and subjective norms (plus gender) were predictive of water conservation behavior. The findings suggest that intervening to target subjective norms and PBC (plus attitudes in those with experience of EWE) may lead to stronger intentions to engage in water conservation. While targeting intentions, attitudes and subjective norms may promote subsequent water conservation behavior in rural populations likely to be threatened by water shortages. Future research targeting these variables is needed to confirm them as useful ways to tackle water conservation in populations facing water scarcity.

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Table 1.

Means, standard deviations and intercorrelations for all study variables (*N* = 2026).

Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Gender	-								
2. Age	.10**	-							
3. Education	.07**	-.40**	-						
4. Behavior	-.09**	.04	-.01	-					
5. Intention	.02	.08**	-.03	.08**	-				
6. Attitude	.04*	.06*	.01	.24**	-.03	-			
7. Norms	.00	.07*	-.05*	.16**	.33**	.10**	-		
8. PBC	.02	.05*	.02	.01	.43**	.00	.29**	-	
9. Extreme Events	.05*	.00	.05*	-.02	-.13**	.07**	.00	-.02	-
Mean	1.47	35.30	2.45	0.70	5.86	0.68	5.37	5.83	1.52
SD	0.50	13.38	1.09	0.20	1.00	0.12	1.09	0.99	1.00

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 2.

Multiple regression to predict intentions from demographic, TPB and EWE variables.

	Model 1			**Model 2**			**Model 3**		
	Socio-demographics			Attitudes, Subjective norms, PBC			Experience EWE		
Predictors	*Estimates*	*SE*	*std. Beta*	*Estimates*	*SE*	*std. Beta*	*Estimates*	*SE*	*std. Beta*
(Intercept)	5.649 ***	0.114	<0.005	2.829 ***	0.188	<0.005	2.876 ***	0.188	<0.005
Gender	0.015	0.045	0.008	0.011	0.039	0.006	0.016	0.039	0.008
Age	0.005 *	0.002	0.062	0.002	0.002	0.027	0.002	0.002	0.028
Education	0.01	0.022	0.011	-0.001	0.02	-0.002	0.001	0.02	0.002
Attitudes				-0.292	0.159	-0.036	-0.263	0.158	-0.033
Subjective norms				0.227 ***	0.019	0.248	0.228 ***	0.019	0.249
PBC				0.330 ***	0.021	0.328	0.331 ***	0.021	0.329
Experience EWE							-0.062 **	0.019	-0.063
Observations	2026			2026			2026		
R^2 / R^2 adjusted	0.004 / 0.002			0.230 / 0.228			0.234 / 0.231		
F-change	2.56			197.97 **			10.329 **		

*Note: * p<0.05 ** p<0.01 *** p<0.001*

Table 3.

Multiple regression to predict behavior from demographic, TPB and EWE variables.

	Model 1			**Model 2**			**Model 3**			**Model 4**		
	Socio-demographics			Intention			Attitudes, Subjective norms, PBC			Experience EWE		
Predictors	*Estimates*	*SE*	*std. Beta*	*Estimates*	*SE*	*std. Beta*	*Estimates*	*SE*	*std. Beta*	*Estimates*	*SE*	*std. Beta*
(Intercept)	0.722 ***	0.023	<0.005	0.613 ***	0.034	<0.005	0.292 ***	0.044	<0.005	0.298 ***	0.044	<0.005
gender	-0.037 ***	0.009	-0.092	-0.038 ***	0.009	-0.093	-0.039 ***	0.009	-0.095	-0.038 ***	0.009	-0.094
age	0.001 *	<0.005	0.049	0.001	<0.005	0.043	<0.005	<0.005	0.027	<0.005	<0.005	0.027
education	0.002	0.005	0.012	0.002	0.005	0.011	0.001	0.004	0.008	0.002	0.004	0.009
intention				0.019 ***	0.004	0.094	0.013 **	0.005	0.062	0.012 *	0.005	0.06
Attitudes							0.388 ***	0.035	0.236	0.391 ***	0.035	0.238
Subjective norms							0.030 ***	0.004	0.163	0.031 ***	0.004	0.164
PBC							-0.009	0.005	-0.046	-0.009	0.005	-0.044
Experience EWE										-0.006	0.004	-0.031
Observations	2026			2026			2026			2026		
R^2 / R^2 adjusted	0.010 / 0.008			0.018 / 0.016			0.101 / 0.098			0.102 / 0.099		
F-change	6.72***			18.299***			61.963***			2.1755		

*Note: * p<0.05 ** p<0.01 *** p<0.001*

Figure 1.

Simple slopes analyses showing how the impact of attitudes on intention to conserve water increases as experience with Extreme Weather Events (EWE) increases.