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Research article

Analysis of the environmental behavior of farmers for non-point source pollution control and management: An integration of the theory of planned behavior and the protection motivation theory

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A R T I C L E I N F O

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A B S T R A C T

Agricultural non-point source (NPS) pollution in water source protection areas poses serious challenges for governments in developing countries. It is important to consider the environmental behavior of farmers when exploring the causes of NPS pollution as well as when establishing scientific controls and management measures. However, the poor understanding of factors influencing the environmental behavior of farmers and the lack of a suitable environmental socio-psychological model limit the application of the environmental behavior of farmers in NPS pollution management. In this study, we therefore integrated the theory of planned behavior (TPB) and the protection motivation theory (PMT) to identify the main determinants of the NPS pollution-related environmental behavior and intention of farmers in the Water Source Area of the Middle Route of the South-to-North Water Diversion Project in China. Results indicated that the integrated model provided a better understanding of the environmental behavior and intention of farmers than that provided by each component when used individually, and revealed that farmers perceived that the susceptibility and severity of threats caused by water deterioration influenced environmental intention through the mediating effects of subjective norm and attitude toward adopting pro-environmental behavior. At the same time, the perceived vulnerability of farmers was relatively high and their perceived severity was relatively low. Furthermore, the subjective norm, attitude, self-efficacy (i.e., the perceived behavioral control), and response efficacy positively and significantly influenced intention. However, response cost had a significantly negative effect on intention. Among them, subjective norm had the largest effect on intention. Intention was the key determinant for the actual environmental behavior of farmers, while self-efficacy also had a significantly positive effect on behavior. Managing and controlling agricultural NPS pollution requires a multi-disciplinary and comprehensive approach. Therefore, an integrated theoretical framework was developed in this study by integrating TPB and PMT to gain insight into the environmental behaviors and intention of farmers. The results provided a theoretical basis for NPS pollution control.

1. Introduction

As a major source of water pollutants, non-point source (NPS) pollution is diffuse, prone to pulse-discharges, and difficult to trace to any single pollution event or source (Dowd et al., 2008; Shen et al., 2015; Yuce et al., 2005; Yuce, 2007). NPS pollution contributes to nearly 81% of the nitrogen and approximately 93% of the phosphorus apparent in China's overall water pollution (Ongley et al., 2010). Previous studies have shown that agriculture is the main contributor to NPS pollution (Shen et al., 2014; Yang et al., 2018). Moreover, NPS pollution has intensified in rural areas because of the large quantities of inputs (e.g., fertilizers and pesticides) used during agricultural production and poor domestic waste management (Han et al., 2018; Min and Shi, 2018).

NPS pollution threatens many basin systems around the world,

Abbreviations: IM1, integrated model 1; IM2, integrated model 2; NPS pollution, non-point source pollution; PEB, pro-environmental behavior; PMT, the protection motivation theory; TPB, the theory of planned behavior

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especially in areas where industrial and urban point-source pollution is efficiently controlled (Culbertson et al., 2016; Yuce et al., 2004). As the largest cross-basin diversion project in the world, the South-to-North Water Diversion Project in China is divided into three routes (i.e., the east, middle, and west) (Wilson et al., 2017). The mid-route construction began on December 30, 2003 and was completed on December 12, 2014. Water is thus transferred to North China at a rate of 9.5 km^3/year. By 2008, a total of 2306 polluting enterprises were effectively shut down, closed off, or transferred in the mid-route water source area to ensure good water quality (Yin et al., 2011). Thus, point-source pollution has now been efficiently controlled. However, agricultural and rural NPS pollution become the main contaminants affecting mid-route water quality today. In 2015, approximately 13.74 million people resided in the mid-route water source area; the rural population accounted for 53.2% of the total population. In 2015, the main pollutant emissions for chemical oxygen demand, ammoniacal nitrogen, and total nitrogen were measured at 170, 230, and 5.96 thousand tonnes, respectively. Agriculture and rural sources accounted for 49%, 43%, and 74% of these totals, respectively (National Develepment and Reform Commission, 2017). At present, 100% of the main urban residents in Tianjin and 70% of those in Beijing use water supplied through this project. Therefore, an effective means is required to control NPS pollution derived from agricultural and rural sources.

Most studies on NPS pollution have focused on identifying the main sources and on estimating pollution loads using statistical methods (e.g., physically based and process-based modeling) (Shen et al., 2012; Yuce et al., 2009). Although these works provide a basis for clarifying the key NPS pollution management and control areas, they do not consistently identify the determinants of NPS pollution management practices. As Oskamp (2000) stated, “in thinking about environmental problems such as these, it is essential for us to realize that they are not solely technical problems, requiring simply engineering, physics, and chemistry for their solution. There is a crucial role for the social sciences in these problems because they are all caused by human behavior, and they can all be reversed by human behavior.” Fundamentally speaking, the environmental behavior of farmers directly affect the condition of the rural environment (Tian et al., 2011). Rural pollution mainly consists of NPS pollution, which occurs randomly and intermittently, is characterized by complex mechanisms and processes, involves uncertain discharge channels and amounts, contains variable spatial and temporal pollution loads, and creates difficulties for monitoring, simulation, and control (Shen et al., 2012). These characteristics are directly related to the modes of activities during agricultural production and daily life of farmers. However, few socio-psychological tests have been conducted on the environmental behavior of farmers in NPS pollution control research. Therefore, in this study, we examined a sample of farmers in the mid-route water source area to develop a socio-psychological model for studying the most influential factors for farmers who are engaged in pro-environmental behavior (PEB) designed to reduce NPS pollution.

Environmental problems are often caused by improper environmental behaviors of farmers (Price and Leviston, 2014). However, PEB is influenced by many factors, including childhood experiences, attitudes, and various worldviews (Gifford, 2014; Burton, 2014). Therefore, it is difficult to determine the role of individual motivations in environmental protection practices. Even so, human behavioral models provide simplified representations of the underlying driving forces and resulting actions involved in particular contexts. These models have shown effectiveness in understanding, predicting, and testing factors that influence human behaviors (Heimlich and Ardoin, 2008; Martin et al., 2017). Social psychologists have developed several theoretical approaches to study PEB, including the theory of planned behavior (TPB) (Ajzen, 1991), norm activation model (NAM) (Schwartz and Howard, 1981), protection motivation theory (PMT) (Rogers, 1983), and value-belief-norm theory (VBN) (Stern, 2010). Each of these theories reveals factual information about PEB, and their relatively few components allow for convenient testing. However, the price of simplicity is incompleteness, and many excluded influences undoubtedly play a role (Gifford, 2014). It is thus particularly important to develop a comprehensive and integrated environmental socio-psychological model to study the environmental behavior of farmers.

In the context of social psychology, TPB has adopted a reasonable decision-making frame and has been widely used in various domains to explain and predict behaviors (Chin et al., 2016; Turaga et al., 2010). Meta-analyses conducted by Overstreet et al. (2013) have revealed that TPB is strongly predictive and explanatory in determining the target behavior and the corresponding intention. In addition, TPB has been used to explain PEB in adolescent subjects, at the workplace, in energy consumption practices, in food waste, and in environmental activism (de Leeuw et al., 2015; Greaves et al., 2013; Park and Kwon, 2017; Russell et al., 2017). Many such studies have indicated the appropriateness of using TPB to explain both behavior and intention.

In addition, PMT has been widely used to study health behavior (Gong et al., 2009; Helmes, 2002). Furthermore, PMT has recently been used to study PEB, further revealing its strong explanatory and predictive abilities (Church et al., 2018; Keshavarz and Karami, 2016). PMT is a more comprehensive theory that not only focuses on the individual costs of adaptive behavior (as with TPB) but also considers collective actions (e.g., response efficacy), which are key factors in NAM and VBN (Keshavarz and Karami, 2016). Most local farmers in this study resided in river valley zones and most of their drinking water was supplied from wells and nearby streams. NPS pollution thus threatened both the safety of drinking water and the living environment, which in turn threatened their health and family life (Yuce et al., 2009; Yuce and Yasin, 2012). These motivating factors thus had an important impact on the intention of farmers to engage in PEB, namely the PMT constructs that were not included in TPB.

A meta-analytic review found that TPB was more successful when conducted in public and among groups than in private locations or by focusing on individuals (Steinmetz et al., 2016). However, Anderson and Agarwal (2010) suggested that PMT was one of the most powerful explanatory theories for predicting individual intention to take protective actions. In summary, TPB and PMT are unique theories that contain some similarities. In this study, we thus integrated TPB and PMT to exploit their complementary benefits. This enabled a deeper and more comprehensive understanding of the driving forces behind the environmental behavior and intention of farmers, thus providing a theoretical basis for managing and controlling agricultural and rural NPS pollution.

2. Theoretical background

2.1. The theory of planned behavior (TPB)

TPB is derived from the theory of reasoned action (Fishbein and Ajzen, 1975) (Fig. S1). It assumes that the main behavioral driving force is the intention to perform a given behavior. Here, intention refers to an individual's willingness and commitment when performing PEB. It is thus a function of attitude, subjective norm, and perceived behavioral control. Furthermore, attitude refers to an individual's favorable or unfavorable evaluation of PEB, while subjective norm summarizes the feeling of social pressure on an individual to perform or not to perform PEB, and perceived behavioral control indicates an individual's subjective belief about the ease or difficulty to perform PEB (Overstreet et al., 2013). However, because many behaviors pose difficulties of execution that may limit volitional control, it is useful to consider perceived behavioral control also works as a proxy for actual behavior (Ajzen, 2006).

TPB has widely been used to understand human environmental behavior because of its usefulness in identifying the main factors affecting the associated decision-making process (Fielding et al., 2008; Gifford, 2014; Martin et al., 2017).

2.2. The protection motivation theory (PMT)

PMT was developed by Rogers (1983) as an extension of the health belief mode (Fig. S2). The theory entails that the formation of protection motives (i.e., whether people take protective actions against potential threats) occurs through a comprehensive appraisal of threats and coping mechanisms. Threat appraisal involves individual assessment of threat level, including perceived severity and vulnerability. Perceived severity and vulnerability reflect how serious an existing risk is perceived to be and perceptions of how susceptible an individual is to the existing threat, respectively (Bockarjova and Steg, 2014). In this case, perceived severity refers to assessing the impact of NPS pollution on river water quality, fish and shrimp populations, and the surrounding environment, while perceived vulnerability refers to how one's susceptibility to NPS pollution will affect production and quality of life. Coping appraisal consists of three sub-constituents: self-efficacy, response efficacy, and response cost. Response efficacy refers to an individual's belief that a recommended response will effectively avert a threat. Self-efficacy is a person's expected capability in performing a recommended coping behavior (Yoon et al., 2012). Response cost refers to all perceived costs associated with protective measures or actions, including both monetary and non-monetary costs (e.g., effort, time, and inconvenience) (Bockarjova and Steg, 2014).

Westcott et al. (2017) suggested that PMT is applicable to "any threat for which there is an effective recommended response that can be carried out by the individual." PMT has also been used to successfully analyze PEB of farmers (Church et al., 2018; Keshavarz and Karami, 2016).

3. The integrated model and hypotheses

In this study, we integrated TPB and PMT to construct integrated model 1 (IM1) (Fig. 1). According to Ajzen (1991), perceived behavioral control is most compatible with the self-efficacy concept. Perceived behavioral control and self-efficacy are thus the same concept (IM1 uses the term self-efficacy).

Ajzen (1991) stated that if an individual's attitude toward the result of a behavior is more positive, the perceived social pressure is greater, and there are more promotional factors, then there will be a stronger intention to implement the behavior. Ultimately, actual behavior is thus more likely to occur. At the same time, self-efficacy has a positive and direct predictive effect on actual behavior. These relationships were confirmed in a previous study on PEB (de Leeuw et al., 2015). We therefore proposed the following hypotheses:

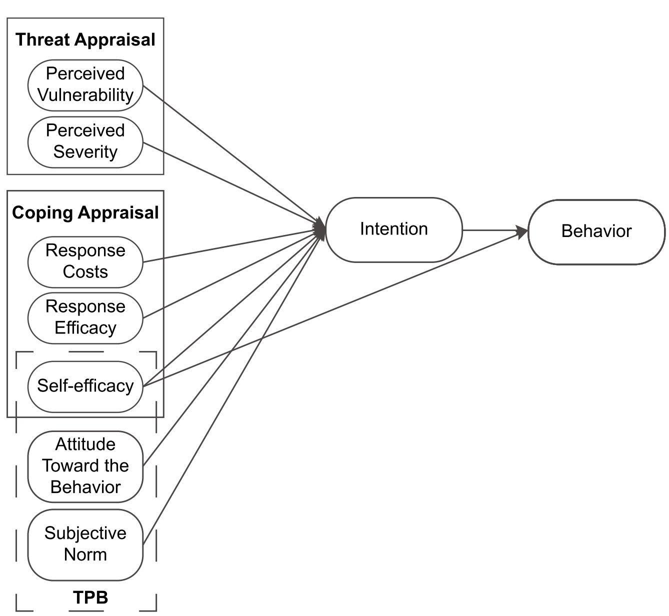

Fig. 1. Basic framework of IM1 model.

H1. Intention and self-efficacy have significant and positive predictive effects on PEB.

H2. Attitude, subjective norms, and self-efficacy have significant and positive predictive effects on intention.

The probability of goal achievement should modify the motivation to perform many environmental actions (Lam, 2006). For example, farmers have adopted various behaviors to reduce water pollution, but they cannot directly mitigate such pollution. It is therefore inefficient for them to exert effort and spend time to engage in PEB. Thus, perceived effectiveness (i.e., response efficacy) affects an individual's intention to perform PEB. Zhao et al. (2016) found that the environmental behavior of farmers was highly susceptible to cost because they typically lacked necessary materials and had few monetary resources. Response cost thus negatively affected intention. We therefore proposed the following hypotheses:

H3. Response efficacy has a significant and negative predictive effect on intention.

H4. Response cost has a significant and positive predictive effect on intention.

As described in a meta-analysis conducted by Witte and Allen (2000), increased appeals to threat produce high perceptions of both severity and vulnerability. Farmers who perceive NPS as a severe threat to agricultural production and quality of life are more willing to engage in PEB to reduce pollution. We therefore proposed the following hypotheses:

H5. Perceived severity and vulnerability have significant and positive predictive effects on intention.

4. Materials and methods

4.1. Procedure and sample

4.1.1. Measurements

PEB refers to behaviors "that consciously seek to minimize the negative impact of one's actions on the natural and built world" (Kollmuss and Agyeman, 2002). In this study, PEB specifically refers to activities that reduce NPS pollution during agricultural production and daily life of farmers. We first determined the PEBs known to reduce NPS pollution by examining the relevant literature and interviewing experts on NPS pollution. We then classified and merged these behaviors. We finally determined the main PEBs related to NPS pollution reduction, including application of pesticides and fertilizers, practice of classifying wastes, and any activity designed to reduce sewage discharge. The items of IM1 included intention, attitude, subjective norm and self-efficacy derived from Deng et al. (2016), and perceived severity, perceived vulnerability, response efficacy and response cost derived from Keshavarz and Karami (2016) and Zhao et al. (2016). Corresponding modifications were made based on the opinions of relevant experts and scholars.

4.1.2. Pilot

In this study, we randomly conducted semi-structured interpersonal interviews with 30 farmers based on a questionnaire designed in Nanzheng County, Hanzhong City in June 2017. The open-question items of the interviews are presented in Table S1. We then performed a content analysis of the responses. The analysis included the classification, merging, and deletion of answers to both closed and open-ended questions, and arcane wording was modified according to the manner of thinking of farmers.

4.1.3. Questionnaire

The questionnaire consisted of three parts. The first part inquired about geographical location and demographic characteristics, including age, gender, and education level. The second part inquired about information on basic family situations and ownership of environmental protection facilities. The third part inquired about information related to TPB and PMT constructs (Table S2). Closed questions were answered on a five-point Likert Scale.

4.1.4. Survey

The mid-route water source area is located at the north-south boundary line of China, where farmers share common characteristics with regard to agricultural production and daily life pertaining to areas in both the South and North of China. The main rivers in the area include the Hanjiang River, Danjiang River, and Duhe River. Except for the Hanzhong Basin, local landforms mostly include mountains, hills, and river valleys. The region belongs to the warm and semi-humid climate zone of the north subtropical monsoon region. Precipitation is unevenly distributed. A three-dimensional climate is also apparent. The region's agricultural production activities are mainly concentrated in the upstream areas of the Hanjiang River, Danjiang River, and Duhe River. The research team in this study conducted face-to-face surveys with farmers in 8 counties in Shangluo, Ankang, and Hanzhong in Shaanxi Province City and 3 counties in Shiyan City, Hubei Province. A total of 420 questionnaires were collected; after excluding incorrectly completed and inconsistent questionnaires, 394 questionnaires were retained (response rate of 94%). Sample distribution is provided in Fig. 2.

4.2. Statistical analysis

In this study, we used the Structural Equation Model (SEM) to examine the relationship between latent variables. SEM has been widely used in social science because it provides researchers with ample means for assessing and modifying the relationships among constructs, and offers great potential for further development of theoretical testing and modification of the relationship between detected structures (Kolar and Zabkar, 2010). SEM is divided into two approaches: covariance-based SEM (CB-SEM) and partial least square SEM (PLS-SEM) (Haenlein and Kaplan, 2004). PLS-SEM is based on SmartPLS 3 software and has been deemed more suitable for our analysis because of its usefulness in estimating extremely complex models involving many latent and manifest variables (Ringle et al., 2009). It is also less stringent in making assumptions about the distribution of variables and error terms. Our sample size was in accordance with the recommendations by Chin (1998b) regarding the use of 10 cases per predictor (i.e., the structure with the largest number of items or the dependent variable with the largest number of independent variables impacting it). We used bootstrapping with a sample size of 5000 to measure the significance of the path coefficient (Hayes, 2009). A global criterion for goodness-of-fit (GoF) (computed as $GoF = \sqrt{\overline{AVE} * \overline{R^2}}$) was built to evaluate the model's overall quality (Tenenhaus et al., 2004). The overall fit of the model was divided into weak, medium, and strong categories according to the GoF cutoffs of 0.1, 0.25, and 0.36, respectively (Wetzels et al., 2009).

5. Results

5.1. Descriptive sample information

Survey provides survey information for 394 households is provided

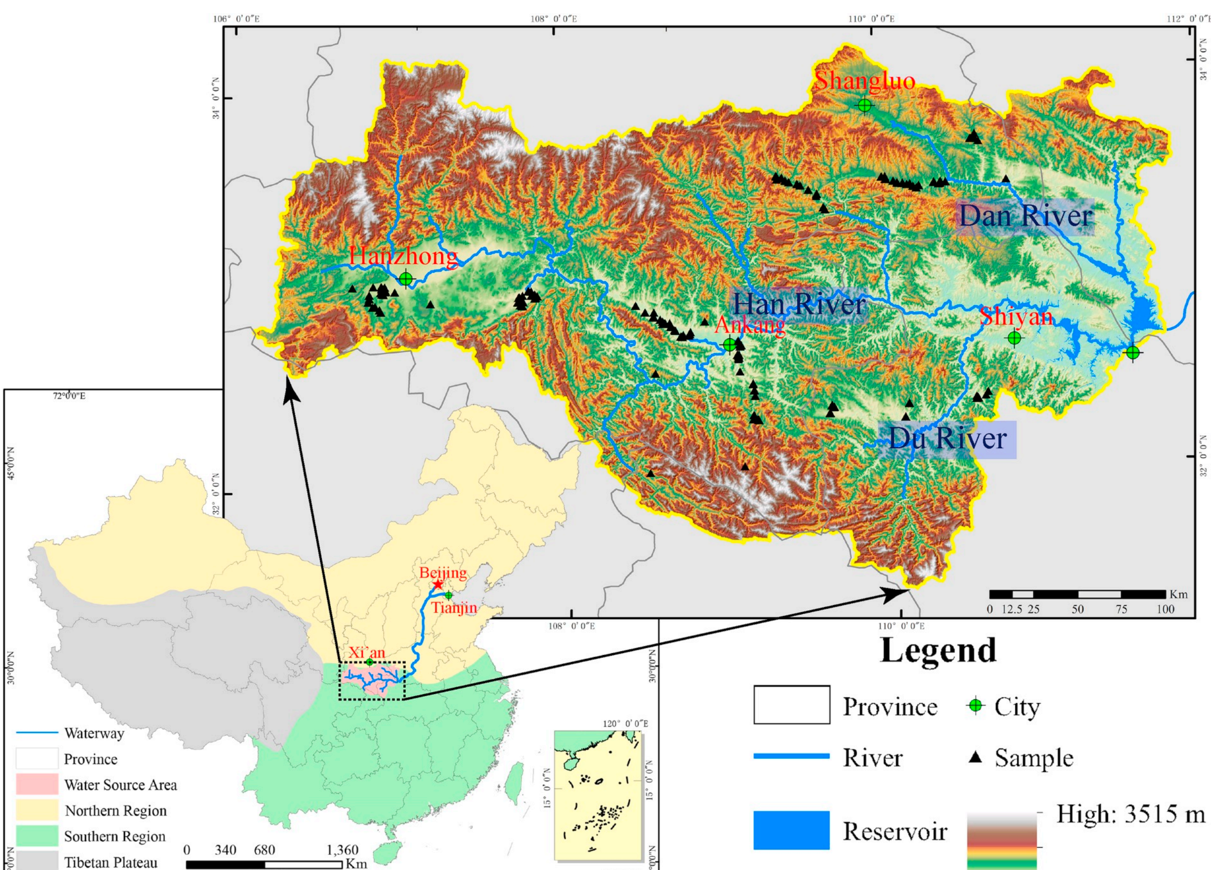

Fig. 2. Location of survey samples.

Table 1
Demographic information of respondents (N = 394).

Items	Category	Number	Percent
Gender	Male	212	53.8
	Female	182	46.2
Age	< 20	2	0.5
	20–40	20	5.1
	40–60	179	45.4
	60–80	189	48.0
	> 80	4	1.0
Education Level	Illiteracy	99	25.1
	Primary school	144	36.6
	Junior high school	110	27.9
	High school	36	9.1
	University	5	1.3
Farmland (mu)	< 1	58	14.7
	1–4	264	67.0
	> 4	72	18.3
Drinking water	Tap water	202	51.2
	Tap water + river water	24	6.1
	Tap water + well water	46	11.7
	River water	48	12.2
	Well water	74	18.8
Facility	Have trash collection system	102	25.9
	Garbage collection systems are too few and far	20	5.1
	No trash collection systems	272	69.0
	Have biogas digester with used	34	8.6
	Have biogas digester with unused	73	18.5
	No biogas digester	287	72.9

Note:1 mu = 667 m^2.

in Table 1. The number of male respondents (53.8%) was slightly higher than that of female respondents (46.2%). With regard to age and education, results showed that farmers aged 40–60 years and 60–80 years accounted for 45.4% and 48.0% of the total respondents, respectively, while those belonging to primary and lower education levels accounted for 61.7% of the total respondents. This indicated an aging rural population with low levels of education. Most farmers held small areas of farmland (81.7% of holdings measured less than 4 mu; per-capita farmland was less than 1 mu as calculated for families comprising 4 people). Since most local farmers resided in river valley zones, 48.8% of farmers mainly used well and river water for their daily needs. In addition, environmental protection facilities were relatively scarce. Results showed that 25.9% of farmers were able to use the garbage collection system, 8.6% of farmers used the biogas digester, and most of the remaining farmers did not have access to environmental protection facilities or did not use them because of scarcity and insufficient technology.

5.2. Measurement model

The scales used in this study were derived from those used in the relevant literature. These scales were modified based on the requirements of this study, the pilot, and scholarly advice. The scales used were therefore content-valid. At the same time, individual item reliability met the relevant criteria of > 0.5 (Hair et al., 2014) and all factor loadings were significant ($p < 0.001$). Thus, the measured indicators in this study were considered reliable (Table S3). Composite reliability was used to evaluate the internal consistency of the latent variables. The results shown in Table S4 indicate that the composite reliability of all constructs used in this study were > 0.8, thereby indicating good internal consistency (Fornell and Larcker, 1981). Average Variance Extracted (AVE) represents the average communality for each latent factor, and can be used as a test of both convergent validity and reliability. An AVE value > 0.5 indicates that the construct has convergence validity (Chin, 1998b). The AVE value of each construct used in this study changed from 0.663 to 0.853, thereby indicating good convergence validity. A Heterotrait-Monotrait Ratio (HTMT) was used to determine discriminant validity (Henseler et al., 2014). Kline (2011) suggested that the HTMT ratio should be < 0.85. The results shown in Table S4 indicate that the HTMT ratio for each of the constructs in this study was < 0.85. Thus, all measurement models used in this study were valid and reliable.

5.3. Structural model

Hypothesized relationships were determined using the path coefficient (β), significance, and f-square effect size (f^2). Explanatory and predictive abilities of the structural model were evaluated using a coefficient of determination (R^2) and construct cross-validated redundancy (Q^2), respectively. The f^2 method was used to calculate the effects of the construct (0.02 represents a small effect, 0.15 a medium effect, and 0.35 a high effect) (Cohen, 1988). Chin (1998b) stated that an R^2 above the cutoffs of 0.67, 0.33, and 0.19 were "substantial," "moderate," and "weak," respectively. A Q^2 above zero supported the predictive relevance of the model regarding the endogenous latent variables (Chin, 1998a).

The PLS analysis of TPB explained 23.7% and 31.2% of the variance for PEB and intention, respectively. PMT results indicated that 27.8% of the total variance in intention was explained. In addition, there were GoF values were > 0.36 and Q^2 values were > 0 for TPB and PMT, respectively (Table 2). These results indicated that TPB and PMT had strong overall fits and were appropriate for explaining and predicting the environmental behavior and intention of farmers. Therefore, both TPB and PMT were appropriate for use in this study.

In PMT, perceived severity and vulnerability had significant effects on intention as they were measured at the significant levels of $p < 0.01$ ($\beta = 0.153$, $f^2 = 0.030$) and $p < 0.05$ ($\beta = 0.108$, $f^2 = 0.015$) (Fig. 3b), respectively. However, when TPB and PMT were merged into IM1, the perceived severe and vulnerable effects were dropped (Fig. 3c). Garson (2016) suggested that multicollinearity inflates standard errors and makes significance tests for independent variables unreliable. We therefore evaluated the multicollinearity of IM1 using the variance inflation factor (VIF). Results indicated that all VIF values were < 1.313. Following Diamantopoulos and Siguaw (2006), VIF values of < 3.3 were considered to indicate no multicollinearity between variables. Using IM1, in this study, we therefore found no significant correlations between the perceived severity and vulnerability variables and intention, which had no connection with the multicollinearity between variables.

It is possible that attitude and subjective norm were mediators for the perceived severity and vulnerability variables if the following conditions were met (Baron and Kenny, 1986; Lam, 2006): (a) perceived severity and vulnerability significantly predicted intention when attitude and subjective norm were ignored, (b) attitude and subjective norm significantly predicted intention, (c) the correlation between perceived severity and vulnerability and intention disappeared when attitude and subjective norms were controlled; and (d) perceived severity and vulnerability significantly predicted attitude and subjective norms. TPB results indicated that the three core constructs of TPB had positive and significant effects on intention ($p < 0.001$) (Fig. 3a). Therefore, our results were in accordance with items (a), (b), and (c). We then constructed integrated model 2 (IM2) to test (d). IM2 results

Table 2
Results of GoF, R^2 and Q.^{2}.

Model	GoF	R^2				Q^2			
		B	IN	AT	SN	B	IN	AT	SN
TPB	0.440	0.237	0.312			0.191	0.180		
PMT	0.459		0.278				0.163		
IM1	0.477	0.237	0.376			0.179	0.226		
IM2	0.390	0.237	0.366	0.146	0.071	0.179	0.223	0.089	0.037

Note: B: Behavior; IN: Intention; AT: Attitude; SN: Subjective Norm.

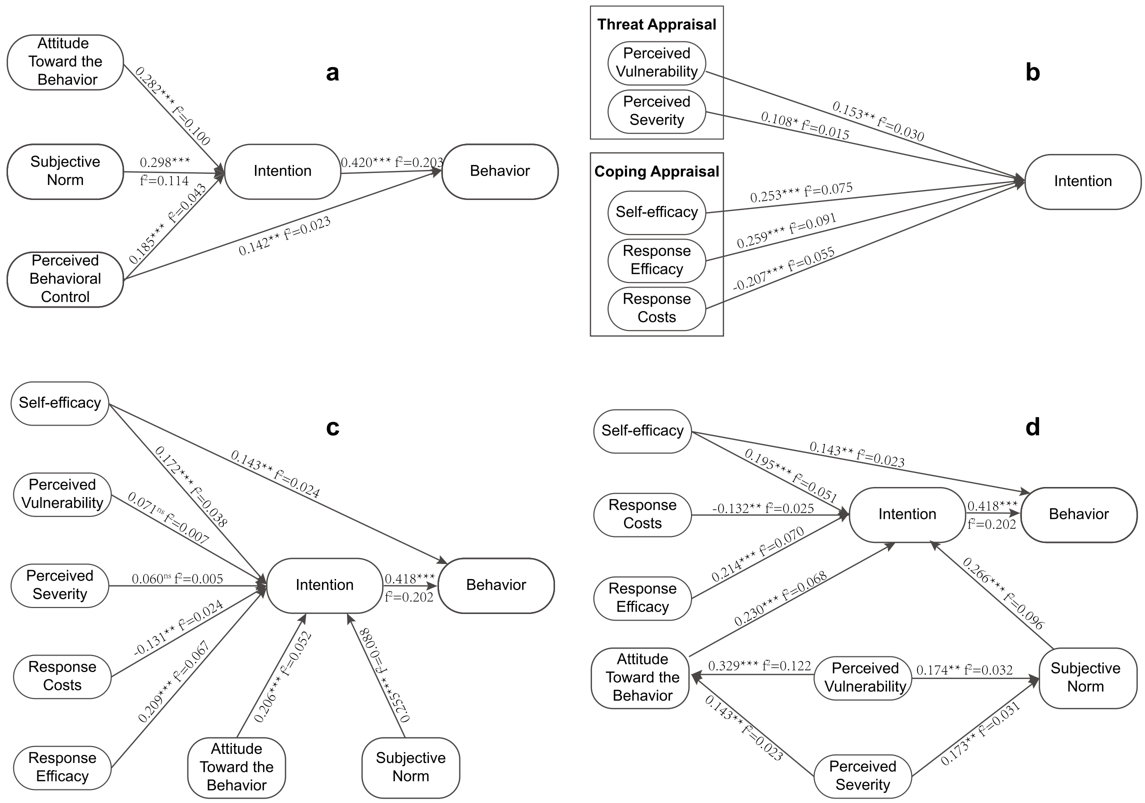

Fig. 3. Significance testing results of the structural model path coefficient. Note: a, b, c and d were significance testing results of TPB, PMT, IM1 and IM2, respectively. Path significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ^{ns} $p > 0.05$.

Table 3
Total and indirect effects of antecedents to intention.

Path	Total effects	Indirect path	Indirect effects	Sobel test	VAF
SN→IN	0.266				
AT→IN	0.230				
RE→IN	0.214				
SE→IN	0.195				
RC→IN	−0.132				
PS→IN	0.122	PS→AT→IN	0.075	3.93	0.998
		PS→SN→IN	0.046	2.55	
PV→IN	0.079	PV→AT→IN	0.033	2.58	0.998
		PV→SN→IN	0.046	2.91	

Note: SN: Subjective Norm; AT: Attitude; RE: Response Efficacy; SE: Self-efficacy; RC: Response Costs; PS: Perceived Severity; PV: Perceived Vulnerability; IN: Intention.

indicated that perceived severity and vulnerability had significant effects on attitude and subjective norm ($P < 0.01$) (Fig. 3d). We then examined the mediating effects of attitude and subjective norm. Sobel test results indicated that all test values were > 1.96. Thus, the indirect paths were significant at the $p = 0.05$ level (Sobel, 1982). Variance accounted for (VAF) values were > 0.8 (Table 3), which meant that attitude and subjective norm fully mediated the effects of perceived severity and vulnerability on intention (Hair et al., 2003). Thus, H5 was not supported.

In IM2, the power to explain intention increased to 36.6%, albeit the power to explain PEB remained unchanged. Perceived severity and vulnerability explained the variances of 14.6% and 7.1% for attitude and subjective norm, respectively. At the same time, Q^2 values were > 0 and GoF value was > 0.36. Therefore, IM2 was appropriate for use in this study and contained explanatory and predictive abilities.

The IM2 path-analysis results are presented in Fig. 3d. Here, intention was the main predictor of PEB, with a significant path coefficient ($\beta = 0.418$, $p < 0.001$) and medium effect size ($f^2 = 0.202$). Self-efficacy also had a significant and positive effect on PEB ($\beta = 0.143$, $p < 0.01$, $f^2 = 0.023$). Thus, H1 was supported. At the same time, subjective norm ($\beta = 0.266$, $p < 0.001$, $f^2 = 0.096$), attitude ($\beta = 0.230$, $p < 0.001$, $f^2 = 0.068$), self-efficacy ($\beta = 0.195$, $p < 0.001$, $f^2 = 0.051$), and response efficacy ($\beta = 0.214$, $p < 0.001$, $f^2 = 0.070$) had significant positive effects on intention. However, response cost had a significant and negative effect on intention ($\beta = -0.123$, $p < 0.01$, $f^2 = 0.025$). Thus, H2, H3, and H4 were supported.

The f^2 effect size (namely, the R^2 change effect (computed as: $\frac{R^2_{original} - R^2_{omitted}}{1 - R^2_{original}}$)) was used to compare the power of TPB and PMT regarding the increase in variance for intention in IM2. Results showed that the effect size of TPB for IM2 was 0.139, while that of PMT was 0.085. That is, the effect size for TPB in IM2 was close to medium, while the effect size for PMT was small. Therefore, TPB contributed more substantially in the IM2 analysis.

6. Discussion

Environmental protection has been the focus of Chinese governmental policy since the 2003 construction of the Middle Route of the South-to-North Water Diversion Project. In this regard, point-source pollution has now been efficiently controlled. However, the proportion of NPS pollution from agricultural production and rural living has increased and is difficult to control. Farmer PEB plays an important role in environmentally governing NPS pollution sources (Gifford, 2014; Keshavarz and Karami, 2016). This study was therefore based on a sample of farmers in the mid-route water source area. An integrated theoretical framework was developed by integrating TPB and PMT to gain a better understanding of the environmental behavior and intention of farmers. The results will be useful in providing necessary advice for NPS pollution control and management organizations.

The primary aim of this study was to integrate TPB and PMT into a theoretical framework useful for understanding and describing the mechanisms that influence the risk responses and behavioral actions of farmers with regard to NPS pollution. TPB is widely used in various domains because of its flexibility and universality in describing behaviors (Steinmetz et al., 2016). Our results indicated that TPB was suitable for analyzing and predicting NPS pollution-related environmental behavior and intention of farmers. However, although TPB is used extensively in explaining PEB, it is an incomplete model (de Leeuw et al., 2015; Gifford, 2014). Lam (2006) stated that TPB did not involve response efficacy (i.e., the effects of perception on PEB engagement), behavioral costs, or behavioral motives involved in PMT. PMT was thus used to explain how protective behaviors were initiated and maintained (Floyd et al., 2000). Our results confirmed the suitability of PMT in analyzing and predicting the intention to perform PEB. Because of the complementary features of TPB and PMT, our results also indicated that integrating the two models provided a better understanding of the environmental behavior and intention of farmers in comparison to either TPB or PMT alone.

Moreover, by comparing TPB and PMT, we found that IM2 provided stronger explanatory power for farmers' intention in addition to being stronger overall for fit and predictive ability. TPB made greater contributions to the IM2 model than PMT. This was due to a more successful application of TPB regarding group and public behavior (Steinmetz et al., 2016). Chinese public goods management (e.g., rural environment) is mainly dependent on the history of village regulations and agreements formed through the acquaintance society. Such regulations and agreements include maintenance of the village social order, social public morals, folk customs, spirituality, and civil construction. The basis for complying with these regulations is community: people live in the same rural environment and thus use the same facilities (e.g., the daily market, ancestral halls, canteens, small rivers, courtyards, and many other places). Villagers who do not comply with these regulations and agreements are alienated by fellow inhabitants (Shang and Shang, 2018). Thus, the nature of acquaintance society more closely relates to TPB than to PMT when using IM2.

The integrated model provided some interesting results. IM2 results indicated that threat appraisals (including perceived severity and vulnerability) did not directly affect intention, but they had indirect effects through attitude and subjective norm (section 4.3). Similarly, examination of the Kaohsiung residential water supply indicated that attitude mediated the effect of susceptibility to threats such as drought on the water saving intentions of residents (Lam, 2006). Results showed that farmers did not directly intend to engage in PEB when they perceived NPS pollution as a threat, but they maintained a positive attitude toward PEB while waiting to see how other farmers behaved before reacting. In addition, results indicated that farmers generally had higher perceived susceptibility (range 1–5, M = 4.09, SD = 0.59) to the threat of NPS pollution, but had lower perceived severity (range 1–5, M = 2.38, D = 0.88) for NPS pollution aggravation (Table S5). Moreover, results indicated that the correlation between perceived severity and vulnerability was also lower. Owing to improved living standards and the popularization of mass media (e.g., television and mobile phones), people are more sensitive to environmental threats. However, threat perception is more often derived from communication (e.g., public and media promotion) than from personal experience.

This study confirmed that intention was the key determinant for behavior. Moreover, intention was directly influenced by subjective norm, attitude, response efficacy, self-efficacy, and response cost, and it was indirectly influenced by perceived severity and vulnerability (Table 3). The behavioral logic of public goods managers does not always involve consideration of their own behaviors with regard to personal gains and losses, but instead draws comparisons with similar areas in rural China (Wang et al., 2018). Thus, pressure from other individuals or groups (i.e., subjective norms) becomes the key determinants of intention. Zhao et al. (2016) indicated that, although Chinese base-of-pyramid consumers believe they have little knowledge and ability to handle environmental problems, they care about environmental quality and are willing to engage in related activities (e.g., reducing water and electricity consumption) to reinforce environmental sustainability. Our survey also obtained similar results. That is, farmer attitude toward PEB was of substantial value (M = 4.34) and had significant and positive effects on intention. Furthermore, farmers are relatively more rational than the general public because of the lack of necessary materials and having few monetary resources. Farmers tend to consider individual ability, behavioral cost, and the effects of PEB. These factors were revealed in previous studies (Church et al., 2018; Keshavarz and Karami, 2016; Lam, 2006; Zhao et al., 2016). Finally, because of the lack of environmental protection facilities and increased farmer age, self-efficacy (i.e., perceived behavior control) had a positive and significant direct impact on actual behavior.

6.1. Implications for research and practice

It was important to understand the relationships between theoretical constructs derived from multiple domains to advance the theories of TPB and PMT in each of their referent domains (Premkumar and Bhattacherjee, 2008). This study empirically integrated these two major psychological theories to analyze farmer PEB. The resulting integrated model had stronger explanatory power in comparison to TPB or PMT alone. This provided a more comprehensive understanding of the complexity involved in the environmental behavior and intention of farmers. The integrated model also indicated that attitude and subjective norm mediated the effects of perceived severity and vulnerability on intention.

The Chinese government tends to focus on urban and industrial environments, thus neglecting environmental management in rural areas. Rural environmental governance has mainly relied on village regulations and agreements developed through the acquaintance society. This has caused farmers to base their actions on community behavior and engage in follow-up awareness. Our empirical results also confirmed that subjective norm had the greatest effect on the intention to perform PEB. It was therefore necessary to strengthen both injunctive (e.g., government regulation and legal constraints) and descriptive (e.g., media propaganda and cultivation of PEB leaders) norms. These factors played an important role in local rural environmental management. At the same time, our results showed that ability, cost, and effectiveness of behavior influenced the intention to perform PEB. Since the market economy has spread to rural areas, farmers also pursue personal interest maximization when engaging in PEB. Therefore, farmers should have relevant abilities before being permitted to engage in PEB. This includes the ability to reduce PEB costs. Farmers should be assured that PEB can indeed alleviate the threat of NPS pollution.

Our results showed that the perceived severity of farmers was slightly correlated with perceived vulnerability; and had relatively small effects on intention, thus indicating that farmers lacked environmental knowledge and awareness. Thus, improved farmer education is also important for NPS pollution management. At the same time, the lack of rural environmental protection facilities and the increased age of local farmers led to PEB restrictions. Therefore, additional environmental protection infrastructures are required, and more efficient and safer agricultural production technology seminars should be conducted in rural areas.

6.2. Study limitations

This study provided a more comprehensive understanding of environmental farming behaviors by integrating two major social psychology theories (i.e., TPB and PMT). However, some limitations in this study are noteworthy. First, the model did not fully explain PEB. Farmer PEB only involved the classification and reasonable treatment of garbage. Because of the need for internal consistency, this study did not involve other types of PEB related to NPS pollution. Second, we conducted face-to-face interviews and informed farmers about survey anonymity to mitigate the impacts of social approval. However, PEB results were still relatively high (range 1–5, M = 4.41, SD = 1.16) (Table S5). Therefore, future studies should consider these limitations before proceeding.

7. Conclusions

NPS pollution from agricultural production and rural living is caused by improper environmental behaviors of farmers. This study thus examined the environmental behavior of farmers in a water conservation area in China. By integrating two social psychology theories TPB and PMT we were able to sufficiently analyze PEB and intention of farmers. Our results indicated that the integrated model provided a better understanding of the environmental behavior and intention of farmers in comparison to TPB or PMT alone. The integrated model showed that pressure from individuals or groups (i.e., subjective norm) was a major predictor of intention. Farmers also held positive attitude toward PEB due to local mass media access. At the same time, their behaviors were rational. Thus, response efficacy, self-efficacy, and response cost had direct effects on the intention to perform PEB. With regard to actual environmental behavior, although intention was still the key determinant, the lack of environmental protection facilities and increased farmer age meant that their environmental behavior was also influenced by self-efficacy (i.e., perceived behavioral control). Notably, unlike with PMT alone, the integrated model indicated that attitude and subjective norm mediated the effects of perceived severity and vulnerability on intention. This also indicates that increased government supervision, the practice of cultivating PEB leaders, and increasing the number of environmental protection facilities are important factors for improving rural NPS pollution management.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2019.02.070.

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