Effects of social capital, risk perception and awareness on environmental protection behavior

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ABSTRACT

Introduction: Environmental protection is an essential issue for sustainable development, and its execution power mainly comes from individual environmental protection behavior. This study investigates the resident environmental protection behaviors and influencing factors in the ecologically fragile areas of western China based on a total of 1062 households by adopting the participatory assessment method. Then, this study used the structural equation model to empirically analyze the impact of social capital, environmental risk perception, and environmental awareness on residents’ environmental protection behavior.

Outcomes: The results showed that environmental awareness is the basis for practicing environmental protection behavior, consistent with the existing research; social capital has a significant impact on residents’ environmental protection behavior, with an impact coefficient of 0.347. Hence, environmental risk perception has an indirect influence on environmental protection behavior through environmental awareness. Besides, compared with urban residents, rural residents’ environmental awareness and social capital have a stronger role in environmental protection behavior.

Conclusions: The study clarified the influence path of residents’ environmental protection behavior, thus effectively providing a decision-making basis for the government to guide residents in the environmental governance system.

Introduction

In 2000, the Chinese government formally issued the “Western Development Strategy,” which aimed to narrow the development gaps between the western region and the eastern central region (Zhang, Zhou, and Wang 2019; Yang et al. 2018). However, due to the extreme fragility of the ecological environment, while the western region has achieved rapid social and economic development, severe eco-environmental deterioration such as soil erosion, land desertification, and grassland degradation have also occurred (Grewal and Ahmed 2011; Yu 2015). The contradiction between regional economic growth and environmental protection is still apparent (Li et al. 2019). China’s western region has essential ecological functions, which is of great significance for maintaining ecological security in China and even in East Asia (Liu and Zhu 2018). Therefore, in-depth systematic research has been carried out by the scientific community concerning soil and water conservation (Wang et al. 2020), the persistence of biodiversity and endangered species (Jing et al. 2020), regional ecological carrying capacity and sustainability (Pan et al. 2017), effects of ecological restoration schemes (Halik et al. 2019), environmental protection behavior and public consciousness of circular economy development (Dou et al. 2019; Jin and Wang 2016).

Existing research shows that public environmental consciousness and behavior play a critical role (Powdthavee 2021). Current studies on environmental consciousness and behavior focus primarily on environmental consciousness. Generally, environmental protection behavior is regarded as a link of environmental awareness, focusing on “farmer groups” to conduct environmental awareness surveys and assessments (Oliver et al. 2020; Papadaví et al. 2017). Besides, some scholars did not include environmental protection behavior in the conceptual operation of environmental awareness and took it as an independent variable to explore their relationship. Most scholars use the Logit regression method (Suárez-Varela, Guardiola, and González-Gómez 2016) and structural equation model (Hasan et al. 2020) based on CGSS data (Li 2020), and in semi-arid areas (Noorhosseini et al. 2017), the inland river basin in the northwest arid zone (Kautish, Paul, and Sharma 2019), the Gannan Plateau (Zhao and Feng 2012) and other regions to carry out empirical research.

Overall, the established research results give some support and inspiration to this research in the
following aspects. First, although there are different views on the definition of environmental awareness, it is generally believed that environmental awareness is a multi-dimensional concept that usually consists of environmental attitudes, environmental values, and environmental knowledge (Dunlap 2002). Secondly, existing studies revealed that people generally expect a high correlation between environmental awareness and environmental protection behavior; that is, people with strong environmental awareness have better performance of the behavior, which provides part of the theoretical basis and practical support for this study.

An overall review of previous studies reveals that environmental awareness is the basis for environmental behavior. Still, awareness and behavior do not have a natural consistency, which is a challenge for theoretical researchers and policymakers (Prothero et al. 2011). The formation and improvement of environmental protection behavior are subject to the comprehensive effect of external environmental conditions and individual internal characteristics (Caiado et al. 2017). The idea of finding shortcut for environmental behavior research through environmental awareness alone has been proved to be unattainable in practice. We therefore need to focus more on integrated studies of environmental behavior directly (Hammami et al. 2017). From the perspective of environmental sociology and behavioral psychology, environmental protection behavior is affected by people’s subjective consciousness and affected by other factors (Figure 1).

On the one hand, the decision-making of environmental protection behavior is not a purely rational technical process, but a highly subjective process embedded in a particular natural background with a value orientation. According to the Protective Action Decision Model’s theoretical framework, no matter what risks or shocks people experience, only when they perceive the need for action and generate behavioral intention (awareness) will they make corresponding behavioral decisions (Lindell, Lu, and Prater 2005; Lazo et al. 2015). That is, residents’ risk perception (especially threat perception) will affect their behavioral decisions. Under the external environment stimulus (such as environmental incentives), residents perceive risks and make corresponding behavioral decisions after comprehensively weighing the pros and cons. In other words, in the research of environmental awareness on environmental behavior, the forward direction of environmental awareness should be considered factor-environmental risk perception. Therefore, as the basis for understanding humanistic response actions, the public environmental risk perception provides a new way to explore the mechanism and process of impact of environmental changes on people’s behavioral decision-making (Jacobson and Adams 2017).

On the other hand, residents’ environmental protection behavior has collective action characteristics (Musavengane and Simatele 2016). Individual environmental protection behavior does not occur in isolation but is embedded in specific social relationships. Thus, the formation of environmental awareness and the realization of environmental protection behavior cannot be achieved without social capital support (Selman 2001). Social capital can be defined as “the characteristics of social organizations, such as trust, norms, and networks, that can improve society’s efficiency by promoting cooperation” (Putnam 1993). According to its core content, social capital refers to the connections between individuals or groups-social networks, reciprocity norms, and trust, which are the resources brought to people by their social structure position (Halpern 2005). Social capital is recognized as institutions and organizations based on social relationships, networks, and societies that generate shared knowledge, mutual trust, social norms, and unwritten rules. Spontaneous collective environmental actions such as community protection and personal protection driven

Figure 1. Schematic diagram of the research framework.
by social capital have long been prevalent abroad and have produced pronounced effects (Videras et al. 2012). Therefore, as a tool for understanding adaptive behavior, social capital can be introduced into the environmental behavior decision-making mechanism to analyze human factors’ role in environmental changes (Feng, Michaels, and Bell 2019).

Note: The map is based on the standard map with the review number GS(2019)1786 downloaded from the standard map service website of the Ministry of Natural Resources, and the base map is unmodified.

Western China is a significant ecologically fragile area that connects the desert oasis in the northwest. The western regions include Xinjiang, Gansu, Qinghai, Tibet, and part of Inner Mongolia (Figure 2). Among them, Gansu Province is located at the confluence of the Tibetan Plateau, the Inner Mongolia Plateau, and the Loess Plateau. This research takes Gansu province as an example to construct a structural relationship model of social capital, environmental risk perception, environmental consciousness, and protection behavior. This model explores the restrictive factors of residents’ sustainable responses in ecologically fragile areas and the difference of its influences, providing a decision-making reference to guide residents to better integrate into the government-led national environmental governance system.

Through theoretical analysis and empirical research, this research contributions of this paper are as follows: First, we take “environmental protection behavior” as the core and conduct a comprehensive research on residents’ environmental protection behavior directly. The goal of this study was to provide decision-making support for residents to better integrate into the government-led and public participation environmental governance system. Second, from the perspective of empirical research, in addition to subjective consciousness, “individual social factors (social capital)” are included in the model. And we also conduct an integrated research on environmental behavior based on the path of “risk perception-environmental consciousness-environmental protection behavior decision.” This study attempts to enhance the depth of the quantitative study of environmental behavior by considering the process of environmental behavior under various complex factors. Third, this study breaks through the data limitations of previous research. The advantage of CGSS data used in previous studies lies in the reliable questionnaire design and representative samples. But its limitation are that the relevant questionnaire section is not specially designed for “environmental behavior research.” For example, the 2003 CGSS data only surveyed urban residents, which cannot form a cross-sectional comparison. To build on the previous research described above, taking Gansu province in the ecological fragile regions as an example, this research can provide an in-depth analysis of the environmental protection behavior of different regions and types of residents. By exploring the mechanisms behind the influencing factors of environmental protection behaviors, we can then propose precise policies and recommendations.

Figure 2. The map of western China.
Data and methods

Data sources

The data used in this paper are mainly from the comprehensive social investigation of residents in Gansu Province, and the survey was conducted from 15 July 2018, to 1 September 2018. Focusing on the research theme, the content of the questionnaire used in this article is designed based on the two sections of “Social Interaction” and “Behavior and Attitude” in the China General Social Survey (CGSS) in 2003, 2010, and 2013. Before the formal field survey, 50 investigators (colleagues, graduate students, and college students) were selected for training. All of the final investigators came from the field related to this research, had specific statistical knowledge, and participated in similar questionnaire investigation projects. Besides, ten investigators were asked to conduct pre-investigation, and then the questionnaire was adjusted, and the final questionnaire was determined after repeated debugging according to the preliminary investigation. Then, the questionnaire was adjusted in time, and the final questionnaire was determined after repeated debugging according to the preliminary investigation. Reliability is an essential indicator for judging the quality of attitude or opinion questionnaires. We calculate the reliability coefficient of the formal questionnaire and finds that the Cronbach’s alpha coefficient is 0.795, which to a certain extent indicates that the questionnaire design is reliable.

The formal questionnaire consists of four parts. First, personal information, including the respondents’ age, gender, education, health, and marital status of personal characteristics; Second, the family status including the family size, family living standard, and residence of the respondents; Third, the social capital survey, including social participation and social interaction frequency of the respondents; Finally, behavioral attitude survey, including respondents’ understanding of environmental issues, environmental knowledge, perception of the environment, awareness of environmental behavior, etc.

The stratified and proportional method was used to select the investigated counties (see Figure 3 for sample county distribution). The respondents were randomly selected for the investigation within the investigated counties. The survey method uses a combination of questionnaire surveys and on-site discussion. Answer options and detailed explanations are given to the questions raised to ensure that the survey respondents answer the questionnaire based on their understanding of the questionnaire to understand the interviewee’s basic situation. A total of 1,100 questionnaires were issued, 1,062 of which were recovered, with an effective rate of 96.5%. The total numbers of valid questionnaires in different cities are as follows: 58 from Lanzhou, 117 from Dingxi, 125 from Zhangye, 77 from Baijin, 112 from Wuwei, 72 from Qingyang, 46 from Pingliang, 66 from Jinchang, 61 from Jiuquan, 105 from Tianshui, 40 from Gannan Tibetan Autonomous prefecture, 38 from Jiayuguan City, 65 from Linxia and 80 from Longnan.

The investigation results show that there are 571 males and 491 females among the respondents (Table 1). Among all respondents, those who live long in rural areas are higher than those in urban areas, accounting for 63.6%. The respondents’ age distribution ranges from 15 to 67 years old, showing a positively skewed distribution; the number of full-time employees accounts for 26.7% of the total respondents. The number of unemployed and full-time employees is relatively large, and the number of farmers only accounts for 13.8%. As the investigation was conducted during summer vacation, a high

Figure 3. The distribution map of the samples.
Table 1. Individual characteristics of respondents.

| Personal feature | Classification | Frequency | Proportion (%) | Personal feature | Classification | Frequency | Proportion (%) |
|------------------|----------------|-----------|---------------|-----------------|----------------|-----------|---------------|
| Gender           | Male           | 571       | 53.8          | Reside          | Urban          | 387       | 36.4          |
|                  | Female         | 491       | 46.2          | Rural           | Rural          | 675       | 63.6          |
| Age              | 15–18          | 56        | 5.3           | Annual income   | 0–10,000       | 161       | 15.2          |
|                  | 19–28          | 262       | 24.7          | 10,001–20,000   | 161            | 15.2      |               |
|                  | 29–38          | 286       | 26.9          | 20,001–30,000   | 163            | 15.3      |               |
|                  | 39–48          | 255       | 24.0          | 30,001–40,000   | 123            | 11.6      |               |
|                  | 49–67          | 203       | 19.1          | >40,000         | 181            | 17.0      |               |
| Employment situation | Unemployed | 445       | 41.9          | Education level | Primary        | 198       | 18.6          |
|                  | Farming        | 147       | 13.8          |                | Junior         | 247       | 23.3          |
|                  | Temporary      | 115       | 10.8          |                | High           | 276       | 26.0          |
|                  | Part-time      | 71        | 6.7           |                | College        | 126       | 11.9          |
|                  | Full-time      | 284       | 26.7          |                | University     | 162       | 15.3          |

Source: Authors’ survey.

The proportion of the respondents were college students, with 15.3% of respondents having a university or higher degree and 276 respondents had high school or technical secondary school diplomas.

Methods

The explanatory variables (environmental awareness, environmental risk perception, social capital) and explained variables (environmental protection behavior) in this paper contain multiple indicators. Compared with the ordinary regression model, the advantage of Structural equation model is that it can process multiple explained variables simultaneously and that the measurement error of explanatory variables and explained variables are allowed. Moreover, the model can simultaneously measure and estimate the factor structure and factor relationship (Fang and Wen 2018). Therefore, this paper chooses a structural equation model based on path analysis and confirmatory factor analysis to achieve the established research objectives. The specific form of SEM constructed in this paper is as follows:

\[ \eta = B\eta + F\xi + \zeta (1) \]

\[ Y = A\eta + \varepsilon (2) \]

\[ X = A\delta + \delta (3) \]

Equation (1) is a structural equation used to define the linear relationship between potential independent variables (environmental consciousness, environmental risk perception, social capital) and potential dependent variables (environmental behavior). Equations (2) and (3) are measurement equations used to define the linear relationship between the potential variables and the observed variables. \( \eta \) is the endogenous latent variable (environmental behavior, environmental consciousness), and \( \xi \) is the exogenous latent variable (social capital, environmental risk perception). \( B \) and \( F \) are the coefficient matrices of endogenous latent variables and exogenous latent variables, respectively. \( \zeta \) stands for the part that cannot be explained. \( Y \) and \( X \) are the observed variable vectors of endogenous and exogenous latent variables, respectively, and \( A\eta \) and \( \delta \) are the correlation coefficient matrices of endogenous and exogenous latent variables and their observed variables, respectively. \( \varepsilon \) and \( \delta \) are residual terms.

Currently, there is no unified standard for the fitting index of the structural equation model. It is generally recognized that the fitting degree of the model is better if the following conditions are met simultaneously: the chi-squared statistic to the degree of freedom < 2, the goodness-of-fit index GFI > 0.90, the adjusted goodness-of-fit index AGFI > 0.90, the root mean square of the approximate error RMSEA ≤ 0.05, and the upper limit of the 90% confidence intervals of RMSEA 0.08. AMOS software was used to test and modify the model to construct the modified structure relationship model. The path relationship was shown in Figure 4. The test results showed that all indicators’ estimated values were in proper compliance with the recommended value standards, indicating that the model fitted well.

Variable setting

Based on the theoretical part’s model setting, a total of 4 latent variables (social capital, environmental risk perception, environmental consciousness, and protection behavior) were set up. The structural validity of the scale was tested by factor analysis. The confirmatory factor analysis results showed that each measurement item's standardized factor load was greater than 0.5, and all were significant at the level of 1%, indicating that the scale had good convergence. Specific variables, indicators, item names, and the descriptive statistical analysis results were shown in Table 2.

The social capital that individuals can use in social relations was measured by applying the method proposed by Postelnicu and Hermes (2018). Social support, formal social networks (social participation), and informal social networks (social communication) are considered indicators for measuring individual social networks. The trust degree of strangers is taken as the measurement index of social trust; and the moral norms, contractual norms, and legal norms are taken as indicators to measure residents’ social patterns. We use the weak connection represented by the frequency of communication with relatives and friends. The
strong connection represented by the help degree of relatives and friends when encounter risks are taken as the specific indicators to measure individual “social network.” The degree of trust to strangers was used as the measurement index of “social trust.” Moral norms, contractual norms, and legal norms are taken as concrete indicators to measure resident’s “social norms.” The Likert five-level scale and 0–1 scale were used to get the social network scores, social trust, and social norm by equal weight summation. Finally, the total evaluation value of social capital was obtained by summing each sub-item. Through the descriptive statistics of social capital measurement indicators, it is found that the average value of the social norms in the residents in the study areas is generally higher. Among them, 92.8% of the respondents believe that they can strictly abide by laws and regulations while the average value of the respondents’ social trust index is 2.625, which means that the respondents’ trust of strangers ranges between “less trust” and “general trust.”

The residents’ environmental consciousness and classifies were grouped into three aspects: environmental cognition, environmental knowledge, and environmental protection. Environmental cognition mainly includes a personal understanding of fundamental environmental issues, and environmental knowledge measures residents’ consciousness of environment-related knowledge. By considering the study area’s education level, basic environmental knowledge such as “using phosphorous washing powder will cause water pollution” was set up. Environmental protection willingness measure an individual’s attitude toward environmental protection, measured by “willingness to contribute to environmental protection projects.” Here, the respondents’ value of the environmental protection willingness was 0.556, which means 44.4% of the respondents were unwilling to donate money to environmental protection projects with a negative attitude toward environmental protection. The investigation on the understanding of environmental problems found that the most concerning environmental issue were “air pollution,” which was related to the vigorous sandstorm activity in northwest China’s ecologically fragile areas.

When measuring the residents’ environmental protection behavior’s consciousness, the mature and standardized application of the CGSS questionnaire was referred to (Li 2020). Based on the general level of the environmental protection practice and a higher level of publicity, four measurement questions, including “whether to discuss environmental protection issues with relatives” were set as the specific measurement indicators of environmental protection. The investigation found that the ones who can “actively participate in environmental protection activities organized by civil society” were the fewest, accounting for only 55.2% of the respondents’ total number. In daily life, “reuse plastic products,” “bring your shopping bag to purchase,” and other life quality behavior was convenient, with the average index of 0.776 and 0.699, respectively, which were partly due to the long-term implementation of the policy “plastic limit” in China. Drawing on the research of Mulenga, Wineman, and Sitko (2017) on risk perception, the residents’ understanding of the possibility and severity of environmental risks, including “air pollution,” is used as the measurement indicators of risk perception. Based on the investigation results, it is found that the average value of understanding of possibility was between 0.202–0.688, and the respondents’ abilities to perceive
Table 2. Major measurement items and descriptive statistics.

| Latent variables | Indicators                                                                 | Indicator setting                                                                 | Options                                                                 | Mean  |
|------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------|-------|
| Social capital   | Social participation Social                                                 | Do you participate in the village committee, neighborhood committee or business committee in your community? communication | 1 = yes, 0 = no                                                         | 0.237 |
|                  |                                                                            | 1 = never, 2 = several times a year, 3 = monthly, 4 = several times a week, 5 = weekly | How often do you get together with relatives?                           |       |
|                  |                                                                            | How often do you go out with friends?                                              | 2.282                                                                  |       |
| Social support   |                                                                            | To what extent do relatives and friends help you when you are in trouble?          | 1 = no effect, 2 = small, 3 = general, 4 = large, 5 = very large         | 3.693 |
| Social trust     |                                                                            | How much do you trust strangers in society?                                       | 1 = distrust, 2 = little trust, 3 = not much, 4 = trust, 5 = very much trust | 2.635 |
| Social norm      |                                                                            | Do you strictly observe the traffic regulations?                                   | 1 = yes, 0 = no                                                         | 0.881 |
|                  |                                                                            | Do you strictly follow the government’s environmental policy?                     |                                                                        | 0.909 |
|                  |                                                                            | Do you strictly abide by laws and regulations?                                     |                                                                        | 0.928 |
| Do you strictly observe organizational discipline? | |                                                                             |                                                                        | 0.914 |
| Environmental awareness | Environmental knowledge | Do you agree that automobile exhaust is harmful to human health? | 1 = yes, 0 = no | 0.917 |
| Environmental protection | Environmental protection will | Do you agree that the use of chemical fertilizers and pesticides will cause environmental damage? | | 0.920 |
| Environmental cognition | Environmental cognition | Do you agree that using phosphorous washing powder causes water pollution? | | 0.875 |
| Environmental behavior | Behavior | Would you like to make a donation to protect the environment? | 1 = yes, 0 = no | 0.556 |
| Environmental risk perception | Perception of possibility | Are you aware of the dangers of air pollution? | 1 = yes, 0 = no | 0.759 |
| Environmental risk perception | Perception of possibility | Do you know about the dangers of water pollution? | 1 = yes, 0 = no | 0.723 |
| Environmental risk perception | Perception of possibility | Do you understand the harm of household garbage to the environment? | 1 = yes, 0 = no | 0.745 |
| Environmental risk perception | Perception of possibility | Are you aware of the environmental impact of industrial waste? | | 0.560 |
| Environmental risk perception | Perception of possibility | Are you aware of the dangers of insufficient green space? | | 0.584 |
| Environmental risk perception | Perception of possibility | Do you know the harm of cultivated land quality degradation? | | 0.594 |
| Environmental risk perception | Perception of possibility | Are you aware of the dangers of inadequate vegetation? | | 0.584 |
| Environmental risk perception | Perception of possibility | Can you reuse plastic products? | | 0.776 |
| Environmental risk perception | Perception of possibility | Can you bring your own shopping bag to go shopping? | | 0.699 |
| Environmental risk perception | Perception of possibility | Can you take an active part in the environmental action organized by civil society? | | 0.552 |
| Environmental risk perception | Perception of possibility | Is there a possibility of extreme weather (snow storm, freezing damage, rainstorm, sand storm, etc.) in your area? | 1 = yes, 0 = no | 0.688 |
| Environmental risk perception | Perception of possibility | Are there any geological hazards (landslide, debris flow, earthquake, etc.) in your area? | | 0.515 |
| Environmental risk perception | Perception of possibility | Are there any potential for groundwater mineralization in your area? | | 0.202 |
| Environmental risk perception | Perception of possibility | Is there a potential for vegetation destruction in your area? | | 0.435 |
| Environmental risk perception | Perception of possibility | Is there a potential water shortage in your area? | | 0.435 |
| Environmental risk perception | Perception of possibility | If extreme weather occurs, how serious is the impact on life? | 1 = not serious, 2 = not serious, 3 = not serious, 4 = serious, 5 = very serious | 2.761 |
| Environmental risk perception | Perception of possibility | In the event of a geological disaster, how serious is the impact on people’s lives? | | 2.187 |
| Environmental risk perception | Perception of possibility | If groundwater mineralization occurs, how serious is the impact on life? | | 1.570 |
| Environmental risk perception | Perception of possibility | If vegetation destruction occurs, how serious is the impact on life? | | 2.089 |
| Environmental risk perception | Perception of possibility | If there is a water shortage, how serious is the impact on people’s lives? | | 2.200 |
| Environmental risk perception | Perception of possibility | If desertification occurs, how serious is the impact on people’s lives? | | 2.316 |

the risk of different types of risk were quite different. Respondents’ perception of severity was sharper for the two environmental risks of “extreme weather” and “soil desertification,” and it is believed that the impact...
of these two risks has a more severe impact on production and life.

Results

Effect factors of environmental protection behavior

The standardized path coefficient estimation results are shown in Table 3. The path coefficients of all latent variables have passed the test at the significance level of 1%, which indicates that residents’ social capital, environment risk perception, and environmental consciousness have significant positive effects on their environmental protection behavior. Besides, as an intermediary factor, the environmental consciousness’s path coefficient was significant at the level of 1%.

The result shows that perception of severity had a more significant impact on the path of environmental risk perception, suggesting that residents’ perception of the severity of the effects on production and life after environmental risk could better explain their risk perception ability. The standardized factor loads of social norms and social networks on social capital were 0.743 and 0.221 respectively, that is, the higher the degree of residents’ compliance with the internal code of conduct of the organization and the more influential the social network of residents, the higher the level of social capital. The standardized load coefficients of environmental protection will, environmental knowledge, and environmental cognition of the three explicit variables of environmental consciousness were 0.601, 0.201, and 0.151, respectively. The factor load of environmental protection will be the largest, indicating that the residents’ positive attitude toward environmental protection can better explain their consciousness level.

The structural model’s simulation results show that there is a significant path relationship between the potential variables. Environmental risk perception has a positive and significant impact on environmental consciousness at the 1% confidence level. The standardized effect coefficient is 0.215; that is, the more pronounced the residents’ perception of the environmental risk changes, the stronger the environmental protection consciousness is. Environmental risk perception plays an active role in enhancing environmental consciousness. In fact, only when the residents perceive the possibility of environmental risk can they realize its threat to their life after the occurrence of environmental risk and generate environmental protection intention (environmental consciousness) under environmental risk stimulation.

The impact value of environmental awareness on environmental behavior is 0.780, which is significant at a 1% confidence level, indicating that residents’ environmental consciousness positively influences their behavior. Correct consciousness is the premise and foundation of reasonable action. The residents’ knowledge drives them to produce positive environmental protection behavior. The stronger the residents’ consciousness, the more frequent the environmental protection practice behavior will be generated. This research result is consistent with the core of the theory of planned behavior.

Environmental risk perception indirectly impacts environmental behavior through environmental consciousness, with an impact value of 0.168 (0.215×0.780), which is significant at 1% confidence level. According to the formation mechanism of environmental perception of environmental stimulation, information acquisition, information processing, and guidance behavior, the deterioration of the natural environment in ecologically vulnerable areas makes residents realize the importance of the ecological environment gradually and form a kind behavior environment consciously guides their environmental behavior.

Table 3. Results of model analysis.

| Path relationship                        | Coefficient | Standard errors | C.R.  | P values |
|------------------------------------------|-------------|-----------------|-------|----------|
| Environmental awareness–Environmental risk perception | 0.215       | 0.011           | 2.948 | 0.003    |
| Environmental behavior–Environmental awareness | 0.780       | 0.222           | 3.476 | ***      |
| Environmental behavior–Social capital   | 0.347       | 0.037           | 4.862 | ***      |
| Environmental protection will–Environmental awareness | 0.601       | 0.283           | 3.772 | ***      |
| Environmental knowledge–Environmental awareness | 0.201       | 0.148           | 3.715 | 0.002    |
| Environmental cognition–Environmental awareness | 0.151       | --              | --    | ***      |
| Behavior-1–Environmental behavior      | 0.601       | --              | --    | ***      |
| Behavior-2–Environmental behavior      | 0.606       | 0.079           | 14.876| ***      |
| Behavior-3–Environmental behavior      | 0.732       | 0.085           | 16.614| ***      |
| Behavior-4–Environmental behavior      | 0.681       | 0.082           | 16.019| ***      |
| Perception of severity–Environmental risk perception | 0.816       | 0.019           | 19.784| ***      |
| Perception of possibility–Environmental risk perception | 0.930       | --              | --    | ***      |
| Social networks–Social capital          | 0.221       | 0.039           | 5.082 | ***      |
| Social trust–Social capital             | 0.126       | 0.047           | 3.158 | 0.002    |
| Social norm–Social capital              | 0.743       | --              | --    | ***      |

Source: Authors’ computation. C.R is the ratio between the parameter estimate and the estimate’s standard error; *** indicates statistical significance at the 1% levels. Behavior 1–4 represents “discussing environmental protection issues with relatives and friends,” “reusing plastic products,” “purchasing with your shopping bags,” and “participating in environmental protection activities organized by private organizations,” respectively.
The effect coefficient of social capital on environmental protection behavior is 0.347, showing a significant positive impact. That is, residents with higher social capital tend to be more sustainable in environmental protection behavior. This paper verifies that social capital significantly impacts residents’ environmental behavior and quantifies the degree of impact. Social capital is one of the indispensable factors for sustainable development. Residents with high social capital are more willing to abide by generally recognized codes of conduct and norms for members’ common interests within the organization. Residents with higher social participation and close social connections are more likely to be consistent with others and take measures to achieve environmentally sustainable common interests. To achieve the common goal of protecting and improving the environment, the increase in social capital means that people can better comply with relevant social norms for environmental sustainability and sustainability. The closer social ties between people make environmentally friendly behavior have a positive “companion effect,” thus promoting residents’ environmental protection behavior. Residents with higher social capital have more social resources and can positively play social networks. Out of the shared vision of environmentally sustainable development, it is easier to pay close attention to environmental issues, hold a high level of environmental protection intentions and achieve environmentally sustainable behavior. An effective way needs to be to build an environmental governance system in which social organizations and the public participate.

Factors in multi-groups

The environmental protection behavior of residents has important group characteristics, and their environmental protection behavior is affected by their regional environment (Su et al., 2021). Therefore, the impact of residence can’t be ignored in the study of residents’ environmental protection behavior. We further combine the multi-group SEM model and takes the residential area as a regulating variable to study the differences of social capital, environmental risk perception, and environmental consciousness between rural residents and urban residents on their environmental behavior. Table 4 shows the path coefficient estimation results of the multi-group SEM model.

It can be seen from Table 4 that the path coefficients of urban residents and rural residents are significantly positive, which means that the theoretical model constructed in this paper has been verified again in different groups in urban and rural areas. In addition, considering the impact of social capital, environmental risk perception and environmental consciousness on individual environmental behavior, the path coefficients of environmental consciousness of rural residents and urban residents are 0.712 and 0.325 respectively; the path coefficients of environmental risk perception of rural residents and urban residents are 0.156 and 0.692 respectively; the path coefficients of social capital of rural residents and urban residents to environmental protection behavior are 0.505 and 0.257 respectively; With comparative analysis of the path coefficients of environmental protection behavior of the two groups, it is found that rural residents’ environmental consciousness and the path coefficient of rural residents’ social capital are more significant than that of urban residents, which indicates that the positive effects of rural residents’ environmental consciousness and social capital on their environmental protection behavior are higher than that of urban residents. Compared with urban residents, the possible reasons are the natural conditions of rural residents are worse, the environmental risks they face are more significant, and their production and lifestyles are more dependent on the natural environment, resulting in the more obvious impact of their environmental consciousness on their environmental behavior (Ghorbani and Xuan 2018). Besides, the social system of the rural circle order makes the social network of rural residents stronger. With the

| Path relationship | Rural residents | Urban residents |
|-------------------|-----------------|-----------------|
|                   | Coefficient | Standard errors | C.R. | Coefficient | Standard errors | C.R. |
| Environmental awareness → Environmental risk perception | 0.156*** | 0.011 | 2.43 | 0.692*** | 0.056 | 10.16 |
| Environmental behavior → Environmental awareness | 0.712*** | 0.205 | 3.42 | 0.325*** | 0.021 | 3.40 |
| Environmental behavior → Social capital | 0.505*** | 0.055 | 5.59 | 0.257*** | 0.055 | 2.46 |
| Environmental protection will → Environmental awareness | 0.608*** | 0.137 | 3.88 | 0.231*** | 0.023 | 3.56 |
| Environmental knowledge → Environmental awareness | 0.225*** | – | – | 0.331*** | – | – |
| Environmental cognition → Environmental awareness | 0.064 | 0.318 | 1.26 | 0.746*** | 0.027 | 4.81 |
| Behavior 1 → Environmental behavior | 0.533*** | – | – | 0.666*** | – | – |
| Behavior 2 → Environmental behavior | 0.548*** | 0.084 | 9.98 | 0.728*** | 0.109 | 11.81 |
| Behavior 3 → Environmental behavior | 0.666*** | 0.105 | 11.35 | 0.837*** | 0.119 | 12.74 |
| Behavior 4 → Environmental behavior | 0.696*** | 0.114 | 13.55 | 0.684*** | 0.011 | 11.25 |
| Perception of severity → Environmental risk perception | 0.823*** | 0.022 | 16.81 | 0.852*** | 0.025 | 16.34 |
| Perception of possibility → Environmental risk perception | 0.919*** | – | – | 0.910*** | – | – |
| Social networks → Social capital | 0.203*** | 0.048 | 4.10 | 0.257*** | 0.066 | 3.27 |
| Social trust → Social capital | 0.070 | 0.063 | 1.46 | 0.214*** | 0.077 | 2.92 |
| Social norm → Social capital | 0.688*** | – | – | 0.801*** | – | – |

Source: Authors’ computation. *** , ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.
support of healthy relationships, people are more willing to implement collective behavior conducive to organizations’ common interests (Yang, He, and Li 2020). Therefore, the impact of rural residents’ social capital on environmental protection behavior is more substantial.

**Discussion**

Existing studies have confirmed the positive impact of environmental awareness on environmental behavior. For example, Chin et al. (2019) collected socio-demographic information, information on the environmental awareness and environmental protection attitudes through surveys in Peninsular Malaysia. The research has found that in the face of air pollution, people have positive environmental awareness and environmental protection behaviors. Kautish, Paul, and Sharma (2019) explored the positive impact of environmental awareness on “green purchase behavior.” Hasan et al. (2020) studied the relationship between carbon footprint, environmental awareness and environmental behavior, and found that the sensitivity of environmental awareness is related to environmental behavior. Consistent with previous studies, we also confirmed the positive effect of residents’ environmental awareness on environmental protection behavior. In contrast, based on the extended theory of planned behavior, our research clarified the forward factor that affects the relationship between environmental awareness and environmental behavior, that is, environmental risk perception. In other words, our research verified the recurrence of perceiving environmental risks, risk perception affecting environmental awareness, and environmental awareness stimulating environmental behavior.

Unlike previous studies that explored the impact of environmental awareness on environmental behaviors focusing on a single dimension. For example, Ma and He (2020) took Beijing, China as an example, and studied how environmental concerns affect people’s willingness to pay for environmental protection actions. Powdthavee (2021) studied the impact of environmental attitudes on environmental behavior. Our research comprehensively evaluated the residents’ environmental awareness through the multi-dimensions of environmental knowledge, environmental concern, environmental attitude, etc., so that the evaluation results are as objective as possible. At the same time, the different dimensions of environmental awareness (environmental awareness, environmental knowledge, environmental willingness) are considered to comprehensively examine the comprehensive impact of environmental awareness on environmental protection behavior. At the same time, different dimensions of environmental awareness are considered, and the impact of environmental awareness on environmental protection behaviors was examined from multiple perspectives.

Social factors have a positive effect on collective action, which has basically reached a consensus (Selman 2001). In terms of social factors on the collective behavior of environmental protection, Videras et al. (2012) studied the impact of different social relationships such as relatives, colleagues, and neighbors on pro-environmental behaviors. Yamazaki et al. (2018) took Indonesian fishers as the research object, and discussed how fishes interactions with other community members affected their pro-environmental behavior. Severo et al. 2019 explored the impact of social networks on people’s environmental awareness and behavior in the context of globalization. On the basis of existing research, our research incorporated the comprehensive index “social capital,” which includes social network, social interaction, and social trust, into the model. We found that social capital is one of the incentives for individuals to implement the environmental protection behaviors. Furthermore, the social environment and social network owned by the individual will affect the practice and improvement of environmental protection behavior. We also found that different aspects of social capital have heterogeneous effects on environmental protection behavior. In addition, the social capital of rural residents and urban residents have different effect on environmental protection behaviors.

To realize the coordinated development of economic and environmental sustainability, governments have made long-term environmental protection efforts and invested many environmental protection efforts in sustainable environmental planning. But the fundamental contradiction between human activities and environmental protection is still prominent, especially in ecologically fragile areas. For western China and other ecologically fragile regions worldwide, taking positive measures to improve residents’ environmental protection behavior is one of the primary ways to achieve sustainable environmental development. The steps for improving residents’ environmental protection behavior to integrate residents into the environmental governance system should be considered. First, in terms of enhancing residents’ perception of environmental risks, the government should appropriately strengthen the implementation of environmental protection policies at the residents’ level to scientifically realize the possibility and severity of environmental risks. Residents’ high-level environmental risk perception is the basis for them to generate environmental awareness and practice environmental protection behavior. The second is to strengthen the environmental restraint mechanism at the “collective level” and create an environmental governance system with “government-led and public participation.” Based on the influence path of social capital-environmental
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