



Urban and Rural Residents' Willingness to Pay for Desertification Prevention and Control and its Influencing Factors

Weipeng Chao, Changjiang Zhang† and Pengcheng Wang

School of Economics and Management, Tarim University, Alaer 843300, China

†Corresponding author: Changjiang Zhang

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ABSTRACT

The prevention and control of desertification cannot be separated from the active participation of local urban and rural residents. However, only a few studies on the difference in urban and rural residents' willingness to pay for the prevention and control of desertification and its influencing factors are available. To explore the differences in urban and rural residents' willingness to pay for desertification prevention and control, the status quo and influencing factors of willingness to pay for desertification prevention and control among urban and rural residents were analysed by linear regression analysis method and the micro-survey data of 300 urban and rural residents in the middle and lower reaches of the Tarim River in Xinjiang, China. Results show that urban and rural residents' willingness to pay for desertification prevention and control is affected by education level, ecological environment concern, ecological environment protection needs, attention to desertification, and cognition of desertification control effect. Several preventive measures were provided with respect to enhancing residents' awareness of desertification prevention and control, raising residents' income and push forward systematic innovation.

INTRODUCTION

Remarkable achievements have been made since the reform and opening-up in China. However, these achievements are accompanied by a series of resource and environmental problems. Particularly in the ecological system, structural imbalance, functional degradation, and other concerns have become increasingly prominent, and ecological civilization construction has a long way to go. According to China's Plan for Sustainable Agricultural Development (2015-2030), desertification has reached 1.73 million square kilometres, and the overall deterioration of the ecosystem has yet to be fundamentally reversed. The Tarim River basin is subject to natural factors such as persistent climate drought, wind erosion and desertification, seasonal imbalance of water resources, social and economic factors such as uneven population distribution and economic backwardness, as well as human activities such as poor land, continuous development of cultivated land, and unreasonable use of water resources. As a result, the Tarim River basin has become a region with severe desertification in China, and is also an important source of dust and floating dust in western China, causing great harm to local ecological environment construction, social and economic development and people's lives. At present, various sand control behaviours either rely on the government's dominant behaviour, or putting huge amount of money on planting trees, or encouraging enterprises to explore prevention and control tech-

niques. In the short run, these methods have achieved certain effects of sand control. However, those methods that rely on the single force are often difficult to sustain.

In fact, based on the complexity and sustainability of the desertification problem, in addition to the role of the government and enterprises, it is necessary to mobilize the core subjects of local urban and rural residents to participate in the whole process of desertification prevention and control. Only by combing multi-subjects' forces and fighting together, the desertification prevention and control can be truly viable and effective. However, desertification control payment entities are mostly concentrated in the government and enterprises. The discussions in existing literature on the participation behaviour of urban and rural residents in the desertification area are not deep enough. Most of the existing literature focus on the discussion of the cognitive level and the root causes of desertification. Moreover, in different research areas, the same factor may have different degrees of influence on the residents' willingness to pay. This means that different subjects or the same subjects from different regions have great differences and complexities in the prevention and control of desertification.

Therefore, this study chose the middle and lower reaches of the Tarim River as a research area, which is less developed and decertified. The questionnaire survey method was used to explore the willingness of local urban and rural

residents' willingness to pay in desertification prevention and control. The degree of influences on the willingness to pay for desertification prevention and control in three dimensions (urban and rural residents' individual characteristics, local ecological environment awareness and desertification awareness) was analysed. The conclusions can provide some references for future studies on multi-subjects' participation in desertification prevention and control, and help to improve the applicability and effectiveness of desertification control policies.

PAST STUDIES

Since monetization calculations were conducted on the willingness of residents to pay for the prevention and control of desertification in multiple desertification regions worldwide (Costanza et al. 1997), the study on the willingness of residents to pay for ecological environment treatment has become a popular topic in the fields of humanities and social sciences. In recent years, many scholars have also conducted numerous studies on desertification control and other related issues from different perspectives. These studies mainly focused on the following aspects. (1) Residents cognition of desertification (Li et al. 2005). Scholars found that local residents have a clear understanding of desertification changes with some limitations (Li et al. 2016, Li et al. 2016). (2) Heterogeneity of residents' payment behaviours for desertification control. Scholars also found that the spatial heterogeneity of residents' perception and decision-making on environmental and the Tarim River protection are mainly due to the differences in resource endowment, economic development and resource dependence, the diversity of environmental sensitivity and vulnerability in production and living areas, and the differences in residents' ecological group consciousness in different regions (Li et al. 2018). (3) Public value analysis and performance evaluation of ecological governance policies (Huang 2017, Buij et al. 2017), and others mainly analysed ecological governance policies and public values and conducted performance evaluations of ecological governance. (4) Residents' ecological cognition and payment decision-making behaviour. Existing studies found that residents' willingness to pay for ecological compensation is slightly different, and income level has no effect on residents' rational and objective cognition of ecological value (Li 2018). (5) Dynamic monitoring of desertification. Existing studies divided the desertification land in the study area into four grades and analysed the changes in area and dynamics (Han et al. 2010, Maro et al. 2017, Wang et al. 2017).

The aforementioned laid a solid foundation for this study. By sorting out existing relevant studies, most scholars considered the influencing factors of respondents, aware-

ness and willingness to pay for desertification from subjective and objective perspectives. However, existing studies are relatively extensive, and some areas can still be comprehensively discussed in existing studies. First, most existing studies focus on understanding the ecological environment, environmental protection, and the willingness to pay compensation, while the studies conducted on desertification in the Tarim River basin, which is extremely fragile ecologically, mainly focuses on the causes of desertification (Zhang 2016) and technological measures for desertification control (Ning et al. 2018). However, due to considerable differences in the cognition and payment intention of different subjects on desertification, study on this aspect must be further deepened. Second, most of the existing studies have single subjects on cognition and willingness to pay for desertification, ignoring the differences in cognition and willingness to prevent and control desertification among different subjects. Different subjects (such as urban and rural residents) vary in terms of resource endowment, vision, and insight; therefore, their cognition of desertification and willingness to pay for its prevention and control must be different as well.

METHODOLOGY

Data: The data used in this study are from questionnaire surveys and interviews of urban and rural residents in the middle and lower reaches of the Tarim River from July to August 2018. A total of 339 questionnaires were issued in this survey, and 300 valid questionnaires were recovered, with a recovery rate of 88.5%. Specifically, 166 males and 134 females accounted for 55.33% and 44.67% of the samples, respectively. The sample population aged between 19 and 45 comprises 279 individuals, accounting for 93% of the total population. In the sample, 25 people have junior high school education or below, 66 people have high school education, 93 people have technical secondary school or junior college education, and 116 people have a bachelor's degree or above, accounting for 8.33%, 22.00%, 31.00%, and 38.67%, respectively. A total of 154 urban residents and 146 rural residents comprised the sample, accounting for 51.33% and 48.67% of the sample population, respectively. In terms of health conditions, 7 people were very unhealthy, 26 people were relatively unhealthy, 72 people were of normal health, 111 people were relatively healthy, and 84 people were very healthy, accounting for 2.33%, 8.67%, 24.00%, 37.00%, and 28.00%, respectively. In the sample, 21 people have been living locally for less than 2 years, 106 people have been living locally for 2 to 5 years, 94 people have been living locally for 5 to 10 years, and 79 people have been living locally for more than 10 years, accounting for 7.00%, 35.33%, 31.33%, and 26.34% of the

samples, respectively. A total of 92 people have a family size of 1-3, 189 people have a family size of 4-6, and 19 people have a family size of 6 or more, accounting for 30.67%, 63.00%, and 6.33% of the sample, respectively. According to the survey results, 69.00% of the residents took the initiative and are willing to pay for desertification control, 26.00% of the residents stated that they are willing to pay if required by the government, and 5.00% of the residents indicated that they are not willing to pay for desertification control under any circumstances.

Variable selection and assignment: This study is based on existing literature considering the actual situation of urban and rural residents in the middle and lower reaches of the Tarim River basin and data availability. The willingness to pay for desertification prevention and control is divided into three classes, namely, "under any circumstances are not willing to pay", "government mandate was willing to pay", and "actively and are willing to pay" and respectively assigned a value of 1, 2, and 3. In terms of the selection of independent variables, this study selects 17 variables in three categories: individual characteristics of urban and rural residents, ecological environment awareness, and awareness of desertification. The types, dimensions, definitions, and assignments of each variable are shown in Table 1.

Model: This study takes the willingness to pay for desertification control as a dependent variable and 17 factors in three dimensions as independent variables to gain a comprehensive understanding of the differences between urban and rural residents' willingness to pay for desertification control in the middle and lower reaches of the Tarim River basin. The dependent variable Y and the independent variables $\chi_1, \chi_2, \dots, \chi_k$ are set. The linear regression model is expressed as follows:

$$Y = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \dots + \beta_k\chi_k + \varepsilon \quad \dots(1)$$

Where, $\beta_0, \beta_1, \dots, \beta_k$ are unknown parameters, β_0 is the regression constant, and $\beta_1, \beta_2, \dots, \beta_k$ are the regression coefficients. Y is dependent variable, and $\chi_1, \chi_2, \dots, \chi_k$ are independent variables.

RESULTS AND DISCUSSIONS

Results

The sample area of the influence of the residents' willingness to pay for prevention and control of desertification is examined using multiple linear regression models, and the correlation coefficient is used to show the strength of the correlation between situations. Through multicollinearity after model testing, model VIF is found in the value between 1 to 2 and less than 5, indicating the absence of

collinearity problems. Moreover, the D-W value is near 2, which indicates that no autocorrelation exists between the models. This finding indicates that no correlation exists between the sample data, and the model is satisfactory. The specific analysis results are shown in Table 2.

Discussion

Influencing factors of urban residents' willingness to pay for desertification prevention and control: Urban residents' willingness to pay for desertification prevention and control has no evident correlation to the following factors: gender, age, monthly income, marital status, length of local residence, family size, ecological environment satisfaction, awareness of the hazards of desertification, cognition of the main causes of desertification and awareness of desertification control regulations, which have a coefficient value that is close to zero, and p -value > 0.05 .

At the significance level of 5%, the regression coefficient between willingness to pay and health status is -0.175, indicating a significant negative relationship between these factors. This finding shows that when urban residents are healthy, their willingness to pay for desertification prevention and control becomes weak. Moreover, when the residents are healthier, their concern regarding the ecological value of desertification control is lessened, making them less willing to pay. The correlation coefficient between willingness to pay and ecological environment concern is 0.298, which indicates the presence of a significant positive correlation between them. In other words, urban residents with high attention to the ecological environment have high willingness to pay for desertification prevention and control. A negative correlation is observed between cognition of the main body of desertification control and the willingness of urban residents to pay for desertification prevention and control ($B = -0.202$), which indicates that the willingness of urban residents to pay is the highest if they think that the main body of desertification control is "local residents." Cognition of desertification control effect is negatively correlated with the willingness to pay for desertification control ($B = -0.155$). That is to say, urban residents who consider the desertification control effect as "very good" have the lowest willingness to pay. It's possibly because they think the desertification control effect is sufficiently good and they do not need to pay extra.

At the significance level of 1%, the correlation coefficient between the willingness to pay for desertification prevention and control and the education level is 0.230, indicating a positive relationship. That is to say, when the education level of urban residents is high, their willingness to pay for desertification prevention and control is also high.

In terms of ecological environment protection needs and attention to desertification, the two variables are significantly positively related to the willingness to pay for desertification prevention and control (B=0.279, B=0.302). These findings suggest that the higher the demand for ecological environment protection and control and the higher the attention paid to desertification, the stronger the willingness of urban residents to pay for desertification prevention and control.

Influencing factors of rural residents' willingness to pay for desertification prevention and control: Desertification prevention and control of rural residents' willingness to pay has no evident correlation to the following factors: gender, marital status, monthly income, health status, family size, ecological environment satisfaction, cognition of the main causes of desertification, cognition of the main body of desertification control and awareness of desertification control regulations, which have a coefficient value that is close to zero, and *p*-value > 0.05.

At the 5% significant level, the regression coefficients between willingness to pay for desertification prevention and control of rural residents and their age and length of local residence are 0.206 and 0.105, respectively. This indicates that the willingness to pay for desertification prevention and control has a significant positive impact on age and length of local residence. The older and the longer the length of local residence is, the stronger their willingness to pay for desertification prevention and control become. The reason behind this is that with the increase in age and the numbers of years of local residence, rural residents have a deeper understanding of the relationship between man and nature, the value of surrounding ecological service system, and the importance of its protection and governance. Thus, their willingness to pay for desertification prevention and control become stronger. The correlation coefficient between the willingness to pay and the education level of rural residents is 0.203 (urban residents is 0.230), indicating that the education level has a positive impact on the willingness to

Table 1: Variables and assignments used by the model.

| Variable types | | Variable dimension | Variable definition and assignment |
|-----------------------|---|--|--|
| Dependent variable | | Willingness to pay (Y) | Under any circumstances are not willing to pay =1; government mandate was willing to pay =2; actively and are willing to pay =3 |
| Independent variables | Individual characteristics of residents | Gender (X ₁) | F = 1; M = 2 |
| | | Age (X ₂) | 18 years and under =1; 19-30 years old =2; 31-45 years old =3; 46-60 years old =4; 60+ = 5 |
| | | Education level (X ₃) | Junior high school and below =1; High school = 2; Technical secondary school, junior college =3; Bachelor degree or above =4 |
| | | Monthly income (X ₄) | 1500 RMB and below =1; 1501-3000 RMB =2; 3001-5000 RMB =3; 5001-10000 RMB =4; Above 10000 RMB =5 |
| | | Marital status (X ₅) | Unmarried = 1; Married = 2; Divorced = 3; Remarried = 4; Widowed = 5 |
| | | Health status (X ₆) | Very unhealthy =1; Less healthy =2; General = 3; Healthier =4; Very healthy = 5 |
| | | Length of local residence (X ₇) | Less than 2 years =1; 2-5 years =2; 5-10 years =3; 10 years or more =4 |
| | | Family size (X ₈) | 1-3 =1; 4-6 =2; 6 or more = 3 |
| | Ecological environment awareness | Ecological environment concern (X ₉) | Never pay attention = 1; General concern =2; Concerned = 3; I'm very concerned about lambda equals 4 |
| | | Ecological environment satisfaction (X ₁₀) | Very dissatisfied =1; Less satisfied =2; General = 3; Satisfactory =4; Very satisfied =5 |
| | | Ecological environment protection needs (X ₁₁) | It doesn't need = 1; Comparatively unnecessary = 2; General = 3; Relatively need =4; Strongly need = 5 |
| | Awareness of desertification | Attention to desertification (X ₁₂) | Never pay attention = 1; General concern =2; Concerned = 3; I'm very concerned =4 |
| | | Awareness of the hazards of desertification (X ₁₃) | Agricultural yield =1; Decreased quality of agricultural products =2; Poor air quality =3; Pasture stocking capacity decreased =4; Other = 5 |
| | | Cognition of the main causes of desertification (X ₁₄) | Over farming, overgrazing =1; Serious industrial pollution =2; Improper utilization of water resources =3; Drought =4; Soil salinization =5 |
| | | Cognition of the main body of desertification control (X ₁₅) | Local resident =1; Enterprises engaged in related desertification control =2; Local government environmental protection department =3; Country = 4 |
| | | Awareness of desertification control regulations (X ₁₆) | I don't know anything about theta =1; A little bit of understanding =2; Know = 3 |
| | | Cognition of desertification control effect (X ₁₇) | Very bad =1; Bad = 2; General = 3; Better =4; Very good = 5 |

Table 2: Linear regression analysis table.

| Independent variables | Residents type | | | | | |
|---|-----------------|---------------|-------|-----------------|---------------|-------|
| | Urban residents | | | Rural residents | | |
| | Coefficient | p-values of B | VIF | Coefficient | p-values of B | VIF |
| Gender | 0.026 | 0.752 | 1.058 | 0.058 | 0.057 | 1.168 |
| Age | 0.056 | 0.497 | 1.393 | 0.206 | 0.013* | 1.635 |
| Education level | 0.230 | 0.005** | 1.222 | 0.203 | 0.014* | 1.592 |
| Monthly income | 0.056 | 0.493 | 1.329 | 0.052 | 0.067 | 1.441 |
| Marital status | 0.006 | 0.206 | 1.497 | 0.013 | 0.304 | 1.398 |
| Health status | 0.175 | 0.032* | 1.206 | 0.024 | 0.137 | 1.127 |
| Length of local residence | 0.083 | 0.314 | 1.262 | 0.105 | 0.016 * | 1.355 |
| Family size | 0.027 | 0.747 | 1.035 | 0.021 | 0.804 | 1.213 |
| Ecological environment concern | 0.298 | 0.012* | 1.322 | 0.129 | 0.035* | 1.561 |
| Ecological environment satisfaction | 0.082 | 0.317 | 1.739 | 0.032 | 0.700 | 1.735 |
| Ecological environment protection needs | 0.279 | 0.001** | 1.37 | 0.206 | 0.013* | 1.118 |
| Attention to desertification | 0.302 | 0.001** | 1.908 | 0.251 | 0.002** | 1.588 |
| Awareness of the hazards of desertification | 0.014 | 0.307 | 1.795 | 0.395 | 0.021* | 1.431 |
| Cognition of the main causes of desertification | 0.059 | 0.426 | 1.597 | 0.027 | 0.129 | 1.658 |
| Cognition of the main body of desertification control | 0.202 | 0.027* | 1.438 | 0.017 | 0.015 | 1.476 |
| Awareness of desertification control regulations | 0.067 | 0.458 | 1.665 | 0.029 | 0.312 | 1.566 |
| Cognition of desertification control effect | 0.155 | 0.035* | 1.598 | 0.216 | 0.001** | 1.321 |
| R squared | 0.812 | 0.856 | | | | |
| Adjusted R squared | 0.856 | 0.876 | | | | |
| F value | 3.838** | 4.093** | | | | |

Notes: The dependent variable (Y) is the willingness to pay for desertification prevention and control; the d-w values in urban and rural areas are 1.896 and 2.166, respectively; "*" means $p < 0.05$, indicating a significance of 5%, and "**" means $p < 0.01$, indicating a significance of 1%.

pay for desertification prevention by both urban and rural residents. That is to say, when the education level is high, their willingness to pay is strong. Simultaneously, this finding also shows that the influence of education level on urban residents' willingness to pay is larger than that of rural residents. This result may be because urban residents are generally better educated than rural residents and have higher incomes, making them more willing to pay than rural residents. Ecological environment concern of rural residents is positively correlated with their willingness to pay ($B=0.129$), while the regression coefficient of urban residents is 0.298. This finding indicates that this variable has a positive impact on the willingness to pay for desertification prevention and control by both urban and rural residents and a larger impact on urban residents. Urban residents may have a better living environment, higher civilization level, paying extra attention to the ecological environment, thereby strengthening their willingness to pay. Ecological environment protection needs have a positive correlation with the willingness to pay by rural residents ($B=0.206$), while the correlation coefficient of urban residents is 0.279. This result indicates that this variable is positively correlated with the willingness to pay by both urban and rural residents but has a more considerable impact on the willingness to pay by urban residents. This may be due to the

higher average level of education of urban residents, a deeper understanding of the needs of ecological environment protection and governance, which leads to a stronger willingness to pay.

Under 1% significance level, the rural residents' attention to desertification has a significant positive influence on their willingness to pay ($B=0.251$), while the coefficient of urban residents is 0.302. This finding shows that urban and rural residents' willingness to pay for desertification prevention and control is enhanced with the increased attention in desertification, but the impact is even bigger on the urban residents. The urban residents may have improved living standards compared with their rural counterparts and paying additional attention to desertification control, thus endowing them with high willingness to pay. With the increasing attention of rural residents to desertification prevention and control, their willingness to pay will also become higher, but limited by their living and income standards, the increase of willingness to pay is not obvious. Cognition of desertification control effect of rural residents has a significant negative impact on their willingness to pay ($B=-0.216$). The regression coefficient of urban residents is -0.155. This finding shows that when the effect of desertification control is improved, the willingness of urban and rural residents to pay for desertification control

will become lower. However, this variable has a more substantial impact on rural residents. This may be due to the lower-income level of urban residents. Rural residents who think that desertification control effect is better are more reluctant to pay for desertification control than urban residents.

CONCLUSION

The urban residents' willingness to pay for desertification control is influenced by education level, health status, ecological environment concern, ecological environment protection needs, attention to desertification, cognition of the main body of desertification control, cognition of desertification control effect. The willingness of rural residents' pay for the prevention and control of desertification is influenced by age, education level, length of local residence, ecological environment concern, ecological environment protection needs, attention to desertification, awareness of the hazards of desertification, cognition of desertification control effect.

The environmental awareness of urban residents is higher than that of rural residents. Therefore, corresponding incentives for environmental protection must be established. Urban and rural residents must improve their ecological social consciousness of the Tarim River basin. For example, organizing personnel to perform environmental publicity work, helping the residents understand the importance of prevention and control of desertification, and improving the rural residents' awareness of prevention and control of desertification.

The per capita willingness of urban residents to pay for desertification prevention and control is relatively high. Which means that, by increasing the family income of urban residents in the middle and lower reaches of Tarim River, their willingness to pay for desertification prevention and control can also be enhanced. Limited by their ability to pay, rural residents are generally unwilling to pay. But they can participate in the form of voluntary labour, which requires systematic innovations by the government. Some cases also show that institutional innovation can fully mobilize the enthusiasm and effectiveness of residents to participate in ecological and environmental protection. Eco-

logical compensation can be a potential environmental policy tool to solve this problem.

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REFERENCES

- Buij, R., Melman, T.C.P. and Loonen, M.J.J. 2017. Balancing ecosystem function, services and disservices resulting from expanding goose populations. *Ambio*, 46(2): 301-318.
- Costanza, R., Darge, R. and Groot, R.D. 1997. The value of the world's ecosystem services and natural capital. *Ecological Economics*, 387(1): 3-15.
- Han, Z., Tao, W. and Yan, C. 2010. Change trends for decertified lands in the Horqin Sandy Land at the beginning of the twenty-first century. *Environmental Earth Sciences*, 59: 1749-1757.
- Huang, D.J., Lai, Z.Q. and Li, H. 2017. Research on agriculture eco-innovation of connotation and implementation path in desert region: a case study on Cistanche Plant. *Issues in Agricultural Economy*, 3: 80-88.
- Li, C.Z., Zhang, Y. and Liu, Y. 2016. Residents cognition to desertification in the lower reaches of the Tarim River. *Journal of Desert Research*, 9: 1271-1276.
- Li, F., Zhang, B. and Su, W. 2005. Sandy desertification change and its driving forces in western Jilin Province, North China. *Environmental Monitoring and Assessment*, 136(1): 379-390.
- Li, Q., Xue, Z., Chen, H.M. and Xu, C.Z. 2016. Cognitive ecology and payment decision-making behavior based on the theory of CVM in the Tarim River Basin. *Resources Science*, 38(6): 1075-1087.
- Li, Q. and Xue, Z. 2018. Spatial heterogeneity of ecological cognition and payment decision behavior in the Tarim River Basin: Based on the survey data of 2133 residents. *Journal of Arid Land Resources and Environment*, 32(1): 14-16.
- Li, Y.B., Lu, Q. and Guo, G. 2018. Farmers' willingness to pay for soil and water conservation technology and its influencing factors. *Journal of Arid Land Resources and Environment*, 32(4): 31-34.
- Maro, D., Vermorel, F. and Rozet, M. 2017. The VATO project: an original methodology to study the transfer of tritium as HT and HTO in grassland ecosystem. *Journal of Environmental Radioactivity*, 167: 235-248.
- Ning, B.Y., Ma, J.X. and Jiang, Z.D. 2018. Patent analysis on desertification control technology in China. *Journal of Desert Research*, 38(05): 989-998.
- Wang F. 2017. Dynamic monitoring of desertification in the Tarim Basin based on RS and GIS techniques. Master's Thesis. Xinjiang Normal University.
- Zhang, L.X. 2016. The causes to and treatment models of desertification in China. *Shaanxi Forest Science and Technology*, 3: 77-79.