Dataset for Evaluating the Environmental Value Loss of Coastal Tourism under the Influence of *E. prolifera* in Qingdao, China

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Abstract: Harmful algal blooms *(E. prolifera)* influence the overall environment of coastal tourism in Qingdao, tarnish its image as an attractive resort, and result to economic losses. A questionnaire was designed based on the principles of the contingent valuation method (CVM), and combined with the situation of the coastal tourism environment and the characteristics of *E. prolifera*. This questionnaire contains three contents: the social and economic characteristics of tourists; tourists' perceptions of *E. prolifera*; and tourists' willingness to pay (WTP) for the treatment of *E. prolifera*. Tourists' social and economic characteristics include 9 indicators: gender, age, origin, education level, occupation, monthly income, satisfaction with the coastal tourism landscape of Qingdao, the frequency with which they travelled to the Qingdao bathing beach in the past year, and the main reasons they go to the Qingdao bathing beach. The content regarding tourists' perceptions of *E. prolifera* includes 5 indicators: tourists' perceptions of *E. prolifera*, the effects on coastal tourism activities, coastal recreational activities, marine tourism activities of tourists during the outbreak of *E. prolifera*, and tourists' perception of the responsibility for the treatment of *E. prolifera*. The survey of tourists' WTP for the protection of the coastal tourism environment and the treatment of *E. prolifera* includes 4 indicators: tourists' WTP and their real values to participate in the treatment of *E. prolifera*, the reasons why tourists are willing to participate in the treatment of *E. prolifera*, and the reasons they refuse to participate in the treatment of *E. prolifera*. A total of 527 valid questionnaires from June to July in 2017 were investigated. The dataset includes 1) tourists' social and economic characteristics; 2) tourists' perceptions of *E. prolifera*; 3) tourists' WTP and the amount of money they would like to pay to treat *E. prolifera*; 4) calculations of tourists' WTP value per capita; 5) evaluations of the environmental value loss of coastal tourism under the influence of *E. prolifera*; and 6) field survey photos. The dataset is archived in .xlsx and .jpg formats and comprises 9 files with data size of 9.39 MB (compressed into 1 file, 9.30 MB).

Keywords: coastal tourism; loss evaluation; contingent valuation method; *E. prolifera*; willingness to pay; Qingdao; harmful algal bloom

1 Introduction

A green tide is caused by the explosive proliferation of large green algae (*E. prolifera*) within a certain period or an aggregation reaching a certain level, which result in the abnormal marine ecology phenomenon[1]. *E. prolifera* have presented a continuous, large-scale and recurring situation in the Yellow Sea of China since 2007 and have become a marine ecological problem of wide concern. The maximum distribution area of algal bloom in the Yellow Sea was 57,500 km^2 in 2016 according to The Bulletin of China's Marine Environment released by the State Oceanic Administration[2]. The rapid proliferating *E. prolifera* have resulted in numerous negative impacts on the aquaculture, tourism and residents' lives in coastal areas, among others[2]. It is estimated that mariculture losses were as high as ¥4.8 billion, with another ¥140 million for emergency response and a total loss of nearly ¥5 billion in 2016[3]. It is worth noting that the period of outbreaks of *E. prolifera* concur with the prime tourism season in Qingdao, sand, rocks and other aspects of the tourism landscape are affected by *E. prolifera*, water quality and atmospheric environment in the coastal area are polluted, and coastal recreational activities such as beach entertainment, sand bathing, sunbathing, and swimming cannot be normally conducted. *E. prolifera* attached to yachts affects some marine tourism projects such as fishing inshore, fishing from the beach, and sports, reducing the service function of the bathing beach.

Coastal tourism resources and the marine ecological environment constitute the significant conditions and basis for the development of tourism in Qingdao. The quality of the coastal tourism environment in Qingdao declines during outbreaks of *E. prolifera*, severely affecting tourists' experiences and satisfaction. Therefore, evaluation of the environmental value loss could be a reasonable starting point to deal with algal blooms (*E. prolifera*). As a kind of public good, the value loss of the coastal tourism environment under the influence of *E. prolifera* cannot be reflected by the market mechanism and needs to be evaluated by a hypothetical market. Therefore, this study would use CVM through investigating tourists' willingness to pay (WTP) for the treatment of *E. prolifera* to improve the coastal tourism environment and evaluate the environmental value loss of coastal tourism under the influence of *E. prolifera*. The aim of this study is to provide a theoretical basis to decision-making by evaluating the environmental value loss resulted from *E. prolifera*.

2 Metadata of Dataset

The metadata of the dataset[4] are summarized in Table 1, including dataset name, authors, year, data format, data size, data files, data publisher, data sharing policy, etc.

3 Methods

The dataset for evaluating the environmental value loss of coastal tourism under the influence of *E. prolifera* is developed by the field survey method using CVM based on tourists' WTP to participate in the treatment of *E. prolifera*.

3.1 Data Sources

The dataset for evaluating the environmental value loss of coastal tourism under the influence of *E. prolifera* was obtained from questionnaires. This study refers to CVM questionnaire design and survey principles proposed by NOAA[5]. The questionnaire was designed based on the characteristics of the coastal tourism environment and the reference regarding tourism damage and ecological environment value loss in this field[6–8]. A pre-investigation

was undertaken to determine the range of tourists' WTP values from June 20 to 22, 2017, and then a formal survey was conducted to obtain valid questionnaires to serve as the main data of this dataset from June 23, 2017 to July 14, 2017. Based on the severity of the impact caused by *E. prolifera* in Qingdao, the First, Second, and Sixth Beaches and the Elderly People's Stone Bathing Beach were selected for a random sampling survey in the study area, and the first-hand questionnaire data were obtained.

3.2 Willingness to Pay (WTP) and the Amount of Payment

The dataset's social and economic characteristics of tourists, tourists' perception of *E. prolifera*, tourists' WTP to participate in the treatment of *E. prolifera* and their value were obtained through the questionnaire survey. In addition, SPSS 20.0 was used for statistical analysis. Specifically, first, this study analyzed tourists' social and economic characteristics, including gender, age, origins of tourists, education level, occupation, monthly income, tourists' satisfaction with the coastal tourism landscape of Qingdao, the frequency at which tourists travelled to the bathing beach in the past few years and the main reasons. Second, this study investigated the degree of tourists' perceptions by the features of *E. prolifera*, the impacts of coastal tourism, coastal leisure activities and marine entertainment activities of tourists during outbreaks of *E. prolifera*. Furthermore, we referred to the principles of questionnaire in CVM[10]. The WTP bidding value was set using continuous payment card guidance technology, and the questionnaire was conducted to obtain the data on tourists' WTP for the treatment of *E. prolifera* and the improvement of the coastal tourism environment.

Table 1   Metadata summary of dataset of evaluating the environmental value loss of coastal tourism under the influence of *enteromorpha prolifera* accumulation in Qingdao, China

Items	Descriptions
Dataset full name	Dataset of evaluating the environmental value loss of coastal tourism under the influence of *enteromorpha prolifera* accumulation in Qingdao, China
Dataset short name	EnteromorphaProliferaQingdao
Authors	Liu, J. L-5287-2016, Ocean University of China, liujia_lemon@163.com Liu, N. P-9206-2018, Ocean University of China, 343955670@qq.com
Geographical area	Qingdao, Shandong province Year 2017
Data format	.xlsx, .jpg Data size 9.3 MB (after compression)
Dataset files	Table 1.xlsx: Social and economic characteristics of tourists Table 2.xlsx: Tourists' perception of *E. prolifera* Table 3.xlsx: Tourists' willingness to pay to participate in the treatment of *E. prolifera* Table 4.xlsx: Tourists' WTP value per capita Table 5.xlsx: Environmental value loss of coastal tourism under the influence of *E. prolifera* Figures 1−6.jpg: Field survey photos
Foundation(s)	National Social Science Foundation of China (17FGL005); Social Science Planning Project in Shandong province (17CLYJ40); Qingdao Social Science Planning Research Project of 2017 (QDSKL1701014)
Data Publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	*Data* from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, in the *Journal of Global Change Data & Discovery*). *Data* sharing policy includes: (1) *Data* are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use *Data* subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute *Data* subject to written permission from the GCdataPR Editorial Office and the issuance of a *Data* redistribution license, and; (4) If *Data* are used to compile new datasets, the 'ten percent principal' should be followed such that *Data* records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[9]

3.3 Dataset for Evaluating the Environmental Value Loss of Coastal Tourism under the Influence of *E. prolifera*

This study used CVM to quantitatively evaluate the environmental value loss of coastal tourism under *E. prolifera* in Qingdao, in combination with the results of tourists' WTP. CVM method is based on the theory of consumer utility constant in the economics of welfare. In this method, the respondents are first directly asked (by questionnaire) about their maximum willingness to pay (WTP) to use or protect given goods or services and are then asked about their intended minimum willingness to accept (WTA) in order to prevent the loss of given goods in a hypothetical market[11]. In this field of study, the environmental value loss is often obtained from the product of respondents' mean WTP and the total number of local residents or tourists in related area[12–14]. Hence, the environmental value loss of coastal tourism under the influence of *E. prolifera* was calculated by multiplying the mean WTP for the treatment of *E. prolifera* by the total number of tourists in Qingdao. For this study, the second and third quarters of tourists were selected as the higher limit value, and the third quarter of tourists in 2016 was selected as the lower limit value because outbreaks of *E. prolifera* have appeared in July since 2007.

3.4 Technical Flowchart

The dataset for evaluating the environmental value loss of coastal tourism under the influence of *E. prolifera* was obtained via the questionnaire design and implementation based on CVM to investigate tourists' social and economic characteristics and tourists' perceptions of *E. prolifera*. In addition, the tourists' mean WTP to participate in the treatment of *E. prolifera* was calculated, and then the environmental value loss of coastal tourism was estimated (Figure 1).
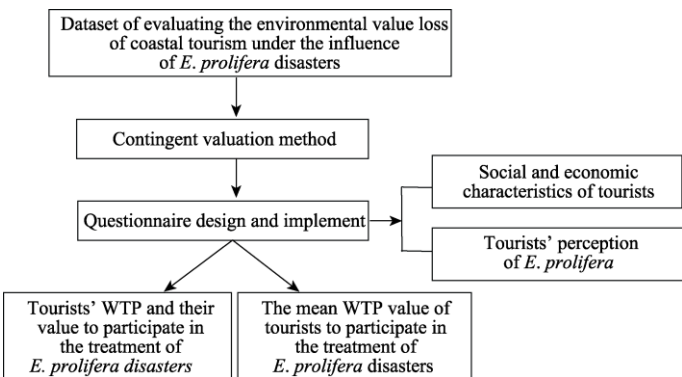

Figure 1   Flowchart for evaluating the environmental value loss of coastal tourism under *E. prolifera*

4 Data Results and Quality Control

4.1 Dataset Composition

Based on aforementioned methods, six data files were created.

(1) Social and economic characteristics of tourists, 9 indicators: gender, age, origins, education level, occupation, monthly income, tourists' satisfaction with the coastal tourism landscape of Qingdao, the frequency with which they travelled to the Qingdao bathing beach in the past year, and their primary reasons to travel.

(2) Tourists' perceptions of *E. prolifera*, 5 indicators: tourists' perceptions of *E. prolifera*, the effects on coastal tourism, coastal recreational activities, marine tourism activities during outbreaks of *E. prolifera*, the responsibility for treating *E. prolifera*.

(3) Tourists' WTP for the treatment of *E. prolifera,* 4 indicators: tourists' WTP and their values to participate in the treatment of *E. prolifera*, the reasons why tourists are willing to

participate in the treatment of *E. prolifera*, and the reasons why they refuse to participate in the treatment of *E. prolifera*.

(4) Tourists' mean WTP to participate in the treatment of *E. prolifera* was calculated.

(5) The environmental value loss of coastal tourism due to *E. prolifera* in Qingdao.

(6) Field survey photos.

4.2 Results

The dataset for evaluating the environmental value loss of coastal tourism under the influence of *E. prolifera* mainly includes tourists' WTP to participate in the treatment of *E. prolifera*, calculations of tourists' WTP value per capita, and the environmental value loss of coastal tourism under the influence of *E. prolifera*. $E(WTP)_+$ represents the mean value of tourists' WTP, which is calculated from the tourists' WTP values (Figure 2) for participation in the

Figure 2   Tourists' WTP values for participating in the treatment of *E. prolifera*

treatment of *E. prolifera*. Considering that the real WTP of the interviewed tourists may be zero, the Kristrom model is used to correct $E(WTP)_+$ to address zero values[15]. The result is estimated to be $E(WTP)$, which represents tourists' WTP value per capita. Finally, we evaluate the environmental value loss of coastal tourism.
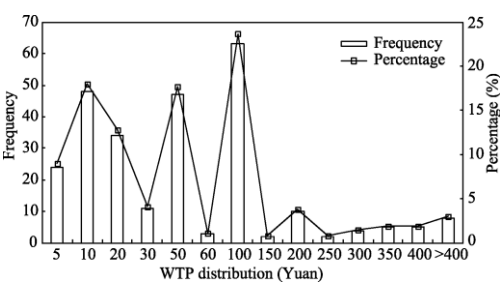
4.3 Quality Control

This dataset was obtained from the field survey, mainly using CVM, although the deviation factors were unavoidable, we undertook numerous measures to deal with those deviations based on the experience of effective measures and the full understanding of the present situation of bathing beach in Qingdao (Table 2). In addition, this study also reduced sample error by increasing the number of survey samples and eliminating unreasonable willingness to pay and controlled the error within a certain range to ensure that the final measurement results are close to the real situation.

Table 2   Error types and preventive measures in the field survey

Deviation type	Deviation treatment
The hypothetical bias	Guide the tourists to understand the authenticity of the hypothetical market for treating *E. prolifera* and remind the tourists to choose WTP values according to their actual monthly incomes
Deviation of bid value range	Conduct the field pre-survey and ask tourists about the maximum/minimum WTP in order to define the range of values
Information deviation	Tell tourists about the actual situation of the bathing beach in Qingdao during outbreaks of these
Strategic deviation	Fill in the questionnaire anonymously and inform the tourists that their willingness to pay greatly influences the evaluation results
Protest bias	"If you refuse to pay for the treatment of *E. prolifera*, what's the reason?" is asked in the questionnaire. This issue is intended to clarify the reasons for refusing payment and to separate the sample data from the protest payment in the data analysis
Investigation of residence time deviation	The questionnaire design is simple and easy to understand for tourists

5 Discussion and Conclusion

This study quantitatively evaluated the environmental value loss of coastal tourism using a Contingent Valuation Method (CVM) to ask tourists to participate in the treatment of *E. pro-*

lifera in a virtual market. The result from this study can be used to formulate relevant policies to prevent the burst of algal bloom (*E. prolifera*) which is of great significance to the protection of the coastal tourism environment and the sustainable development of coastal tourism in Qingdao. However, there are some uncertainties and limitations in the present study, so more efforts are needed for improvement.

　(1) Compared with the actual market, the results may have some bias due to the particularity of CVM in the hypothetical market. More evaluation methods may be tested in the future to reduce the uncertainties caused by CVM alone.

　(2) The results of this study may be dynamic, and tourists' WTP for the treatment of *E. prolifera* may change over time, with the enhancement of public awareness and government regulation.

　(3) It should be made clear that the loss referred in this paper is only about lose in terms of tourism industry and in the hardest-hit region by *E. prolifera*. Accordingly, this is only a part of the losses inflicted by *E. prolifera*. More comprehensive approaches are expected to appraise the total losses in more industries imposed by outbreaks of *E. prolifera*.

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