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Quantitative Study on Effects of the Blue-green Algae Event in Taihu Lake on Environment in Suzhou, Wuxi and Changzhou City

[1]Sun Fuhua, [2]Shen Juqin, [1, 3]Wang Juan and [1]Kang Kai
[1]Business School, Hohai University,
[2]Institute of Environment Accounting and Asset Management, Business School, Hohai University,
[3]Nanhang Jincheng College, Nanjing, Jiangsu, China

Abstract: The Blue-Green Algae Event in Taihu Lake has a wide influence on the society and it is quite complicated. On the basis of cost-benefit analysis on effects of the Blue-Green Algae Event in Taihu Lake on the environment, this study discussed the quantitative method of analyzing effects of the Blue-Green Algae Event in Taihu Lake on the environment. Besides, a quantitative model was established. Finally through intension survey method and market value method, monetary quantification was carried out for effects of the Blue-Green Algae Event in Taihu Lake on the environment according to relevant data. This can provide references for readjustment of local industrial structure, repair and improvement of ecological environment, compensation of social environment influence, readjustment of industrial development layout and long-term planning and treatment of the environment.

Key words: Environmental quality, intension survey method, market value method, the blue-green algae event in Taihu Lak

INTRODUCTION

In recent 10 years, there have been numerous water pollution events in the world: Hydrargyrism event of Japan in 1850, cadmium poisoning event of Japan in 1955, chemical plant event of Switzerland in 1986, gold ore event of Rumania in 2000 etc. These events have caused great losses to life and assets of the affected residents. Water pollution events also emerge endlessly in China: The great water pollution event of Tuojiang River, water pollution event of the intake of Yellow River in Puyang of Henan, the great water pollution event of Songhua River and water pollution event of Shuyang of Jiangsu. Moreover, water pollution of Chinese famous freshwater lakes like Dian Lake, Chaohu Lake and Taihu Lake is becoming more and more severe and the water quality is getting worse and worse.

These water pollution events have brought about intense social impact to local people. Especially the Blue-Green Algae Event in Taihu Lake breaking out in 2007 has not only caused great economic losses to Wuxi City, but also destroyed the ecological environment to a large extent. Moreover, it has also resulted in extensive and far-reaching social impact, covering influences on life quality, physical health, mental health, employment and social harmony of residents in Wuxi City. Of course, it can also promote environmental awareness of public service and residents. The Blue-Green Algae Event in Taihu Lake has a wide influence on the society and it is quite complicated, so it's hard to reflect its complete social impact. This study mainly studied effects of the Blue-Green Algae Event in Taihu Lake on environmental quality of Wuxi. It's a hot issue and difficult problem in accounting field to evaluate these effects, especially to measure the impact degree of the Blue-Green Algae Event in Taihu Lake via unified monetary quantitative method. Therefore, on the basis of cost-benefit analysis on effects of the Blue-Green Algae Event in Taihu Lake on the environment, this study discussed the quantitative method of analyzing effects of the Blue-Green Algae Event in Taihu Lake on the environment. Besides, a quantitative model was established. Finally it carried out monetary quantification for effects of the Blue-Green Algae Event in Taihu Lake on the environment according to relevant data.

COST-BENEFIT ANALYSIS ON EFFECTS OF THE BLUE-GREEN ALGAE EVENT IN TAIHU LAKE ON THE ENVIRONMENT

It is a strategic mission of medium-term and long-term plans in development of Chinese national economy and

Corresponding Author: Sun Fuhua, Business School, Hohai University, Nanjing, Jiangsu, China

society to construct a resource-saving and environment-friendly society. As for what is environment-friendly society, there is still no agreement in the academic circle. PAN Yue from State Environmental Protection Administration gave a relatively specific definition, "Environment-friendly society is a social form devoted to harmony between human and nature as well as human and human. It sets carrying capacity of environmental resources as the foundation, natural law as the principle and sustainable social, economic and cultural policies as the means. In terms of China, the fundamental objective of environment-friendly society is to establish a production system of low consumption, a life system of moderate consumption, a resource and environment system of continuous circulation, a stable and efficient economic system, a technical system of continuous innovation, an open and orderly trade finance system, a distribution system that values social equity and a liberal and progressive system of socialist democracy (Li, 2003).

Breakout of the Blue-Green Algae Event is undoubtedly a disharmonious note on the construction way of an environment-friendly society in China. It has an extremely abominable impact on Taihu Lake water environment. More and more people have realized the severity and urgency of water environment pollution in Taihu Lake. Meanwhile, it is also a rare chance to treat the water environment of Taihu Lake. As a result, breakout of the Blue-Green Algae Event has both advantages and disadvantages for the environment.

LOSSES OF THE ENVIRONMENT CAUSED BY THE BLUE-GREEN ALGAE EVENT

- Breakout of the Blue-Green Algae Event has increased cost of treating the water environment of Taihu Lake. Large-scale breakout of the Blue-Green Algae Event has caused degradation of Taihu Lake water environment. On the one hand, the government of Wuxi City organized experts to study deodorization for tap water; on the other hand, it organized people to refloat blue-green algae and later increased investment in treating blue-green algae. Therefore, breakout of the Blue-Green Algae Event has increased difficulty of treating the Blue-Green Algae in Taihu Lake and promoted input of labor, property and goods
- It has caused losses to the living environment of residents. Blue-green algae broke out and died in a large scale, which has caused water stink. This has not only influenced drinking water, but also threatened the living environment of residents. Thus the living environment deteriorated, the subjective satisfaction of residents has been inevitably reduced and then the life quality of residents has also been affected
- It has caused losses to real estate value. Environment is an important factor of affecting real estate value. The Blue-Green Algae Event has made common people query the environment of communities facing the lake, thus turnover of communities facing the lake has decreased. Therefore, in the short run, owing to the Blue-Green Algae Event, sales volume and market value of communities facing the lake has reduced. This is the loss caused by the Blue-Green Algae Event to real estate along the lake.

ENVIRONMENTAL BENEFIT OF THE BLUE-GREEN ALGAE EVENT

With increasing severity of environmental problems, the government has invested more and more in prevention and treatment of water environment. The expenditure item of environmental protection was brought into financial budget of the state in 2006. At the 6th National Conference on Environmental Protection, Premier Wen Jiabao put forward that investment in environmental protection should be further increased; he emphasized that investment in environmental protection should be treated as the key point of public financial expenditure, finance at different levels should adjust the expenditure structure, support for environmental protection should be increased and the increase range of investment in environmental protection should be higher than economic growth rate (Pan, 2006). On 31 Dec. 2010, the State Council of CPC Central Committee issued a decision about accelerating reform and development of water conservancy. It pointed out, "Investment should be increased in water conservancy from public finance. Funds can be raised from multiple channels and we should try to increase the annual average investment in water conservancy by 2 times in the next 10 years when compared with 2010 (Wen, 2006).

Breakout of the Blue-Green Algae Event has aroused attention from all sectors of society to treatment of Taihu Lake water environment. Therefore, it has provided a rare opportunity to treat water environment and develop green industry. However, treatment of Taihu Lake water environment is a long-term project, so unremitting endeavor is required to improve Taihu Lake water quality and eradicate blue-green algae. As a result, it is also a long-term process to reflect environmental benefits like improvement of water environment, development of green industry and increase of real estate development value which are produced by water environment treatment.

MONETARY QUANTIFICATION FOR EFFECTS OF THE BLUE-GREEN ALGAE EVENT IN TAIHU LAKE ON THE ENVIRONMENT

Quantitative method analysis

Method 1: Intrinsic real estate value method: Intrinsic real estate value method is a value assessment method to judge the quantity of value endowed by people with the environment according to the price of real estate commodity with environmental attributes. Real estate commodity possesses multiple properties and its price reflects people's comprehensive assessment for all its properties, covering the local environmental quality.

Price of real estate can not only reflect properties of the real estate but also show location conditions and supporting facilities of the area where the real estate is located. Besides, it can also reflect environmental quality around the real estate. When other conditions are the same, difference of environmental quality will affect willingness to pay of consumers, thus price of the real estate will be influenced. Therefore, when other conditions are the same, price variance of similar real estates caused by the difference of environmental quality can be used to measure the monetary value of environmental quality change.

However, application of intrinsic real estate value method has to find contrast communities with internal and external conditions like supporting facilities, location conditions and building quality that are similar to the target community, or there will be a lack of comparability. There are multiple differences among communities, so it is extremely difficult to find two similar communities. This study won't adopt this method.

Method 2: Intension survey method: Intension survey method is one of the most important methods in ecological and environmental economics and is also the method with the most extensive application in estimation for the value of public goods. It is typical value assessment method to declare preference. On the simulative market, by adopting the principle of utility maximization, it directly investigates or enquires people's Willingness to Pay (WTP) for improvement of a certain environmental benefit or resource protection measurement, or people's Willingness to Accept (WTA) for loss of environmental or resource quality. Therefore, the economic value for improvement of environmental benefit or loss of environmental quality can be estimated according to people's WTP or WTA (Zhang, 2008).

This study adopted intension survey method mainly to investigate WTP for improvement of water environment among influenced people in Wuxi City through questionnaire design. According to data acquired in the survey, losses of residents caused by the Blue-Green Algae Event in Taihu Lake could be evaluated.

Method 3: Combination of market value method with Delphi method and level analysis method: Market value method (also known as production effect method or changes in productivity approach) holds that environmental change will affect output, cost and profit of producers through the production process. Meanwhile, it can be measured through supply of consumer goods and price change according to the market value. Market value method is to measure the economic effect of environmental quality change through the change of product output and profit caused by change of environmental quality (Xu and Zhao, 2007).

In this study, market value method was used to determine effects of the Blue-Green Algae Event in Taihu Lake on the real estate value by comparing prices of real estate markets before and after the Blue-Green Algae Event in Taihu Lake and deducting benefits caused by other influencing factors. There were numerous influencing factors of real estate value, so Delphi method and level analysis method were also adopted to determine the proportion of Taihu Lake water environment among all influencing factors of real estate value: firstly, Delphi method was used to determine relative importance among indexes and then after consistency check, level analysis method was adopted to get the weight of various influencing factors.

Quantitative thought and model

Method 1: Intension survey method: Through intension survey method, WTP per capita for improvement of water environment among people in Wuxi City could be gained; then according to number of people who have been under the influence of the Blue-Green Algae Event in Taihu Lake in Wuxi City, the following formula could be obtained:

$$R_s = Ws*n \quad (1)$$

where, R_s is loss caused by the Blue-Green Algae Event in Taihu Lake to water environment under intension survey method, ws is WTA per capita n is the number of people who have been under the influence of the Blue-Green Algae Event in Taihu Lake in Wuxi City.

Method 2: Combination of market value method with Delphi method and level analysis method: Generally speaking, before and after environmental treatment, there will be a great change as for land value or real estate value. Occurrence of the Blue-Green Algae Event in Taihu Lake has caused deterioration of water environment along the lake and also affected price of real estate beside the lake. According to fluctuation of real estate price before and after the Blue-Green Algae Event in Taihu Lake, by obtaining the weight of Taihu Lake water environment in all factors that influence real estate value at this stage, the following formula could be gained:

$$H = \alpha (P-P_0)S \quad (2)$$

where, H is the effect of the Blue-Green Algae Event in Taihu Lake on the surrounding real estate value, P means the real estate value at a certain stage after the Blue-Green Algae Event in Taihu Lake happened, P_0 indicates the real estate value when there is no the Blue-Green Algae Event in Taihu Lake, S signifies the area of real estate development, α refers to the weight of Taihu Lake water environment gained via analysis on multiple factors that influence real estate development.

Note: Such calculation method is aimed at measurement for long-term impact of the Blue-Green Algae Event in Taihu Lake on the water environment. In another word, the measurement part is the fluctuation of real estate value after improvement of Taihu Lake water environment promoted by the Blue-Green Algae Event in Taihu Lake. However, treatment and improvement for Taihu Lake water environment is a long-term project and the effect cannot be reflected in a short term. Besides, increase of real estate value is under the influence of multiple factors and improvement of water environment only plays a small role in it. This report will not consider the long-term benefit of the Blue-Green Algae Event in Taihu Lake on improvement of water environment. Instead, it used market value method to measure the effect of the Blue-Green Algae Event in Taihu Lake on real estate value.

Determination of relevant data

Method 1: Intension survey method: Intension survey method was adopted. According to setting of the questionnaire, the subject was set as "How much will you spend on improvement of water environment each year?" Thus money that residents are willing to spend on improvement of water environment can be determined. Survey results of the questionnaire are presented in Table 1.

Table 1: Survey results about WTP for improvement of water environment

Option	Frequency	Proportion	Accumulative proportion of options
Unfilled	84	11.0	11.0
Below 50 Yuan	197	25.7	36.7
50~100 Yuan	145	18.9	55.4
100~150 Yuan	143	18.7	74.0
150~200 Yuan	93	12.1	86.2
Above 200 Yuan	104	13.6	100.0
Total amount	766	100.0	

Eight hundred questionnaires were issued at this time and there were 766 effective questionnaires. The following two points should be clarified before calculation: Firstly, the group involved in the questionnaire should be consistent with the group of Wuxi City in distribution rate of different industries. It should accord with occupation distribution situation of people in Wuxi and proportion of people with middle and lower incomes could be slightly higher in the survey. Therefore, WTP amount gained through the questionnaire survey could almost reflect WTP of residents at different classes for improvement of water environment. Secondly, treatment aimed at survey options: For conservative calculations, the mid-value of each option was selected as WTP of residents for water environment. In another word, as for the option of "below 50 Yuan", the payment amount should be set as 25 Yuan; for "50-100 Yuan", 75 Yuan was set as the payment amount; for "100-150 Yuan", 125 Yuan was set as the payment amount; for "150-200 Yuan", 175 Yuan was set as the payment amount; for "above 200 Yuan", 250 Yuan was set as the payment amount. In terms of unfilled questionnaires, repayment amount of the questionnaire was treated as 0.

According to the above analysis and results of 766 questionnaires, WTP of the investigated residents for improvement of water environment is 75,950 Yuan, 99.15 Yuan per capita.

Method 2: Market value method: Market value method was used to calculate the short-term impact of the Blue-Green Algae Event in Taihu Lake on the real estate market along the lake in Wuxi. Breakout of the Blue-Green Algae Event has caused some influences on real estate market in Wuxi. Therefore, Weekly Report of Wuxi City issued an article named Effects of the Blue-Green Algae Event in Taihu Lake on Real Estate beside the Lake on 14 Jun 2007. It pointed out that within one week after the Blue-Green Algae Event broke out (5/6/2007-11/6/2007), sales volume on real estate market in Wuxi dropped on the whole while the price increased; common residential market requirement fell after rise and meanwhile turnover of villas fell to 8 sets and the area reduced to 2,763.91 m^{-2}, decreasing by 6 sets

and 1,965.57 m^{-2}, respectively. Insiders considered that the reason of such phenomenon was that "under the influence of the blue-green algae in Taihu Lake, people hold wait-and-see attitude toward villas beside the lake".

Occurrence of the Blue-Green Algae Event in Taihu Lake was bound to affect the real estate market of Wuxi City. However, common residence is rigid demand for people, so it would not undergo severe influence of the Blue-Green Algae Event. The high grade villa communities along the lake are developed in order to appreciate the lake scenery and get close to nature. As a result, the Blue-Green Algae Event would inevitably affect images of villa communities, thus the turnover would be influenced.

Based on this, by combining with various factors that affect real estate market like market requirement and consumer preference, 80% of 1,965.57 m^{-2}, the decreased transaction area of villas along the lake-1,572.46 m^2 was set as the adverse effect of the Blue-Green Algae Event in Taihu Lake on real estate market in Wuxi. Meanwhile, the average price 11,391.9 Yuan m^{-2} during the current week (5/6/2007-11/6/2007) was treated as the unit price.

RESULTS AND ANALYSIS

Method 1: Intension survey method: According to the conservative estimation, there are 2,394,900 people who have experienced the influence of the Blue-Green Algae Event in Taihu Lake in Wuxi. By combining with the survey, WTP per capita for improvement of water environment is 99.15 Yuan and WTP of residents in Wuxi for improvement of water environment is 237, 457, 774.15 Yuan. That is to say, the Blue-Green Algae Event in Taihu Lake has caused the loss of 237,000,000 Yuan to the living water environment of residents.

Method 2: Market value method: According to the above analysis, the loss of real estate market in Wuxi City caused by the Blue-Green Algae Event in Taihu Lake is 17, 913, 261.51 Yuan that is 18 million Yuan.

Analysis on results: Intension survey method lays particular stress on WTP of residents for improvement of water environment that is rehabilitation expense paid by residents to improve the nasty water environment. This is cost brought about by the Blue-Green Algae Event in Taihu Lake to residents. Market value method reflects the economic losses caused by the fact that residents deny Taihu Lake water environment. However, such losses are temporary. They will reduce after the Blue-Green Algae Event calms down and the environment gets better. Therefore, this study set WTP of residents for improvement of water environment as the loss caused by the Blue-Green Algae Event in Taihu Lake to the environment, which is 237 million Yuan.

CONCLUSION

Effects of the Blue-Green Algae Event on the environment have both advantages and disadvantages. In the short term, the Blue-Green Algae Event has caused some losses to the local environment. With the advance of industrial process, water pollution is becoming more and more severe and water environment problems are more and more prominent. Social problems caused by this have gained more and more attention from people. Meanwhile, measurement for social impact caused by water pollution events is bound to draw attention from the accounting field. Moreover, it has been widely applied to fields like urban planning, engineering construction and environmental treatment. Besides, it can provide references for readjustment of local industrial structure, repair and improvement of ecological environment, compensation of social environment influence, readjustment of industrial development layout and long-term planning and treatment of the environment.

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