Research Article
Evaluation of Water Resources Ecological Service Function based on Agricultural Food Perspective

[1]Li Yang and [2]Chun Fu
[1]Department of Mathematics,
[2]Center for Central China Economic Development Research, Nanchang University, Nanchang, Jiangxi 330031, China

Abstract: Water resource is the material basis of human survival that closely linked with human living and production activities and is one of the most important factor restricting the natural environment, human survival and development. In this study, we aim to explore water ecosystem service function by set up the evaluation index system, which is based on the principle of evaluation index selection and combining with the existing research involved in water ecosystem evaluation index. By using questionnaire to collect data, we make empirical analysis based on factor analysis method. According to the model as each evaluation factor scores and overall value, we analyze water resources ecological service function and find out the factors that will influence ecological function. Finally, we find out the advantages and disadvantages according to the result of model evaluation and then put forward relevant policy suggestions.

Keywords: Agricultural food, ecological service function, factor analysis, water resources

INTRODUCTION

As the essential basic natural resource for human survivals, water is closely linked with human living and production activities and is one of the most important factor restricting the natural environment, human survival and development (Li and Ning, 2012). During the long-term period of using water resources, people excessively pursuit of the social and economic benefits brought by water, but ignore protecting the stability of water ecosystem (Camille and Houeto, 2014), which results in the loss of the ecological value of water resources. Especially since from the 1970s, with the rapid economic development and population growth, socio-economic water diverted that for ecological environment, which deteriorating the worldwide aquatic ecosystems and the level of achieving the aquatic ecosystem service functions has a serious decline (Javier and Everaert, 2013). So, to understand clearly and carry out a scientific evaluation of the water ecological service function, is great significant to solve the contradiction between the aquatic ecosystem and human needs. As an important part of the aquatic ecosystem, river ecosystem supplies the basic resources and power protection for the progress of human civilization and the development of social economy (Liedloff and Woodward, 2013). It has a pivotal affection for the sustainable development of society that if the river ecosystem can supply sustainable service.

So, from the perspective of regional sustainable development, it is extremely significant to study the river ecosystem service functions.

The source of ecological value is the function of ecosystem service; ecological system provides the power and source for the civilization of the human society and economic development, to meet the material and spiritual needs of human beings, which is also a reflection of the value of ecological system. Most scholars' research on the ecological value from the perspective of philosophy, some believe that the ecological value is a reflection of human sensibility and moral aspects of things are the natural concern (Richard and Elizabeth, 2013). Intrinsic value without transferring any person to the natural environment, that is, human centered theory and some think that the natural environment system itself has value objectively, not rely on people will exist. There is also theory given by human interaction with humans (Crystele and Duvail, 2013), because the resulting values, namely the natural center theory. From the point view of economics, the value of the resources and the environment on the scarcity is useful to them and improve the social welfare in the role. From a sociological point of view, ecological value is a historical category and is the product of society. With the change of social and economic development, its connotation and extension will be changing.

Corresponding Author: Chun Fu, Center for Central China Economic Development Research of Nanchang University, Nanchang, Jiangxi 330031, China

Ecological value is the source of ecosystem service function of ecological system for human society civilization and economic development has provided the source and the power, in order to satisfy the demands of human material and spiritual, which is the value of the ecosystem (Vijay and Adamowski, 2014). About the connotation of ecological value, scholars at home and abroad, respectively from the perspective of philosophy, economics and sociology Angle on the interpretation. From scholars of ecological value philosophy angle (Zhou, 2013; Ning and Li, 2013), some think ecological value reflects people's perceptual desire and moral level, is a concern for nature, without giving anyone's intrinsic value to the natural environment, namely anthropocentrism, also some think natural environment system itself has the objective value (Li, 2014; Qing and Li, 2014) and it does not depend on the will of people. There are also given by the human, with human interaction to generate the value of the natural dilemma (Zhang and Chen, 2013; Li and Zhou, 2011). From the perspective of economics, the resources and the environment depends on the value of their scarcity and usefulness, as well as the role in improving social welfare. From the point of view of sociology, ecological value is a historical category, is the product of society, along with the change of social economic development, environmental condition, its connotation and denotation constantly changing. Ecological awareness refers to the public as that is associated with the ecosystem of ecosystem services provided by the level of recognition and judgment (Daniel, 2015; Chen and Zhou, 2013). The public as a water ecological service function of the receiver, as the immediate beneficiaries of ecological value, but also cause the negative effects of ecological value for the night. Ecosystem services influence each other between human well-being, ecosystem services function directly affects the human welfare, at the same time, human well-being Yi one by changing their strength of environmental resources consumption, thus influence the realization of ecological service function. Zhang and Lu (2014) pointed out different types of water ecological service function that caused public concern and perception of the same kind of service function also is not the same, Crystele and Duvail (2013) pointed out that women in an important position in water ecosystem service functions accept, their many daily activities directly reflect and influence the supply of water resources, management and protection. Therefore, from the perspective of public decision-making, studies the evaluation of ecosystem service functions, the tradeoff for multiple service functions and service functions of superior conservation selection problem, which has high reference value.

Literatures in river ecological service function evaluation mainly focused on two aspects. One is the selection of evaluation index; the second is the choice of evaluation method. In the context of existing research results, has not yet formed a unified evaluation index system and evaluation method of effective. Market value is through product market prices and output to estimate, advantage is strong objectivity; Opportunity cost method is no market for the prices, the cost of resources used by the sacrifice of the alternative use of income to estimate, the advantage is easy to operate, simple calculation; Cost recovery and protection method, in order to prevent the deterioration of ecosystem, to restore damaged ecosystems and the cost of produce, advantage is that data is easy to obtain, defect is low evaluation effect. For river ecosystem service function value assessment, scholars have conducted a lot of index selection and method to try. The same kind of river ecosystem service functions, according to the different assessment method of the result is different. No matter what kind of method will be affected by subjective and objective factors, unavoidably cause function between repeat winners to ignore.

In this study, we aim to explore the perspective of food safety water ecosystem service function evaluation system of the build process. Based on the principle of evaluation index selection, combining with the existing research involved in water ecosystem service function value evaluation index, set up the evaluation index system of ecological service function of public and by way of questionnaire to collect data and then, using factor analysis method to deal with the evaluation index, the corresponding evaluation model is constructed. According to the model of each evaluation factor scores and overall value and analysis of water resources ecological service function of the public satisfaction evaluation level, regional function is analyzed on the implementation status. Finally, according to the result of model evaluation and find out the regional ecological service function condition to realize the advantages and disadvantages and then to improve the water quality.

QUESTIONAIRE AND MODEL DESIGE

Questionnaire survey: Questionnaire survey is a method which has been widely applied in the discipline of sociology, suitable to understand people's opinions, attitudes and behavior, through in-depth field investigation and a large number of first-hand information (Zhang and Chen, 2012). In this study, we collect data from residents and non residents along the river. Among them, the residents along the river refers to place where residence living near the river within 1 km; non residents along the river can be divided into river management, residents living near the river who engage in productive activities, often come to the river to play and the occasional tourists. We collected data from Nanchang city by recycling of 190 valid questionnaires, mastered the truest, the most abundant statistic data. Also, we recycle questionnaire and make data analysis effectively. At the same time, we take the depth interview method. Depth interview is through the verbal communication with respondents and the

Table 1: Variables and symbolic hypothesis

Variables	Secondary variables	Variable description	Symbolic hypothesis
Product function α1	Water flow indicator X1	Perception for change of river water flow	++
	Number of fish X2	Perception for the changes of fish total quantity	+ or −
	Fish varieties X3	Perception for fish species diversity	+
Environmental function α2	Water quality X4	The current conditions of river water quality	++
	VegetationX5	The status of grass and tree near river	+
	The river of garbage X6	The status of the river of garbage	++
Entertainment function α3	Landscape X7	River landscape is beautiful or not	+
	The distanceX8	The distance from the river resident	++
	SuitabilityX9	Suitability for leisure entertainment	+
Cultural and educational function α4	Environmental protection X10	Environmental protection status	++
	History X11	Lake related historic or cultural attractions	+
	CultureX12	Consciousness of protection of water resources	+

"++" means the strong positive influence; "+" means positive influence; "–" means negative influence

collected according to the respondents answer without personal bias, objective, authentic materials, is a small number of samples and view and accurately express the sample represents a way of overall. In order to understand the questionnaire can not thoroughly the problems and reasons.

In order to improve the questionnaire as simple and effective, we will release a part of the pretest questionnaire, through the screening of the results to determine the final items. Finally, we will release a lot of formal questionnaire and collect data, then make reliability test, validity test, correlation analysis and regression analysis by using SPSS software. In this study we construct four variables as: product, environment, entertainment, cultural and educational function. All variables were shown in Table 1.

Model design: For the sake of convenience, assume that the standardization of treatment received data matrix is denoted by X. Its correlation matrix R and the covariance matrix S is exactly the same. Then the correlation matrix can be expressed as:

$$R = X \cdot X' \tag{1}$$

R characteristic equation of a matrix is |R-λ|, assuming that their p eigenvalues satisfy the following relations: λ1>λ2>…>λip≧0, the eigenvectors corresponding is U1, U2,…, Up and each feature vector as a column vector of matrix:

$$U = [U_1, U_2, \cdots, U_p] = \begin{bmatrix} U_{11} & U_{12} & \cdots & U_{1n} \\ U_{21} & U_{22} & \cdots & U_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ U_{p1} & U_{p2} & \cdots & U_{pn} \end{bmatrix} \tag{2}$$

Let F = U'X, then the above formula becomes:

$$FF' = \Lambda = \begin{bmatrix} \lambda_{11} & & & 0 \\ & \lambda_{22} & & \\ & & \ddots & \\ 0 & & & \lambda_{pn} \end{bmatrix} \tag{3}$$

After the simplification, we obtain:

$$F = [U'x_1, U'x_2, \cdots, U'x_n] \tag{4}$$

The Fa = U'Xa (α = 1, 2, …, n) and every Fa can be considered as sample observation value of main factor, which can be written as:

$$F_a = [f_{1a}, f_{2a}, \cdots, f_{pa}] \tag{5}$$

In the factor analysis, we usually only use the m (m<P) as main factor, namely according to variables that are associated with the selected first factor $f1$. After selected M, we divide U matrix into two parts. Because Fa = U'Xa, then we can get Xa = Ufa:

$$X_a = [U_1, \cdots, U_m, U_{m+1}, \cdots, U_p] \cdot \begin{bmatrix} f_{1a} \\ \vdots \\ f_{pa} \end{bmatrix} \tag{6}$$

One of the coefficient matrix of main factors is U(1), which is called the loading matrix of factors. Due to the characteristics of vector Ui, it is typically representation by unit vector, so it needs to be normalized, i.e.:

$$a_{ij} = U_{ij}\sqrt{\lambda_i} \tag{7}$$

Therefore, the factor loading matrix can be shown as:

$$A = (a_{ij}) = \begin{bmatrix} U_{11}\sqrt{\lambda_1} & U_{12}\sqrt{\lambda_2} & \cdots & U_{1m}\sqrt{\lambda_m} \\ U_{21}\sqrt{\lambda_1} & U_{22}\sqrt{\lambda_2} & \cdots & U_{1m}\sqrt{\lambda_m} \\ \vdots & \vdots & \vdots & \vdots \\ U_{p1}\sqrt{\lambda_1} & U_{p2}\sqrt{\lambda_2} & \cdots & U_{pm}\sqrt{\lambda_m} \end{bmatrix} \tag{8}$$

RESULTS AND DISCUSSION

By analyzing the existing literature, draw lessons from the existent research and analysis in the study of inadequacy, design the research framework, research hypothesis and research method is put forward. Using the statistical software SPSS to analyze recycling questionnaire data, specific include: through descriptive

analysis and ordinal regression analysis to explore the influencing factors of food consumption; Through the analysis of the reliability and validity to ensure the quality of scale; Through correlation analysis, multiple regression analysis and path analysis to explore the influencing factors of water resources ecological service function.

Data sources and sample: This study taking 2014 (6-9 months) as the survey time period, whether residents along the river or not participated in the study. The author choose Nanchang city of Jiangxi province as the main sampling area to most residents, as the investigation object, a population is more concentrated large residential areas along the river, the river management office and mainly river visitor center for the survey locations, by field questionnaire survey, 600 questionnaires were distributed, recovery of 577 copies, out no answer or reply invalid questionnaire 38 is not correct, effective questionnaire 539, effective questionnaire rate was 89.8%.

Statistical analysis of questionnaires' basic characteristic: From the survey of the residents in the whole, the average sense, the participation of residents age trend was younger (average age 37.21 years), with

Table 2: Statistical analysis of collected data

Personal characteristics	Minimum	Maximum	Average	S.D.
Years of schooling	12	22	17.52	18.253
Age	14	68	37.21	56.502
Gender	0	1	0.44	1.426

In the gender calculation; male = 1; female = 0; Min.: Minimum; Max.: Maximum; Avg.: Average; S.D.: Standard deviation

Table 3: Reliability analysis

Factor	Evaluation index	Corrected item-total correlation	Cronbach's Alpha if item deleted	Cronbach 's Alpha
$\alpha 1$	X1	0.7531	0.8428	0.9014
	X2	0.8486	0.8567	
	X3	0.7614	0.8206	
$\alpha 2$	X4	0.6853	0.7018	0.8627
	X5	0.7218	0.7846	
	X6	0.6932	0.7128	
$\alpha 3$	X7	0.7644	0.8124	0.8315
	X8	0.7856	0.8215	
	X9	0.7315	0.7864	
$\alpha 4$	X10	0.7845	0.8552	0.8139
	X11	0.7923	0.8204	
	X12	0.7302	0.8032	

Table 4: Second-order confirmatory factor analysis

Relationship	Un-standardized estimates	S.E.	t	Standardized estimates
$\alpha 1 \rightarrow X1$	1.503	0.112	9.761	0.87
$\alpha 1 \rightarrow X2$	1.461	0.095	15.261	0.89
$\alpha 1 \rightarrow X3$	1.125	0.087	12.596	0.82
$\alpha 1 \rightarrow X4$	1.263	0.106	11.215	0.76
$\alpha 2 \rightarrow X5$	1.088	0.097	10.157	0.75
$\alpha 2 \rightarrow X6$	1.056	0.105	9.674	0.80
$\alpha 2 \rightarrow X7$	1.012	0.113	9.562	0.78
$\alpha 3 \rightarrow X8$	0.956	0.102	9.145	0.76
$\alpha 3 \rightarrow X9$	1.307	0.115	10.281	0.76
$\alpha 3 \rightarrow X10$	1.521	0.156	9.762	0.82
$\alpha 4 \rightarrow X11$	1.258	0.114	11.234	0.88
$\alpha 4 \rightarrow X12$	1.204	0.115	9.836	0.79

S.E.: Standard error

Table 5: Result of Convergent validity test

Latent variable	Factors	R2	Composite reliability	Average variance extracted
Product function $\alpha 1$	X1	0.87	0.823	0.634
	X2	0.75		
	X3	0.65		
Environmental function $\alpha 2$	X4	0.74	0.848	0.726
	X5	0.63		
	X6	0.70		
Entertainment function $\alpha 3$	X7	0.86	0.879	0.683
	X8	0.51		
	X9	0.72		
Cultural function $\alpha 4$	X10	0.67	0.764	0.622
	X11	0.79		
	X12	0.65		

Table 6: The results of regression model

Model		Non-Standardized Coef.		Std. Coef.		
		B	Std. Err.	β	t	Sig.
α1	Constant	2.104	0.423		5.206	0
	Product function	0.549	0.142	0.518	7.425	0
α2	Constant	0.835	0.947		2.829	0.022
	Environmental function	0.674	1.321	-0.005	1.426	0.314
α3	Constant	-1.023	0.672		1.508	0.152
	Entertainment function	0.642	0.136	0.473	6.142	0
α4	Constant	0.673	0.713		-0.820	0.208
	Cultural function	0.361	0.148	0.251	2.325	0.031

S.E.: Standard error

higher years of schooling (average 17.52 years), disposable gender more abundant (0.44), as shown in Table 2.

Reliability analysis: In order to guarantee the questionnaire has high reliability and validity, before the formation of a formal questionnaire, he shall make test for the questionnaire and the test results are reliability and validity analysis, according to the results of screening questionnaire item, adjust the structure of the questionnaire, so as to improve the reliability and validity of the questionnaire. Cronbach alpha reliability coefficient is by far the most commonly used reliability coefficient, total table of reliability coefficient over 0.8, the best acceptable between 0.7 to 0.8; Subscales of reliability coefficient over 0.7, the best 0.6 0.7 was acceptable. Cronbach's alpha coefficient if below 0.6 will consider making questionnaire. The result of Validity analysis was shown in Table 3. From the Table 3; we can know that the reliability of the data can be acceptable.

Second-order confirmatory factor analysis: Confirmatory factor analysis is a statistical analysis of the social survey data. It tests a factor and the relationship between a corresponding measure is in line with the theory design by researchers The correlation degree is high between these factors and then we make second-order confirmatory factor analysis by using SPSS software, the result was shown in Table 4.

Convergent validity inspection: Construct validity is divided into two kinds: convergent validity and the difference between validity. Convergent validity is refers to the concept of project, in the same high correlation between each other. Validity refers to the difference between different concepts in the project, low correlation with each other. Confirmatory factor analysis can test the main measurement model of latent variable by using convergent validity or discriminate validity. Three scale for the three measurement model for convergent validity test, the standardization of the first step to investigate each latent variable factor loading coefficient, load value should be >0.5, this means that the multi-item with common variance between latent variables is greater than the multi-item and error variance between common variance, are significant; The second step is to investigate the AVE

values. AVE values should be >0.5, which means that each factor can be extracted by explain more than 50% of the variance. Then we convergent validity test, as shown in Table 5.

Regression analysis: Then we make regression analysis of all variables, as Table 6. From the result, we can get that: first, environmental function is the most important factor to water resources ecological service function, the correlation between environmental function and ecological service function is 0.674, which means environmental function has significant positive influence to ecological service function. Second, entertainment function is the second important factor to ecological service function, the correlation relationship between entertainment and ecological service function is 0.642 and the constant is -1.023, which means that when the entertainment advantage is not obvious, residents will not be satisfied with ecological service function. Third, product function and cultural function are also important factor to ecological service function, the correlation between product function and ecological service is 0.549 and the correlation between cultural function and ecological service is 0.361, it means that the water flow indicator and fish varieties are important indicators, but ecological service function also decided by culture and education.

CONCLUSION

This study take the public factor analysis method to build evaluation system of river ecosystem service function, can on regional river service function realization condition for effective evaluation analysis. By extracting the functional evaluation, the river ecosystem service functions into the product function, environmental function, entertainment function and cultural function of education and each factor is composed of several function indicators, on the whole and single aspects of stream function of the realization of the situation can be evaluated. Modern research proves that the ecological service function is the foundation of human survival and modern civilization, science and technology can influence the ecological service function, but not a substitute for the natural ecosystem service function, ecological service function is the foundation of sustainable development. Water

ecological service function, a kind of important ecosystem service function, it provides the human life and production activities of the indispensable basic resources and motivation. Water ecological service function can be divided into product, function, cultural function and life support four categories, such as water is the carrier of ecological service function of water ecosystem, such as rivers, lakes, wetlands, the service object is human, the main function is the social and economic services.

According to the evaluation of various river service function score and the total value of the service function of regional level, combined with the characteristics of public service groups present and in the valley, we put forward the related proposal. First is protecting the water resources supply, the way to protect the river basin water resources supply two: increase the supply of water resources, reduce waste of water resources. In the first, reduce waste of water resources, to increase the propaganda and the importance and urgency of protecting water resources, strengthen water saving consciousness of the public, reduce water waste:; secondly, starting from the larger part of industrial and agricultural water demand in the proportion of the two, to encourage the development of water saving engineering and technology enterprise, moderately reduce the high consumption water companies and promote the development of farmland irrigation, spray irrigation and other uses high-tech means; thirdly, make full use of market mechanism, improve the various types of water prices, to reduce the waste of water resources. Second is protection of biological diversity; at present, the river level of biodiversity decline, the main factors affecting the rivers of biodiversity is water and river governance. River in addition to meet irrigation, flood control, water storage, service demand, but also will protect the biological survival environment as the focus. first, do a good job protection measures for river engineering projects have been built, prolong the service life; secondly, to maintain sustainable development of river organisms; at the same time, consider the use of non polluting materials for channel maintenance, finally, to ban public fishing fish, river pollution behavior.

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REFERENCES

Camille, B. and P. Houeto, 2014. Ecological risk assessment of the presence of pharmaceutical residues in a French national water survey. Regulatory Toxicol. Pharmacol., 69: 296-303.

Crystele, L. and S. Duvail, 2013. Floods and livelihoods: The impact of changing water resources on wetland agro-ecological production systems in the Tana River Delta, Kenya. Global Environ. Change, 23: 252-263.

Chen, Q. and L. Zhou, 2013. Efficiency of finance development on improving technological innovation: Interactions with carbon markets. J. Appl. Sci., 13(24): 5700-5707.

Daniel, Hering, L. Carvalho, C. Argillier, M. Beklioglu, A. Borja and *et al.*, 2015. Managing aquatic ecosystems and water resources under multiple stress-An introduction to the MARS project. Sci. Total Environ., 503:10-21.

Javier, E.H. and G. Everaert, 2013. Development and application of an integrated ecological modelling framework to analyze the impact of wastewater discharges on the ecological water quality of rivers. Environ. Modell. Software, 48: 27-36.

Liedloff, A.C. and E. Woodward, 2013. Integrating indigenous ecological and scientific hydro-geological knowledge using a Bayesian Network in the context of water resource development. J. Hydrol., 499: 177-187.

Li, Z., 2014. Energy efficiency and investments in low-carbon economy: The impact of carbon finance on sustainability development. J. Chem. Pharmaceutical Res., 6(5): 1255-1261.

Li, Z. and L. Zhou, 2011. Water resource's ecological counter accusation towards Garden City. Procedia Environ. Sci., 10: 2518-2524.

Li, Z. and Z. Ning, 2012. Research on liquidity risk and financial fragility of Chinese commercial banks. Adv. Inform. Sci. Serv. Sci., 4(22):787-793.

Ning, Z. and Z. Li, 2013. Principal component model for comparative evaluation of e-learning system: An empirical investigation. Int. J. Appl. Mathe. Statistics, 42(12): 330-336.

Qing, C. and Z. Li, 2014. Evaluation of E-commerce performance in SMES based on vector auto regression model. Int. J. u- and e- Serv. Sci. Technol.,7(5): 151-160.

Richard, R. and A. Elizabeth, 2013. Generalizing ecological, water and carbon footprint methods and their worldview assumptions using embedded resource accounting. Water Resour. Ind., 1: 77-90.

Vijay, K. and J. Adamowski, 2014. Recasting payments for ecosystem services (PES) in water resource management: A novel institutional approach. Ecosyst. Serv., 10: 144-154.

Zhang, N. and C. Chen, 2013. Value-at-risk modelling for risk management of RMB exchange rate. Int. J. Appl. Mathe. Statistics, 43: 297-304.

Zhou, L., 2013.Optimal compensation rate appraisal and selection based on data mining method. Int. J. Appl. Mathe. Statistic, 50(20): 37-46.

Zhang, N. and Q. Chen, 2012. Study on how financial institutions positively impact on China's Lowcarbon economy growth. Adv. Inform. Sci. Serv. Sci., 4(22): 779-786.

Zhang, Z. and W.X. Lu, 2014. Development tendency analyssis and evaluation of the water ecological carrying capacity in the Siping area of Jilin Province in China based on system dynamics and analytic hierarchy process. Ecological Modell., 275: 9-21.