Analysis of the effect of resources, environment and ecological environment synergistically affecting ecological economy based on coupling model

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Abstract. In order to study the effect analysis of resources, environment and ecological environment on ecological economy, the author proposes a method based on coupling model. Taking the relevant data of province A from 2001 to 2019 as the research basis, and screening indicators based on the response, state and driving force dimensions in the DPSIR model, construct the water environment DSR system and the economic DSR system, and obtain the comprehensive evaluation value and weight value of the system by means of the entropy weight method, the economic change and water environment assessment are briefly analyzed, and the coupling coordination degree of the two is discussed at the same time, and finally some suggestions for water environment optimization are put forward. Experimental results show that, the high-quality coupling degree of the total system cannot represent the content of the economic and water environment subsystems, and the collaborative goals, so it is necessary to conduct in-depth research on the degree of coordination. From the data in Table 4, it can be found that there is a significant difference in the degree of synergy between the two. Its synergy is in the range of 0.34799 to 0.93041, showing an upward trend year by year. It is proved that the coupled model can be used to analyze the effect of resources, environment, and ecological environment on the ecological economy.

Keywords: Coupling model; water resources ecological environment; ecological economy

1. Introduction

With the continuous and rapid development of my country's social economy, we have quietly entered the era of information big data. Various industries and fields are actively introducing big data technology to assist work to improve work efficiency, including ecological environment monitoring. The integration and application of big data technology in ecological environment monitoring work can not only conduct scientific, professional and comprehensive evaluation of various information of environmental monitoring, but also help staff effectively predict future development. With the passage of time, the big data technology in the ecological environment will be continuously improved and optimized. How to maximize the integration and application of big data technology in the coordinated impact of resources, environment and ecological environment on the ecological economy is a key research issue for relevant departments and staff [1].

The impact of human production and survival activities on water ecology makes the sustainable development of water resources ecological environment face great challenges. The current national sustainable development strategy adjusts the competitive relationship between man and nature to a "harmonious coexistence between man and water". To promote the development between the ecological environment of water resources and the regional economy, the research on the coupling and coordination of environmental and economic development in recent years has mainly focused on: Research on the connotation of environment and economic development, research on coupling relationship, empirical research on coupling and coordination relationship, research on measurement methods, etc.

There is an inevitable relationship between the ecological environment of water resources in a certain area and the social economy[2]. In order to seek sustainable development and utilization of regional water ecology and ensure the common development of water resources ecological environment and social economy, evaluate and analyze the interaction and coordinated development between social and economic development and regional water ecology, in order to protect the water resources ecological environment, by building models and other methods, evaluate ecological economy and water resources ecological environment, and study measures to promote the coordinated development of ecological economy and water resources ecological environment.

2. DPSIR model

The DPSIR model can accurately describe the causal relationship and complexity of environmental system factors. The model is mainly composed of five aspects: pressure, state, response, driving force and influence. Taking the water resources ecological environment as an example, in the DPSIR conceptual framework, these driving forces D such as population size and economic development lead to increased wastewater discharge or disturbance to the water resources ecological environment, the resulting pressure P (water demand and wastewater discharge, etc.), the pressure forces the state of the water resources ecological environment system to change S (characterized by the characteristics of the water environment and water quality parameters, etc.), changes in the ecological environment of water resources have an impact on humans or water ecosystems I, and these impacts prompt human society to make direct and indirect responses to the ecological environment of water resources R (take measures to improve and restore the environment, etc.), human society's responses act on drives, pressures, states or directly on influences to keep this feedback chain stable and balanced, adjust and improve the interaction between human society and the water resources ecological environment system, so that the water resources ecological environment system is in a safe and bearable range, and ultimately seek sustainable development between social development and the water resources ecological environment[3]. In recent years, the DPSIR model has been widely used in China's environmental management capability analysis, sustainable utilization of water resources, and ecological security assessment.

3. Evaluation indicators

3.1 Water environment indicators

Based on the DPSIR model, the DSR is constructed in combination with the water environment system, according to this indicator framework, the driving force of economic development will have a certain impact on the healthy development of the water environment, causing changes in the state of the water environment, these indicators have a direct impact on economic activity, prompting humans to optimize the water environment through responsive measures [4]. Response refers to the reflection of economic activities in the water environment, the measures taken to optimize the water environment, and the ideas for optimizing the water environment. For example, the Central Committee of the Communist Party of China put forward the requirements of the "new five modernizations", which clearly require the utilization of water resources and the utilization of water environment, which are indirect driving forces, as shown in Figure 1.

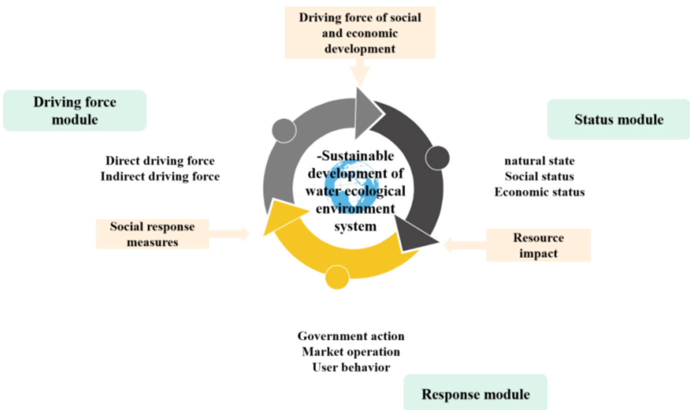

Fig 1. DSR model of water environment (Learned through a questionnaire)

3.2 Evaluation model and comprehensive evaluation index determination

(1) Matrix construction

Taking t as the research time and n as the number of indicators, the nXt matrix is constructed, for the xij set, set to X, xij is the i-th index, the j-th year data, j=1, ..., t, i=1, ... n.

(2) Index change and normalization

When conducting systematic evaluation, deal with low-quality indicators and high-quality indicators, to ensure a good trend among various indicators, it is convenient for model unification and analysis [5].

In the case where xij is positive, $y_{ij}=\frac{x_{ij}-\min_{ij}}{\max_{ij}-\min_{ij}}$, among them, yij is the contribution value of systematic research efficacy; minij is the lower limit value of each index in the xi set, and maxij is the upper limit value of each index in the xi set. For the yij set, is the efficacy matrix, set to Y. The matrix Y is processed in a normalized form, and the processing index is set as the set P. Pij is the ith index, the jth year sanitized value, and Pij $\in$ [0, 1].

(3) Calculate indicator weights

If an indicator has a greater degree of data difference, randomness, and disorder in different years in the set period, it indicates that the indicator has a greater weight in the systematic review [6]. See formula (1).

$$d_i=\frac{1-\left(-\frac{1}{\ln t}\sum_{i=1}^{t}P_{ij}\ln p_{ij}\right)}{n-\sum_{i=1}^{n}\left(-\frac{1}{\ln t}\sum_{i=1}^{t}P_{ij}\ln p_{ij}\right)} \tag{1}$$

(4) Determine the evaluation value

The comprehensive evaluation value of the index in the jth year is obtained by summing the product of the evaluation value and the corresponding weight value, which is set as G_j. As the index weight value increases, the degree of its influence on the research system will also increase, and vice versa [7].

3.3 The role of big data technology in ecological economy

Under the background of the new era, the content of ecological economy is becoming more and more complicated. It is not only necessary to fully analyze the ecological environment information index, but also to consider the relationship between the environment, society, economy, and people. negotiated governance reason. The purpose of applying big data technology in ecological economy is to save the time and energy of relevant staff, to accurately analyze a large amount of data, to have a comprehensive grasp and control of relevant data, and to make scientific predictions on the ecological environment. Develop a plan to protect the environment. Traditional technology is not only difficult to operate, but also wastes time, while big data technology can not only save time, but also make the collected data more accurate. Therefore, the effect achieved by big data technology means is unmatched by traditional technology. Big data technology can amplify different types of ecological environment pollution events, thereby helping relevant staff to formulate a series of protection strategies, thereby protecting the environment and improving the decision-making efficiency in ecological environment monitoring work. In the ecological environment monitoring work, when applying big data technology to analyze data, the data is always in a state of flow, so that the data can be better analyzed, so as to find more usable value, not only that, the results of the analysis It can also be communicated to the public better and more completely, so as to improve the decision-making level of relevant departments. Applying big data technology in ecological economic work can also create a cloud analysis platform on this basis, so that various types of ecological problems can be understood and fed back in a timely manner, and real-time data and results can be presented to the relevant public. The relevant public can also use information technology to know the specific situation, so as to effectively participate in the actual work of the ecological economy.

4. Experimental results and analysis

Taking the water environment and economic situation of province A as the starting point, combined with the DSR content and the principles of evaluation index construction [8].

4.1 Water Environment System Assessment

The comprehensive evaluation value of the water environment is obtained by calculation, which is set as GS, as shown in Figure 2.

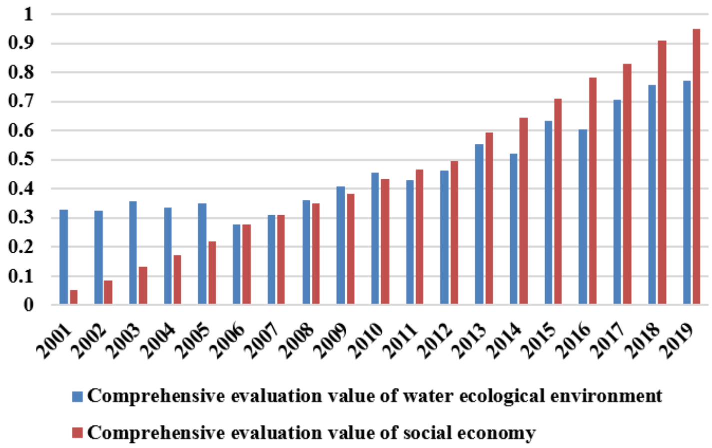

Fig 2. Water environment and economic evaluation values(self-painted)

It can be found that the comprehensive evaluation value of water environment in Province A shows an increasing trend, indicating that the water environment is developing in a good direction [9]. From 2001 to 2005, the water environment assessment index fluctuated greatly and was continuously adjusted around 0.3391. Since then, the evaluation value has continued to rise, reaching 0.7746 in 2019. See Table 1 for the grade characteristics, grade standards and comprehensive index values determined by the author [10].

Table 1. Water environment grade characteristics, grade standards and comprehensive index values (Learned through a questionnaire)

quality level	Comprehensive index value	Hierarchical features
excellent	0.800—1.000	The water environment functions well and has not been significantly damaged, and the water environment has not been significantly polluted.
good	0.550—0. 800	The water environment system is relatively good and suffers less damage, and the water environment pollution and water resource consumption are not obvious, which can effectively manage and control water ecological disasters
middle	0.375—0.550	The water environment has been damaged to a certain extent, with obvious environmental pollution and water resource consumption. In the event of a water disaster, the water environment can be restored.
Difference	0.000—0.375	The water environment has been severely damaged, and water resources have been severely depleted, making it difficult to restore the water environment.

The GS of the water environment shows an upward trend year by year, and through this good situation, it can be predicted that the water environment quality level will rise to the excellent level in recent years. From 2004 to 2008, GS was rated as poor, and the government and the public began to pay attention to water environmental protection and improved the water environment through a series of environmental restoration and water conservancy projects [11]. From 2001 to 2015, the GS chain index increased by about 1.0593 per year, and the growth rate reached 5.933 7%. Taking 2003 as the base period, the average value of the fixed base index was about 1.3439, the average annual growth rate reached 34.3948%, and the contribution rate of the driving force index was about 31.0767%, and the state index value and GS change were basically the same. The X X1 and X X2 contribution rate trends hovered around 15% after bottoming out quickly [12].

The changes in driving force, response and state in water environmental assessment are, after 2006, the contribution rate of the response index showed an upward trend, from 2008 to 2009, after the adjustment of the contribution rate of the response index and the status index, the response index became the main factor. Then, in terms of contribution rate, corresponding>state>driving force [13]. The improvement of G_S is mainly based on the pull of response indicators, under the joint action of water environment subjects such as the masses, the government and enterprises, indicators such as sewage treatment rate and water environment utilization rate have been effectively optimized [14].

4.2 Economic Evaluation

The comprehensive evaluation value of the economy is set to be GH, showing an upward trend year by year, with a change rate of about 19.24%. There are three main stages of GH change:

1. From 2001 to 2003, G_H increased steadily, with a growth rate of about 16.2234%.
2. From 2007 to 2013, G_H fluctuated greatly.
3. After 2010, the change rate of G_H was around 9.368 2%. The main performance is rapid growth in the early stage and stable growth in the later stage [15].

4.3 Coupling Analysis

For coupling, it is mainly a phenomenon in which different systems combine their influences with a certain role. Coupling will determine the structural direction of the system after it reaches the critical region, fully reflect the relationship between subsystems, and fully emphasize the mutual influence and dependency fit of different subsystems [16]. The characteristic index describing the relationship of each subsystem is the coupling degree. Although the coupling degree can reflect the coordination of subsystems, it cannot reflect its development level. Therefore, it is necessary to combine the degree of coordination to determine the degree of subsystem coordination. See the formula below:

$$M = \beta G_H + \alpha G_S \tag{2}$$

$$D = \left(M * C\right)^{\frac{1}{n}} \tag{3}$$

$$C = q \times \left[\frac{\left(G_H \times G_S\right)}{\left(G_H + G_S\right)^q} \right]^{\frac{1}{q}} \tag{4}$$

Among them, M is the comprehensive harmonic index; D is the degree of synergy, which is [0, 1]; C is the degree of coupling, which is [0, 1]; α is the undetermined coefficient of the water ecological subsystem, and β is the substitution coefficient of the economic subsystem, both taken as 0.5 in this study; q is the number of neutron subsystems in the total system, q=2 in this study, see Table 2.

Table 2. Coupling degree of water environment and economic subsystem (part)

years	2001	2008	2009	2014	2015
Coupling	0.681 234	0.999 545	0.999 683	0.994515	0.998 321
degree of coupling	Moderate coupling	Premium Coupling	Premium Coupling	Premium Coupling	Premium Coupling
Synergy	0.361 473	0.591 919	0.631480	0.756 089	0.819 351
degree of synergy	Collaborative transition	Collaborative transition	Moderate synergy	Moderate synergy	Highly collaborative

The high-quality coupling degree of the total system cannot represent the content of the economic and water environment subsystems, and the collaborative goals, so it is necessary to conduct in-depth research on the degree of coordination. From the data in Table 2, it can be found that there is a significant difference in the degree of synergy between the two. Its synergy is in the range of 0.34799 to 0.93041, showing an upward trend year by year [17].

The author determined the D value standard:

In the range of 0 to 0.35, it represents the system is synergistic.

In the range of 0.35 to 0.60, it means the system is in a coordinated transition.

In the range of 0.60 to 0.80, it means the system is moderately coordinated.

Within the range of 0.80 to 0.95, the representative system is a height system [18]. The degree of synergy between water environment and economy shows a development trend of synergistic transition, moderate synergy and high synergy. Among them, 2002-2008 was a low degree of coordination. From 2009 to 2014, there was moderate synergy, and after 2015, there was high synergy [19-25].

5. Conclusion

For coupling, it is mainly a phenomenon in which different systems combine their influences with a certain role. Coupling will determine the structural direction of the system after it reaches the critical region, fully reflect the relationship between subsystems, and fully emphasize the mutual influence and dependency fit of different subsystems.

By constructing models and other methods, evaluate the ecological economy and water resources ecological environment, and study measures to promote the coordinated development of ecological economy and water resources ecological environment. Experimental results show that, the high-quality coupling degree of the total system cannot represent the content of the economic and water environment subsystems, and the collaborative goals, so it is necessary to conduct in-depth research on the degree of coordination. From the data in Table 4, it can be found that there is a significant difference in the degree of synergy between the two. Its synergy is in the range of 0.34799 to 0.93041, showing an upward trend year by year. It is proved that the coupled model can be used to analyze the effect of resources, environment, and ecological environment on the ecological economy.

All in all, with the continuous development of society, environmental problems are becoming more and more serious, so we must attach great importance to the problem of ecological environment pollution. However, if we want to speed up the speed of effectively solving the problem of ecological environment pollution, we must strengthen the development of ecological environment. The big data technology is the product of the development of the times, and the application and integration of big data technology in the actual work of ecological environment monitoring is also an inevitable choice to follow the pace of the times.

References

[1] Jia, R., & Dai, L.. (2021). Analysis of economic benefits of mineral resources development ecological environment based on ecological footprint. Arabian Journal of Geosciences, 14(15), 1-19.

[2] Zhao, J., Meng, W., & Zhao, F.. (2020). Analysis on synergistic effects of the ecological environment construction and the economic growth — a case study of shandong province, china. IOP Conference Series: Earth and Environmental Science, 480(1), 012002 (9pp).

[3] Xiao, J., & Guo, S.. (2021). Analysis on the coordinated development of marine economy and ecological environment coupling in guangdong province. Journal of Physics Conference Series, 1774(1), 012011.

[4] Yu, M. A., Wang, X. Y., & Song, X. . (2019). Study on impact of the development of rural formal finance and informal finance on rural ecological environment - based on panel quantile regression analysis. Journal of Environmental Protection and Ecology, 20(3), 1536-1543.

[5] Liu, Y., Zhou, Y., Wang, T., Pan, J., Zhou, B., & Muhammad, T. , et al. (2019). Micro-nano bubble water oxygation: synergistically improving irrigation water use efficiency, crop yield and quality. Journal of Cleaner Production, 222(JUN.10), 835-843.

[6] Yang, Z.. (2020). The eewrs-based regional ecological environment water resource allocation model. Journal of the Mine Ventilation Society of South Africa, 73(2), 212-216.

[7] Cao, C.. (2021). The ecological concept based on big data is integrated into the strategy analysis of landscape design. Journal of Physics Conference Series, 1744(2), 022021.

[8] Xia, C., Li, Y., & Li, R. . (2019). Research on coordination relationship between ecological environment and urbanization in kunming based on coupling model. International Journal of Environmental Science and Development, 10(7), 216-222.

[9] Liu, Y. , Yang, L. , & Jiang, W. . (2020). Coupling coordination and spatiotemporal dynamic evolution between social economy and water environmental quality – a case study from nansi lake catchment, china. Ecological Indicators, 119(5), 106870.

[10] Cheng, K. , Yao, J. , & Ren, Y. . (2019). Evaluation of the coordinated development of regional water resource systems based on a dynamic coupling coordination model. Water science & technology, 19(1-2), 565-573.

[11] Wan, X. , Yang, T. , Zhang, Q. , Yan, X. , & Zheng, Y. . (2021). A novel comprehensive model of set pair analysis with extenics for river health evaluation and prediction of semi-arid basin - a case study of wei river basin, china. Science of The Total Environment, 775(8), 145845.

[12] Wang, X. , Liu, L. , & Zhang, S. . (2021). Integrated model framework for the evaluation and prediction of the water environmental carrying capacity in the guangdong-hong kong-macao greater bay area. Ecological Indicators, 130(6), 108083.

[13] Cui, D. , Chen, X. , Xue, Y. , Li, R., & Zeng, W. . (2019). An integrated approach to investigate the relationship of coupling coordination between social economy and water environment on urban scale - a case study of kunming. Journal of Environmental Management, 234(MAR.15), 189-199.

[14] Liu, Q. , Xue, H. , Zhou, S. , & Wang, H. . (2020). Evaluation of the synergy level between water environment and urban development for the new smart city: a case study of guangzhou. Journal of Coastal Research, 115(sp1), 543.

[15] Xu, E. , Wang, R. , Zhang, H. , & Yu, Z. . (2019). Coupling index of water consumption and soil fertility correlated with winter wheat production in north china region. Ecological Indicators, 102(JUL.), 154-165.

[16] Kalantari, Z. , Ferreira, C. S. , Page, J. , Goldenberg, R. , Olsson, J. , & Destouni, G. . (2019). Meeting sustainable development challenges in growing cities: coupled social-ecological systems modeling of land use and water changes. Journal of Environmental Management, 245(SEP.1), 471-480.

[17] Naderi, M. H. , Arab, N. , Jahandideh, O. , Salarijazi, M. , & Arab, A. . (2021). Estimation of optimal release flow range from jamishan dam considering the optimal instream ecological water demand for conservation the habitat potential of the dinavar river. Journal of Water and Soil Science, 35(2), 203-225.

[18] Gou, X. , & Li, Y. . (2021). Coupling spatial distribution and industrial structure optimization analysis of economic and environmental pollution in chongqing. IOP Conference Series: Earth and Environmental Science, 631(1), 012013 (7pp).

[19] Zhong, W. , & Zhang, D. . (2020). Study on coupling mechanism of carbon-water symbiosis system and regulation and control of water resources in the context of regional collaborative development. IOP Conference Series: Earth and Environmental Science, 546(3), 032036 (6pp).

[20] Peng, S. , & Jin, Y. . (2019). Study on the coupling and coordination relationship between urbanization and ecological environment in the yangtze river economic belt of china. IOP Conference Series: Materials Science and Engineering, 562(1), 012110 (6pp).

[21] Sharma, K. , & Chaurasia, B. K. . (2015). Trust Based Location Finding Mechanism in VANET Using DST. Fifth International Conference on Communication Systems & Network Technologies (pp.763-766).

[22] Intelligent eco friendly transport management system based on IoT in urban areas.P Ajay, B Nagaraj, BM Pillai, J Suthakorn, M Bradha.Environment, Development and Sustainability, 1-8.

[23] Liu, X., Su, Y.-X., Dong, S.-L., Deng, W.-Y., Zhao, B.-T.“Experimental study on the selective catalytic reduction of NO with C3H6 over Co/Fe/Al2O3/cordierite catalysts”, Ranliao Huaxue Xuebao/Journal of Fuel Chemistry and Technology, 2018, 46(6), pp. 743–753.

[24] Zhang, X., Rane, K., Kakaravada, I. & Shabaz, M. (2021). Research on vibration monitoring and fault diagnosis of rotating machinery based on internet of things technology. Nonlinear Engineering, 10(1), 245-254.

[25] P. Ajay, B. Nagaraj, R. Arun Kumar, Ruihang Huang, P. Ananthi, "Unsupervised Hyperspectral Microscopic Image Segmentation Using Deep Embedded Clustering Algorithm", Scanning, vol. 2022, Article ID 1200860, 9 pages, 2022.