Study on Harmonious Identification Method and Application of Human-Water Relationship

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Abstract: Based on the deep mechanical analysis of human-water relationship, this paper put forward the concept of harmonious identification and carry out quantitative analysis of the harmonious relationship between two or more related parties. The contribution of different related persons to the harmonious relationship, the primary and secondary relationship, the influence of different influencing factors on the harmonious relationship and the process of the primary and secondary relationship are explored. The harmony identification methods are studied both for modeling and non-modeling methods. It is sure that the present findings should lay a foundation for the harmonious regulation of human-water relationship.

1. Background
Man has been dealing with water since he appeared. The relationship between human and water is close and complex. Human water understanding is changing with the progress of human civilization, which brings about the continuous evolution of the relationship between human and water. During recent years, the study of the relationship between human and water has become a hot spot in water science. Many scholars have carried out extensive and in-depth research on the interaction between human and water from different angles. Unfortunately, it is very difficult to establish a harmonious relationship between human and water. It can be said that the process of establishing a harmonious relationship between human and water is the adjustment process of many stakeholders and influencing factors, which together affect the harmonious development situation of the relationship between human and water. However, different stakeholders and influencing factors play different roles in the process. Finding out those leading parties or key factors that have a great influence on the harmonious relationship is the key to establish the harmonious relationship effectively.

Therefore, this paper put forward the concept and definition of harmonious identification, construct the method of harmonious identification and the framework of applied research system, and studied the relationship between human and water.

2. The concept of human-water relationship and harmony identification
2.1 Analysis on the mechanism of the relationship between human and water
In the human-water system, both man and water are members of nature, and their movement has its own inherent attributes and objective laws. At the same time, they are mutually external environment. Through input and output of the matter, energy and information, they play an important and counteractive role. On the one hand, from the viewpoint of water system, it has the functions of resources,
ecology and environment, and its role in the human system is to ensure the survival and reproduction of mankind, social progress, economic prosperity and other development needs. However, the basic properties of water system, such as the uneven distribution of water resources in time and space, the limitation of water environment carrying capacity and the limitation of water ecological remediation, are also facts of objective existence, which are inherent constraints to the function of water system. When it is serious, it will threaten the survival and development of human beings, which is also the test of nature to human beings. On the other hand, based on the humanistic system, human survival, security and development cannot be separated from the water use, so water use and water control activities are inevitable. However, human activities will interfere with the process of natural water circulation, change the attribute characteristics and related functions of water system, and in turn affect the quality of human life, water usage, economic structure and industrial layout, and promote or restrict improvement of society, economy, science and technology and culture, which will affect the development of human culture system. They depend on each other and influence each other, creating a very complex system of interaction and feedback, see Fig.1.

Fig.1 The mechanism of the relationship between human and water

2.2 The concept of harmony identification

The objective of harmonious identification research can be the complex relationship at the macro level, or the next component element of the related party (that is, the next correlation party), the harmonious relationship of the influencing factors, and even the harmonious relationship of the next layer. Therefore, according to the specific situation, the objective of harmonious identification can be divided into different levels of harmonious relations, the leading and key factors can be found relevant to multi-levels. Then, through research of harmonious identification, the clear relationship can be established at different levels, which is helpful to understand the complex relationship more comprehensively.

3. The basic theory on harmony identification method

3.1 The framework of harmonious identification method

3.1.1 Research method of harmony identification

(1) Modeling identification method

According to the purpose of harmonious identification and the number of input and output variables, the modeling and identification methods can be generally divided into three kinds. The first method is the method of modeling harmony identification for "single input and single output" type. The second method is for "multi-input and multi-output" type. The third is based on the time series of dependent variables.

(2) Non-modeling identification method

Based on the correlation between quantitative variables, quantitative identification is carried out through comparative analysis. The representative algorithms include correlation analysis and gray correlation analysis, in which, correlation analysis method is generally used to study the correlation between variables, the expression of correlation and the degree of closeness. Identification is carried out through calculation of the correlation coefficient. Gray correlation analysis is used to judge the degree of correlation between variables according to the similarity degree of geometric shape of variable change
curve, and the gray correlation degree is used to quantitatively characterize the degree of correlation.

3.1.2 The framework of harmonious identification method and application research system.
From the angle of the whole complex relation and the concrete harmonious problem, the application of the method of harmonious identification should be expanded based on three levels of Macroscopic, middle and microcosmic.

As the macro level as concern, the overall harmony degree of complex relationships and stakeholders, the overall harmony degree of complex relationships and the influencing factors, and the quantitative identification of possible future results of overall harmony should be included. At the middle and microcosmic level, the relationship between stakeholders at the same and different levels, the relationship between stakeholders and influencing factors, the changing trend of the variables between stakeholders and the possible results in the future should be quantitatively identified. Therefore, the method of harmonious identification and the framework of applied research system are constructed (see Fig. 2).

3.2 Discussion on the application of harmony identification method
Firstly, a harmonious quantitative index system of human water relationship should be established and the harmony degree of human water relationship should be evaluated. This is the basis of harmonious regulation. Secondly, selecting the influencing factors used for regulation (recorded as x) as input variables, and other factors closely related to it (y1, y2…) as output variables. So knowing clearly the influence relationship of the regulation factor x on the other factors y becomes a harmonious identification problem. According to the result of harmonious identification, the change of y1, y2… is calculated every time x is adjusted, and the result of a new index system is obtained. Again, quantitative evaluation of the degree of harmony between human and water after adjustment and regulation was carried out. By constantly adjusting x, we can get many sets of harmonious control schemes. Through comprehensive comparison and analysis, the optimal scheme is selected and approximately regarded as the optimal scheme for harmonious regulation of human-water relationship.

4. Application of Harmonious identification method in human-water relationship

4.1 Application examples
In order to illustrate the application of the harmonious identification method, we selected Zhengzhou city of Henan Province as an example.

Zhengzhou is located in the central part of China and is the provincial capital of Henan Province. The population density is high, water resources are relatively short, and the contradiction between human and water is prominent. It is of great significance to study the harmonious regulation and control of human-water relationship. The data series of Zhengzhou from 2006 to 2015 are selected for calculation and analysis. The data are derived from Zhengzhou Water Resources Bulletins and Statistical Yearbooks.
4.2 Selection and calculation steps of harmony identification method

According to the method of harmonious identification and the framework of applied research system, this paper intends to quantitatively identify the leading parties and key influencing factors of human-water harmony in the changing process. Considering the length of sample data sequence and the purpose of identification, this paper takes the gray correlation analysis method of non-modeling identification as an example to illustrate the concrete application method in human-water relationship. The calculation steps for harmonious identification are as follows:

(1) Identify harmonious objective and quantitatively calculate causality variable

We should firstly quantify the harmonious degree of the human-water relationship. Among them, the harmonious degree of human system, water system and human-water relationship is obtained by comprehensive integration. The harmony degree of influencing factors is obtained by piecewise linear membership function.

(2) Selection of harmonious identification method and calculation

The method of gray correlation analysis is used in this example. The calculation process is as follows:

① Determining reference and comparison sequences. Dependent variables constitute reference sequences \( x_0(k) = \{x_0(1), x_0(2), \ldots, x_0(n)\} \) \((k = 1, 2, \ldots, n)\)

\[ x_j(k) = \{x_j(1), x_j(2), \ldots, x_j(n)\} \] \((k = 1, 2, \ldots, m)\)

② The data sequence is dimensionless and the sequence \( x_0 \) and \( x_i \) are obtained. The common methods are mean value method and initial value method. The mean value method is used here.

③ Calculation of gray correlation coefficient \( r(x_0, x_i) \).

\[
\Delta_0(k) = |x_0(k) - x_i(k)|
\]

\[
r(x_0, x_i) = \frac{\min_{k=1}^n \Delta_0(k) + \xi \max_{k=1}^n \Delta_0(k)}{(\Delta_0(k) + \xi \max_{k=1}^n \Delta_0(k))}
\]

In which, \( \Delta_0(k) \) is the difference sequence, \( \xi \) is the identification coefficient, the range is \((0, 1)\), and the value is usually 0.5.

④ Solve the gray correlation degree \( r_{0i} \) and sort by its size.

\[
r_{0i} = \frac{1}{n} \sum_{k=1}^{n} r(x_0(k), x_i(k))
\]

4.3 Calculation result and analysis

4.3.1 Calculation result.

Through calculation, the sub-harmony degree of each index and the harmony degree between human system, water system and human-water relationship are obtained. The result is shown in Table 1. The bigger the grey correlation degree, the more consistent the two changes, and the closer the relationship would be.

| Variables | C1 | C2 | C3 | ...... | C12 | Human system | Water system |
|-----------|----|----|----|--------|-----|--------------|-------------|
| r0i       | 0.70 | 0.81 | 0.91 | ...... | 0.92 | 0.62         | 0.58        |

4.3.2 Analysis on key influencing factors of harmonious relationship between human and water

The contribution of 12 factors to the change of harmonious degree of human-water relationship in Zhengzhou City from 2006 to 2015 is as follows: Water consumption; Green coverage rate; Urbanization rate; The proportion of environmental governance investment; waste water discharge; water consumption; ratio of river length with standard water quality to the total river length; per capita GDP; per capita grain holdings, economic growth rates, rainfall and per capita water resources, in which, water consumption, green coverage rate and urbanization rate can be selected as the three most critical factors, which can be reflected in the three levels of science and technology, environment and social development. As the provincial capital of Henan Province, Zhengzhou has made unremitting efforts in
recent years to promote Henan Province from a traditional agricultural province to a new economic and industrial province, and the development of various levels has greatly improved its human-water relations. The degree of harmony increased from 0.603 in 2006 to 0.630 in 2015.

4.3.3 Analysis on the leading side of harmonious relationship between human and water
It is considered that the two stakeholders, the human system and the water system, have the same contribution to the change of harmony degree between human and water, both occupy a dominant position. It can be seen in Fig. 3 that the change trend of the three curves be basically consistent with time in Zhengzhou.

To a certain extent, this indicates that the harmonious development of the humanistic system and the water system in Zhengzhou is more balanced, which is conducive to the mutual adaptation and synergetic evolution of the humanistic system and the water system. This may be related to the strong social and economic foundation and environmental protection measure.

5. Conclusions
Based on the analysis of the mechanism of human-water relationship, this paper expounds the necessity of quantitative identification when establishing various harmonious relationships, and then puts forward the concept and definition of harmonious identification. In view of the complexity of the system to be identified, starting from both modeling identification and non-modeling identification methods, harmonious identification theory is dealt with to construct harmony identification method and framework, and explore the application of harmonious identification method in the harmonious regulation of human and water. Taking the harmonious identification of human-water relationship in Zhengzhou as an example, the application research is carried out. The present findings can provide direction and guidance for the improvement of regional human-water relationship.

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