ASSESSMENT ON THE COMMONWEAL VALUES OF WETLANDS

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ABSTRACT: Assessment on wetland values is being payed more and more attention by researchers, administrators and public. This question is related to human's sustainable development in biosphere. This article analyses the commonweal values of wetlands and establishes an index system by Analytical Hierarchy Process, then assigns quantitatively the system through calculating matrix eigenvalue and characteristic vector, at last, sets up an integral way of commonweal value assessment. This paper takes Zhalong Wetland and Xianghai Wetland as study cases, the assessment results show that the both wetlands belong to the first grade importance protective wetland, which validates the method's practicability, scientific nature and rationality.

KEY WORDS : wetlands ; commonweal values; assessment; case study

1 THE COMPOSITION OF WETLANDS' COMMONWEAL VALUES

The matter flow, energy flow and information flow generated from natural capital of wetlands form ecosystem commonweal values. The flows as well as artificial capital and labor capital commonly generate humanity welfare(COSTANZA *et al.*, 1997). Generally speaking, the values of wetlands may be divided into three types: direct production values, values brought with biological functions of wetlands ecosystem, and attributive values as part of social makeup(BARBIER, 1997). These values can not all be embodied in commodity market, or difficultly quantified in the index of economic services and product capital, this makes it have little proportion in leaders decision-making, therefore brings about crisis to humanity sustainable development in biosphere. There are many difficulties and a lot of indeterminacy in the ecosystem assessment. If we generally assess the commonweal values of wetlands, at first, we must determine how many commonweal values there are in wetlands . COSTANZA Robert thinks that wetlands have 17 commonweal values(Table1).

This article divides commonweal values of wetlands into 5 classifications, 20 types to assess wetlands. The 5 classifications are as follows. Special conservation value : as rare wildlife habitat , wetland protect those species which are in danger; natural resources value: direct products from wetlands; eco-environment value:

Table 1 Classification of commonweal values of
wetlands by COSTANZA Robert

Order number	Commonweal values types of wetlands
1	Atmosphere control
2	Climate control
3	Interference control
4	Water control
5	Water supply
6	Erosion control and deposit detaining
7	Soil formation
8	Nutrient cycling
9	Draff treating
10	Pollination
11	Biota control
12	Shelter
13	Food product
14	Raw material
15	Gene resources
16	Recreation
17	Culture

Edward B. BARBIER puts forward 20 commonweal values of wetlands (Table 2) (Wetlands International-China Program, 1999).

Table 2 Classification of commonweal of wetlands by BARBIER

Order number	Commonweal values types of wetland
1	Flood controlling
2	Water supply
	a) groundwater supply
	b) water supply to other wetlands
3	Avoiding saltwater invasion
4	Avoiding natural force eroding
	a) avoiding shoreline eroding
	b) lowing wind speed
5	Removing and fixing nutrient
6	Removing and fixing toxicant
7	Removing and precipitating sediment
8	Climate control
9	Habitat for wildlife
10	Maintaining nature system and course
	a) ecological geologic course
	b) carbon cycle
11	Water supply
12	Vegetable product of wetlands
13	Animal product of wetlands
14	Energy product
15	Water transport
16	Recreation /tourism
17	Study and education area
18	Biological diversity
19	Society and culture importance
	a) culture value
	b) history value
	c) esthetics value
20	Typical ecosystem

the functions that wetlands can protect ecosystem and environment; scientific research and education value: the value that wetlands can be regarded as the base of research, model, science and promulgating education.

2 THE PRINCIPLE AND METHOD OF INDEX SYSTEM FOR WETLANDS COMMONWEAL VALUES

2. 1 Indexes and Index System

We select assessment indexes according to the features of wetlands ecosystem when assessing commonweal values of wetlands . Indexes are concepts and concrete numerical values reflecting system elements or system courses (CAO, 1999) . Ecosystem assessment indexes-can reflect ecosystem functions, qualities and uses. It is an organic series made up by series indexes that are related. Wetlands ecosystem values have different complexity and effect differently owing to different levels. And even the values in the same level have different effects and features. The commonweal assessment system for wetlands should reflect comprehensively wetlands features, accurate values, as well as administrative levels frame. The index system is made up by a suite of function groups that mutually related, a function group is composed by a lot of functions reflecting different features of system (CAO, 1999).

2. 2 The Principles of Indexes Selecting

The structure of wetlands ecosystem is complicated and has multiple administrative levels. Therefore, the indexes that are sensitive , conveniently quantified, with rich connotation should be selected. When setting up comprehensive assessment system of wetlands ecosystem, besides basic standard of statistics, the following principles must be abided: science nature, integrity, maneuverability, independency (CAO, 1999).

When selecting indexes and setting up index system, science nature and integrity has far-reaching meanings to the theoretical control of commonweal value for wetland ecosystem. And maneuverability, main ingredient and independency are beneficial to the

spreading and applying of index system in practical assessment .

2. 3 The Clue of Index Selection and the Method of Index System Establishment

When assessing the commonweal values of wetland ecosystem, a scientific and rational index system is important to the consequence. In building index system , following three things should be avoided: one is pursuing excessive integrity, which can result in the excessive large numbers of indexes and poor maneuverability and can make the system being difficult to be spred and applied, thus even will low the comparability of different ecosystems owing to excessively elaborate norms. The other is depending on the valuators' experiences to choose indexes , which can cause index system more subjective . The last thing is overlapping of indexes , which can affect the accuracy and science nature.

This research sets up assessment index system by Analytical Hierarchy Process(LIN, 1988), and assigns the index weights. The index system built-up in this research can be divided into three levels(CUI *et al.*, 1997):

(1) General target level

The general target of this index system is carrying out comprehensive assessment to commonweal value of wetlands.

(2) Comprehensive assessment level

In this level , the commonweal values of wetland are divided into several aspects whose nonlinearity summation can reflect the value of total target. They are special protective values, natural resources values, ecological environment values, social culture values, science and research values.

(3) Item assessment level

This level will assess all the items branched from the upper comprehensive assessment level. Special protective values can be divided into following values : biological shortage, biological diversity, ecosystem typicalness and integrity. Natural resources values: water resources value, biological resources value, mineral resources value(Fig. 1).
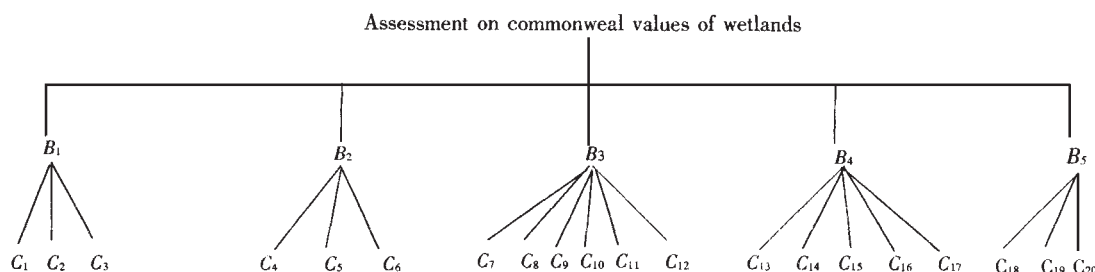

Fig. 1 Index system of wetland assessment

B_1 special protective value; B_2 natural resources; B_3 ecological environment value; B_4 social culture value; B_5 science , research , and education value; C_1 biological shortage; C_2 biological diversity; C_3 ecosystem typicalness and integrity; C_4 water resources; C_5 biota resources; C_6 minerals resources; C_7 flood control; C_8 water supply; C_9 avoiding saltwater invading; C_{10} avoiding natural forces eroding; C_{11} removing and fixing toxicant; C_{12} climate control; C_{13} culture value; C_{14} history value; C_{15} esthetics value; C_{16} moorland value; C_{17} recreation and tourism value; C_{18} science and research value; C_{19} model spot; C_{20} environment education spot

3 EVALUATION METHODS OF COMMONWEAL VALUE FOR WETLANDS

3. 1 Forming Measured Matrix

This research forms the following measured matrix to the comprehensive assessment level(SONG *et al.*, 1997):

$$A = \begin{bmatrix} 1 & 7 & 5 & 8 & 6 \\ 1/7 & 1 & 1/5 & 2 & 1/3 \\ 1/5 & 5 & 1 & 5 & 4 \\ 1/8 & 1/2 & 1/5 & 1 & 1/3 \\ 1/6 & 3 & 1/4 & 3 & 1 \end{bmatrix}$$

$\lambda_{max} = 5.36$
$CI = 0.09$
$CR = 0.08 < 0.1$

$CR < 0.1$ means the measured matrix has satisfactory uniformity.

As to the 5 function groups of item assessment level, we form 5 measured matrixes after adjusting and deliberating again and again, which maximum eigenvalue and uniformity is as follows(Wetlands International -China Program, 1999):

$B_1 \lambda max = 3.0037 \quad CI = 0.00185 \quad CR = 0.0032 < 0.1$

$B_2 \lambda max = 3.0349 \quad CI = 0.01745 \quad CR = 0.0030 < 0.1$

$B_3 \lambda max = 6.2182 \quad CI = 0.04364 \quad CR = 0.0352 < 0.1$

$B_4 \lambda max = 5.0711 \quad CI = 0.017775 \; CR = 0.0159 < 0.1$

$B_5 \lambda max = 3.0385 \quad CI = 0.01925 \quad CR = 0.0332 < 0.1$

The 6 random uniformity proportion CRs are all less than 0.1 , which show satisfactory uniformity .

3. 2 Weight Order of Elements

The element's importance weights of every level means the importance order of certain element in one level. The research get following results （Table 3 and Table 4）.

Table 3　The factors and their order in　comprehensive level

Index	Weight	Order	Total weight
B_1	0.486	1	
B_2	0.143	3	
B_3	0.221	2	1
B_4	0.041	5	
B_5	0.109	4	

Table 4　The factor weights and their order in item assessment level

Index	Weight	Order	Total weight
C_1	0.315	1	
C_2	0.112	2	0.486
C_3	0.059	6	
C_4	0.044	8	
C_5	0.083	4	0.143
C_6	0.016	14	
C_7	0.034	9	
C_8	0.046	7	
C_9	0.031	10	
C_{10}	0.015	15	0.221
C_{11}	0.086	3	
C_{12}	0.009	16	
C_{13}	0.005	17	
C_{14}	0.005	17	
C_{15}	0.005	17	0.041
C_{16}	0.002	20	
C_{17}	0.024	12	
C_{18}	0.065	5	
C_{19}	0.017	13	0.109
C_{20}	0.027	11	

3. 3 Constructing Parameters Table

Table 5 is the parameters table constructed.

Table 5　The quantified assessment parameters table of commonweal values of wetlands

Comprehensive level	Scores	Item level	Scores
B_1	48.6	C_1	31.5
		C_2	11.2
		C_3	5.9
		C_4	4.4
B_2	14.3	C_5	8.3
		C_6	1.6
		C_7	3.4
		C_8	4.6
B_3	22.1	C_9	3.1
		C_{10}	1.5
		C_{11}	8.6
		C_{12}	0.9
B_4	4.1	C_{13}	0.5
		C_{14}	0.5
		C_{15}	0.5
		C_{16}	0.2
		C_{17}	2.4
		C_{18}	6.5
B_5	10.9	C_{19}	1.7
		C_{20}	2.7

3. 4 Assessment Method Analysis

Table 3 lists the weights and orders of 5 elements in the comprehensive level. In evaluating wetlands , the commonweal value importance of all elements in this level is $B_1 > B_3 > B_2 > B_5 > B_4$. Table 4 calculates more weights and gives their orders in the item level. The result shows that C_1, C_2, C_{11}, C_{18}, C_{10} take more important roles and C_5, C_7, C_9, C_{17}, C_{20}, C_8 less important roles. The last parts are the attributes of wetlands , such as C_{10}, C_{15}. The score of wetlands' biological shortage is much higher than other elements, which reflects the importance of wetlands as species habitat. Most wetlands are the habitat of the species being in severe danger, for example, the number of *Nipponia nippon* which is Chinese 1st grade specially protected animal, is only in tens in the earth （Wild Animal and Forest Plant Protection Bureau, Forestry Minstry of PRC 1996）. Then, regardless the other non-important functions, features and uses, the wetlands which *Nipponia nippon* take as habitat have perfectly important special protective value—biological

shortage value. Therefore, this wetland has the highest protective value. In order to make the assessment result more benefit to wetlands protection, the score of biological shortage is much higher.

4 THE CASES OF COMMONWEAL VALUES ASSESSMENT OF WETLANDS

4.1 The Scores and Grades of Commonweal Values for Wetlands

On the basis of quantified parameters table, when valuating a specific wetlands, firstly we must get the modules, and measure the commonweal values of wetlands. Secondly, calculate the total scores of wetlands. Those between 70 and 80 belong to the first grade wetlands. Those between 50 and 70 are the second grade. And under 50 are the third.

4.2 Cases Assessment

(1) The Zhalong Wetland

Using the above method , Zhalong wetland gain the following scores(Table 6).

Table 6 The scores of commonweal values of Zhalong Wetland

Indexes	Modules	Scores	Order
C_1	0.9	28.4	1
C_2	0.7	7.8	2
C_3	0.7	4.1	6
C_4	0.5	2.2	9
C_5	0.8	6.6	3
C_6	0	0	
C_7	0.7	2.4	8
C_8	0.6	2.8	7
C_9	0	0	
C_{10}	0.8	1.2	12
C_{11}	0.7	6.0	4
C_{12}	0.5	0.5	13
C_{13}	0.2	0.1	15
C_{14}	0	0	
C_{15}	0.5	0.3	14
C_{16}	0.7	0.1	15
C_{17}	0.8	1.9	10
C_{18}	0.8	5.2	5
C_{19}	0	0	
C_{20}	0.6	1.6	11
Total		71.2	

① Ramsar Conservation Bureau, 1997. The Ramsar Conservation Mannal.

(2) Xianghai wetland

The following results are the scores of Xianghai wetlands(Table 7):

Table 7 The scores of commonweal values of Xianghai Wetlands

Index	Modules	Scores	Order
C_1	0.9	28.4	1
C_2	0.85	9.5	2
C_3	0.95	5.6	4
C_4	0.4	1.8	9
C_5	0.8	6.6	3
C_6	0	0	
C_7	0.7	2.4	8
C_8	0.6	2.8	7
C_9	0	0	
C_{10}	0.8	1.2	12
C_{11}	0.6	5.2	5
C_{12}	0.5	0.5	13
C_{13}	0.2	0.1	16
C_{14}	0.4	0.2	14
C_{15}	0.4	0.2	14
C_{16}	0.7	0.1	16
C_{17}	0.7	1.7	10
C_{18}	0.8	5.2	5
C_{19}	0	0	
C_{20}	0.6	1.6	11
Total		73.1	

4.3 Results Analysis

(1) The scores of comprehensive values of Zhalong wetland and Xianghai wetland is 71.2 and 73.1, which all belong to the 1st grade important wetlands. Generally speaking, the two wetlands all maintain better natural landscape, and are plenty of resources being the habitat of red-crowned crane (*Grus japonensis*) and other rare animals(Forestry Ministry of PRC, 1997) . Thus in 1992, they are listed into the Toponym Index of International Important Wetlands [①] .

(2) The scores of Zhalong Wetland is lower than that of Xianghai Wetland, which describes the difference between the two : 1) The area of Zhalong Wetland is 210 000ha and that of Xianghai Wetland is 105 470ha. But since recent years, the humanity effects on Zhalong Wetland is increasing, and there are increasing large-scale projects. The 301 national highway changed its routes in 1992, going through

Zhalong Wetland from the east to the west. The seasonal roads in the reserve have turned into passing road in all seasons, and the villages in the core part also build up roads. The Long Hu diversion works of Daqing City was finished in 1996, which goes through Zhalong from the south to the north in the west. These large scale artificial projects destroyed the integrity and continuity of wetland ecosystem. Natural wetlands are separated into a lot of isolated islands, thus wetlands have degenerated. But the ecosystem of Xianghai Wetland is protected well, with less obstruction of human activities, and it is still model and integrity ecosystem of the natural wetlands. 2) The landscape types of Xianghai Wetland is richer than that of Zhalong Wetland. In Zhalong Wetland, the main protective objects are rare birds such as red-crowned crane, natural wetland landscapes, swamp landscapes. As located in the transition area between the Mongolia Plateau and the North-east Plain, there are not only fixed and semi-fixed sanddune deposited by winds in Xianghai, but also wide lakes and dials; not only sparse elms (*Ulmus macrocarpa* var. *mongolica*) bushes on sand dune, but also semi-arid alkaline plain; even the bulrush swamp and aquatic vegetation. The main protective objects of Xianghai Wetland are Mongolia yellow-elms and sand dune deposited by winds besides water birds such as red-crowned crane and wetland landscapes.

(3) From the scores of all benefits, in the 20 indexes listed in this article, there are four zeros in Zhalong, C_6, C_9, C_{14}, and C_{19}. In another words, Zhalong don't have the four benefits. There are three zeros in Xianghai, that is C_6, C_9, and C_{19}.

(4) From the score order of all benefits C_1, C_2, C_5, C_{11}, C_{18} all stand in the order from 1 to 5, which take important roles in the total scores. The former 4 benefits of Xianghai Wetland are in turn C_1, C_2, C_3, and C_{11}.

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