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Assessment services and functions of natural ecosystems due to their role in the dry areas with local communities Fuzzy Analytical Hierarchy Process

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Abstract
Today, with the increase in population and the environmental crisis, and non-normative indiscriminate use of natural ecosystems in full swing, so that the power of natural ecosystems, the services and functions they do not balance. The purpose of this study is to prioritize services and functions of natural ecosystems in arid and semi-arid, with regard to their role in local communities. In this study, after determining the function of natural ecosystems, the analysis of hierarchical graphs were plotted based on the importance of each factor, weighted by the experts, the procedure was fuzzy. Finally, after analy zing the fuzzy matrix, the results showed that the regulatory function of the weight of 0.30, it is of utmost importance. Habitat and manufacturing services of equal value and weight of 0.28, placed second in priority. T he intelligence function, weighing 0.12, the priorities are secondary. However, the following operational criteri a, planning, water supply, soil formation and maintenance of soil with an equal weight of 0.5, the highest values are. In the production function, the function of food, pharmaceutical raw materials and resources, are the most weight. The intelligence function, the maximum value of the function and aesthetic services, recreation and ecotourism, so that other services do not have a large role in the economy of local communities.

Keywords: *functions ecosystems, natural ecosystems, environmental crisis, South Khorasan province.*

1.Introduction

Functions and ecosystem services as a component of natural processes and the ability to provide goods and services that are designed to directly or indirectly provide defined [1]. Using this definition, ecosystem functions as a subset of the ecological processes and ecosystem structures are co nsidered. Each function (goods and services), is the result of natural processes, the total ecological subsystems, which constitutes a part. Natural processes, one after another, the result of complex interactions between critical components (living organisms) and non critical (chemical and physical) ecosystems, materials and en ergy among the forces of the world are. Ecosystem functions, when the "ecosystem goods and services" are considered to be worthy of human beings. In other words, this is the man in charge of valuation, structures and processes enabling valua ble ecological phenomena [2]. In the classical multi-criteria decision to try the various factors in deciding calculated using mathematical concepts. The expression of many of the classical mathematical logic, are not allowed. On the other hand, there is always uncertainty in the real world and uncertain conditions, at different stages of the study, there was a problem. Thus, in many cases, all or part of the data in a multi-criteria decision problem, fuzzy. In this case, if the

problem using deterministic data model is formulated , accurate answers can not be achieved and thus the option will not be selected. Such decisions are imprecise, it is impossible to achieve the desired purpose. Therefore, in the decision that the da ta are random or fuzzy, there should be more reasonable and accurate calculation of the deal. Uncertainty in the de cision-making model and uncertainties in modeling decision problems, to be done by fuzzy sets.

Fuzzy AHP method, then the graph AHP, the decision maker is asked to experts to compare the elements of each level and the relative importance of using fuzzy numbers to express [3]. Since the functioning of natural ecosystems, due to their wide range of goods and services, and to determine an appropriate framework for a comprehensive evaluation of the functions of natural ecosystems into four main groups: conservation, habi tat functions, production functions and information fu nctions divided [4].

Operation and planning services

This group of functions related to the ability of natural and semi-natural ecosystems, essential ecological processes and systems to adjust to life support, through biogeochemical cycles and processes of the biosphere (the biosphere) are. Regulatory functions, many of the services that the direct and indirect benefits to humans, they provide [4]. These functions include regulation of gas and air and water regulation, soil formation an d retention, nutrient regulation, the disposal of wastewater.

Function of habitat

Natural ecosystems, suitable for all kinds of plants and animals living on land provided. Whereby, to maintain genetic diversit y, biological and evolutionary processes contribute. Healthy habitat pr otection, a necessary condition for the preparation of all backgrounds and ecosystem goods and services directly and indirectly [5-7]. This function includes the treasury function and is a haven.

Operation and Production

Natural and semi-natural ecosystems, many resources such as oxygen, water, food, medicine and genetic resources, energy resources and raw materials to provide clothing and buildings [8- 11]. In this paper, the functions of food and raw materials, genetic resources, medical supplies, craft supplies and cosme tics used.

Functionality and information services

Natural ecosystems, provide an essential source function and the health of humans, with opportunities for reflection, spiritual en richment, spiritual development physical, leisure, recreation and aesthetic experiences and help Henry [12]. Functions of information, including information aesthetic, recreati on and ecotourism, cultural and artistic inspiration, historical, religious, educational, and scientific information.

The aim of the study: The aim of this research, assessment and valuation of natural ecosystem functions of life of local communities, so that the authorities can be required to plan and develop programs and strategies to develop these are as.

Fuzzy methods

Fuzzy logic and fuzzy set theory, by the Iranian-born scientist, named Professor Lotfali Askrzadeh (University of California), was introduced in 1965 for the first time in the world. Despite several years old, probability theory, complex and classical logic, it is overshadowed. So that, today, a kind of fuzzy sets are classic. Fuzzy logic states that everything is relative. Phase, the mean value being. This means that, in response to each question, there are three or more choice, and maybe unlimited range of choices, not just exist in the final selection. That is, instead of the analog duplex mode using the shades of gray between black and white is assumed to be unlimited [13].

Fuzzy logic features

In fuzzy logic, reasoning closely approximate reasoning are considered as borderline cases. In fuzzy logic, whatever degree possible, any logical system, can be fuzzy. In fuzzy logic, knowledge as a set of constraints or the equivalent phase change, which is applied on a set of variables, can be interpreted. Inference, as a process of expanding the limits of variability to be considered [14].

Analytical Hierarchy Process (AHP)

AHP, this force is known as one of the methods of analysis, to measure the effect on the total value of non-consumptive values, used [15]. This method was presented by Thomas Sati and Y1970 in the eyes of Applied Sciences, has been used [16]. AHP, on the basis of a comparison of each two criteria under analysis, has been established. Has 4 main steps:

Creating a hierarchy of criteria;

1. The comparisons based on the sample, the criteria for obtaining people's preferences;
2. Analysis of the results of person;
3. The sum total of preference, to assess the main results [17].

This method is used to study scientifically critical positions in industry, agriculture and the environment is used. With the development of criteria and priorities for the options to be performed. Also, the technique of multi-criteria decision-making process is a complex decision problem, for example, shows the ranking of the different levels. Each level consists of various elements associated with a general character. Using this method, a numerical measure of the importance and priority of each element on the surface, or to compare two elements in the surface of all the loses.

There are several objectives that should be obtained. The most important goal is that, during the ranking process is done, the system must be indicated. Similarly, the list of objectives must be clear and cconvey the same meaning to all visitors [18].

2. Case study area

Southern province, the eastern most province of Iran, which is 84184.18 square kilometers. Between 57 degrees and 46 minutes and 60 degrees 57 minutes east longitude and 30 degrees 35 minutes and 34 degrees north latitude, 14 minutes, is located and47.5% of the country's land area is devoted to the provinces of East and Afghanistan, to the north of Khorasan Razavi province of Yazd and Kerman West to the south of the province of Sistan and Baluchestan neighbor [19]. Average annual rainfall in South Khorasan province, 134 mm and mean annual temperature of 17.5 degrees Celsius. 95 percent of the province's vast natural areas consist of the amount, 22.7 percent of the desert, desert pastures, 63.3 percent, 7.2 percent average good pastures and 6.8 percent and forests. The province has an area of 880334 hectares, is one of the centers of the critical wind erosion [20].

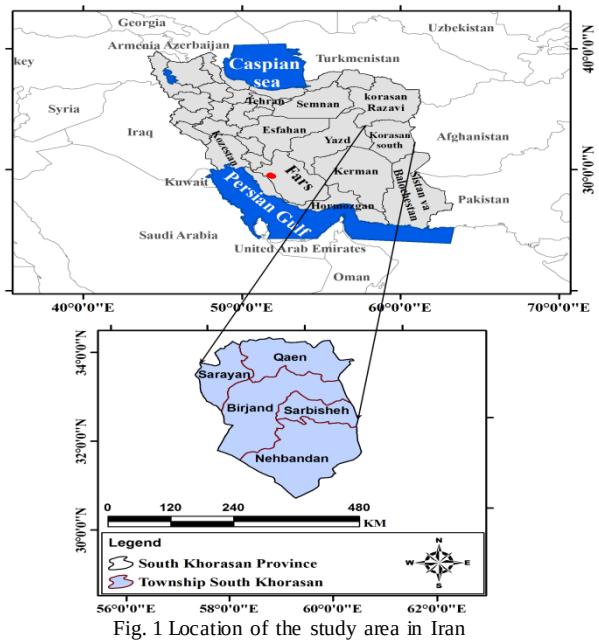

Fig. 1 Location of the study area in Iran

3. Materials and Methods

Fuzzy analytic hierarchy process technique [3]:

1. A hierarchical diagram.

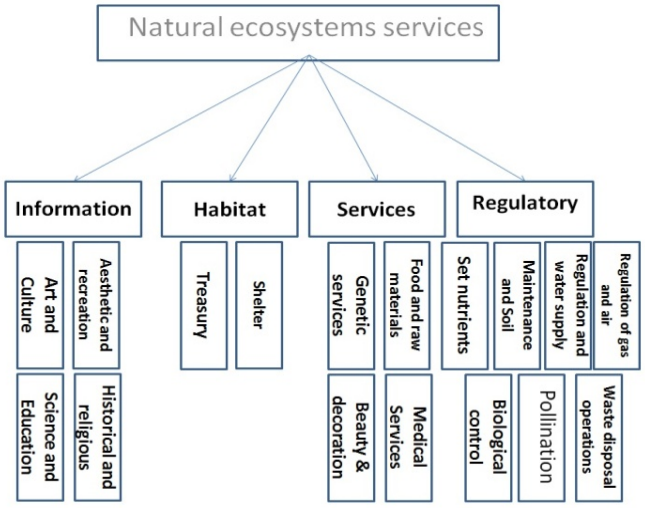

Fig. 2 Diagram of hierarchical fuzzy

1. The definition of fuzzy numbers, to perform the test
2. paired comparison matrix (Ã), using fuzzy numbers

$$\begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix}$$

1-Calculation (Si) for each pair of rows of the matrix: Si, which is a triangular fuzzy number is calculated as follows:

$$S_i = \sum_{j=1}^{M} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1}$$

In this equation, i represents the number of rows and j represents the number of columns. In this regard, the triangular fuzzy numbers are paired comparison matrices. Values

$\sum_{j=1}^{M} M_{gi}^{j}$,
$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}$,

$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$ Can thus be calculated from the following relationship:

$$\sum_{j=1}^{M} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j , \sum_{j=1}^{m} m_j , \sum_{j=1}^{m} u_j \right)$$
$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_j , \sum_{i=1}^{n} m_j , \sum_{i=1}^{n} u_j \right)$$
$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i} , \frac{1}{\sum_{i=1}^{n} m_i} , \frac{1}{\sum_{i=1}^{n} l_i} \right)$$

In the above equations, l_i ، m_i ، u_i , the first and third components are fuzzy numbers.
1-Calculate the magnitude of Si relative to each other
2-Generally, if M1 = (l1, m1, u1) and M2 = (l2, m2, u2) are two triangular fuzzy numbers, according to the following order of magnitude M1 to M2 is defined as follows:

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) =$$

$$\begin{cases} 1 & if \quad m_2 \geq m_1 \\ 0 & if \quad l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases}$$

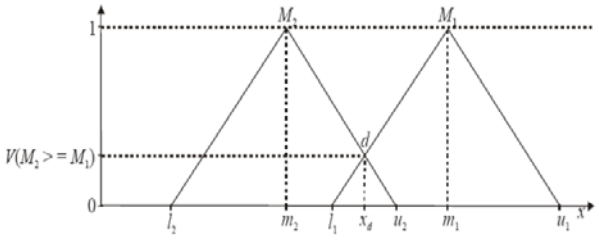

Fig. 3 A large degree of fuzzy two numbers add together

3. The calculation of the weighting of criteria and options in the paired comparison matrices. To do this, we use the following equation

$$d'(A_i) = \text{Min } V(S_i \geq S_k) \quad k = 1,2,3,\dots,n \ , \ k \neq i$$

Thus, the normalized weight vector will be as follows:

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T$$

3. The calculation of the final weight vector.
To calculate the final weight vector must be normalized weight vector calculated in the previous step. Therefore:

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T$$

4. Discussion

In this study, we tried a comprehensive comparison of the services and functions of natural ecosystems to take place. That is, the importance of each service are determined to be of service to local communities play an important role, the other prominent display. To evaluate the services and functions of natural ecosystems, after charting hierarchical fuzzy pair wise comparison matrix, functions according to Table 1, the entire process is referred to in the Materials and methods, and are calculated according to the following tables.

Table 1: Example of fuzzy numbers are defined in the Analytical Hierarchy Process

Scale phase	Definition	Fuzzy number
(7 ،9 ،9)	Absolute importance	$\tilde{9}$
(9 ،7 ،5)	very importance of a strong	$\tilde{7}$
(7 ،5 ،3)	importance of a strong	$\tilde{5}$
(5 ،3 ،1)	Lesser importance	$\tilde{3}$
(3 ،1 ،1)	Equally important	$\tilde{1}$
(1 ،1 ،1)	Exactly equal	1

$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (12.31,22.41,37.5)$

$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (0.026,0.044,0.081)$

Calculation (Si) for each of the rows of paired comparison matrix

S_1= (4.2,7.33,12) ⊗ (0.026,0.044,0.081)= (0.109,0.322,0.972)
S_2=(3.25,6.5,11) ⊗ (0.026,0.044,0.081)=(0.084,0.286,0.891)
S_3=(3.25,6.5,11) ⊗ (0.026,0.044,0.081) = (0.084,0.286,0.891)
S_4= (1.61,2.08,3.5) ⊗ (0.026,0.044,0.081) =(0.041,0.091,0.283)

Large degree of each of the values of each other

$V(S_1 \geq S_2)$ =1 $V(S_2 \geq S_1)$ =0.95 $V(S_3 \geq S_1)$ =0.95 $V(S_4 \geq S_1)$ =0.42
$V(S_1 \geq S_3)$ =1 $V(S_2 \geq S_3)$ =1 $V(S_3 \geq S_2)$ =1 $V(S_4 \geq S_2)$ =0.5
$V(S_1 \geq S_4)$ =1 $V(S_2 \geq S_4)$ =1 $V(S_3 \geq S_4)$ =1 $V(S_4 \geq S_3)$ =0.5

Table 3: Calculation of net weight normalized to criteria

weight normalized	Not normal weight	index
0.30	1	Regulatory
0.28	0.95	Habitat
0.28	0.95	Productional
0.12	0.42	Informational

$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (45.11,72.62,113.32)$

$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (0.022,0.013,0.008)$

Calculation (Si) for each of the rows of paired comparison matrix

S_1 = (5.5,10,15) ⊗ (0.022,0.013,0.008) =(0.121,0.13,0.12)
S_2 =(11,18,28) ⊗ (0.022,0.013,0.008) = (0.242,0.234,0.224)
S_3 =(11,18,28) ⊗ (0.022,0.013,0.008) = (0.242,0.234,0.224)
S_4 = (5.5,10,15) ⊗ (0.022,0.013,0.008) = (0.121,0.13,0.12)
S_5 = (3.684,5.06,8.66) ⊗ (0.022,0.013,0.008) =(0.081,0.065,0.069)
S_6= (5.5,8,13) ⊗ (0.022,0.013,0.008)=(0.121,0.104,0.104)
S_7 = (2.93,3.56,5.66) ⊗ (0.022,0.013,0.008)=(0.064,0.046,0.045)

Large degree of each of the values of each other (Calculations on the next page, single column)

Table 6: Calculation of net weight normalized to criteria

Normal weight	**Not normal weight**	**Performance Tuning**
0	0	Regulation of gas and air
0.5	1	Regulation and water supply
0.5	1	Formation and maintenance of soil
0	0	Set nutrients
0	0	Waste disposal operations
0	0	Pollination
0	0	Biological control

Table 7: Calculations on the next page, single column

$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (17.73,23.56,37.66)$

$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (0.056,0.042,0.026)$

Calculation (Si) for each of the rows of paired comparison matrix

S_1 = (6,9,14) ⊗ (0.056,0.042,0.026) = (0.121,0.13,0.12)
S_2 = (2.4,3.66,7) ⊗ (0.056,0.042,0.026) = (0.242,0.234,0.224)
S_3 = (6,9,14) ⊗ (0.056,0.042,0.026) = (0.242,0.234,0.224)
S_4 = (1.53,1.9,2.66) ⊗ (0.056,0.042,0.026) = (0.121,0.13,0.12)

Large degree of each of the values of each other

$V(S_1 \geq S_2)$ $V(S_2 \geq S_1)$ =0 $V(S_3 \geq S_1)$ =1 $V(S_4 \geq S_1)$ =0 =1
$V(S_1 \geq S_3)$ $V(S_2 \geq S_3)$ =0 $V(S_3 \geq S_2)$ =1 $V(S_4 \geq S_2)$ =0 =1
$V(S_1 \geq S_4)$ $V(S_2 \geq S_4)$ =1 $V(S_3 \geq S_4)$ =1 $V(S_4 \geq S_3)$ =0 =1

Table 8: Calculation of normalized net weight to criteria

Normal weight	Not normal weight	Productional
0.5	1	Food and raw materials
0	0	Genetic resources
0.5	1	Medical resources
0	0	Decorative resources and Beauty

Table 9: Comparison matrix phase test the performance criteria habitat

Habitat	Treasury	Shelter	$\sum_{j=1}^{M} M_{gi}^{j}$
Treasury	(1,1,1)	(0.25,0.5,1)	(1.25,1.5,2)
Shelter	(1,2,4)	(1,1,1)	(2,3,5)

$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (3.25,4.5,7)$

$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (0.307,0.222,0.142)$

Calculation (Si) for each of the rows of paired comparison matrix

S_1 =(1.25,1.5,2) ⊗ (0.307,0.222,0.142)= (0.121,0.13,0.12)
S_2 =(2,3,5) ⊗ (0.307,0.222,0.142)= (0.242,0.234,0.224)

Large degree of each of the values of each other

$V(S_1 \geq S_2)$ =0
$V(S_2 \geq S_1)$ =0

Table 10: Calculation of net weight normalized to criteria

Normal weight	Not normal weight	Habitat
0	0	Treasury
0	0	Shelter

Table 11: Calculations on the next page, single column

$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (12.15,20.16,33)$

$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (0.0823,0.049,0.030)$

Calculation (Si) for each of the rows of paired comparison matrix

S_1 = (4,9,15) ⊗ (0.0823,0.049,0.030)= (0.328,0.441,0.45)

S_2 = (2.45,2.83,4) ⊗ (0.0823,0.049,0.030)= (0.2,0.138,0.12)

S_3 = (2.45,2.83,4) ⊗ (0.0823,0.049,0.030)= (0.2,0.138,0.12)

S_4 = (3.25,5.5,10) ⊗ (0.0823,0.049,0.030)= (0.266,0.269,0.3)

Large degree of each of the values of each other

$V(S_1 \geq S_2) = 1$ $V(S_2 \geq S_1) = 0$ $V(S_3 \geq S_1) = 0$ $V(S_4 \geq S_1) = 0$

$V(S_1 \geq S_3) = 1$ $V(S_2 \geq S_3) = 1$ $V(S_3 \geq S_2) = 1$ $V(S_4 \geq S_2) = 1$

$V(S_1 \geq S_4) = 1$ $V(S_2 \geq S_4) = 0$ $V(S_3 \geq S_4) = 0$ $V(S_4 \geq S_3) = 1$

Table 12: Calculation of net weight normalized to criteria

Normal weight	Not normal weight	Performance Information
1	1	Information aesthetic, recreation and ecotourism
0	0	Cultural and artistic inspiration
0	0	Historical and Religious Information
0	0	Educational and Scientific Information

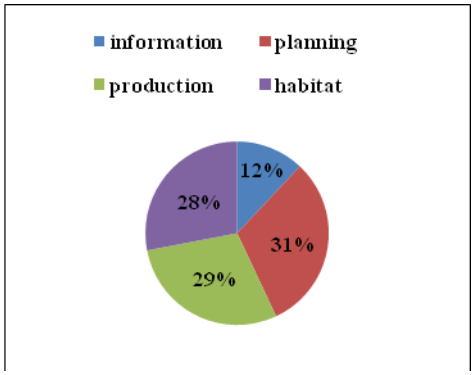

Fig. 4 Comparison of the main functions

5. Conclusion

The role and functions of ecosystems is obvious to everyone. So that the most important human needs (water, soil and air) directly to the relationship of man and ecosystems back. This relationship is much more logical, human life and other animals will be healthier. However, conservation of habitats that provide the context for human life in different situations and destroy it reduces genetic diversity is an essential condition for the survival of humans and other organisms. Enough to talk about tourism and ecotourism and tourism in particular, can play a role in the economy of local communities in arid and semi-arid. The results using fuzzy AHP method, showed that the core services of natural ecosystems, operational weight of 0.30, it is of utmost importance. Habitat and production services, with equal value and weight of 0.28, the second priority will be given. The intelligence function, weighing 0.12, the priorities are secondary. But in sub-regulation function, and regulation of water resources, soil formation and maintenance of soil with an equal weight of 0.5, the highest values are. In the production function, the function of food and raw materials and medical supplies are the most weight. The intelligence function, the maximum value of the function and aesthetic services, recreation and ecotourism so that other services do not have a large role in the economy of local communities.

Table 2: Fuzzy paired comparison matrix between the main criteria (performance of natural resources)

Operations	Regulatory	Habitat	Productional	Informational	$\sum_{j=1}^{M} M_{gi}^{J}$
Regulatory	(1,1,1)	(0.2,0.33,1)	(1,2,4)	(2,4,6)	(4.2,7.33,12)
Habitat	(1,3,5)	(1,1,1)	(0.25,0.5,1)	(1,2,4)	(3.25,6.5,11)
Productional	(0.25,0.5,1)	(1,2,4)	(1,1,1)	(1,3,5)	(3.25,6.5,11)
Informational	(0.16,0.25,0.5)	(0.25,0.5,1)	(0.2,0.33,1)	(1,1,1)	(1.61,2.08,3.5)

Table 4: Fuzzy paired comparison matrix between regulatory performance standards

Performance Tuning	Regulation of gas and air	Regulation and water supply	Formation and maintenance of soil	Set nutrients	Waste disposal operations	Pollination	Biological control	$\sum_{j=1}^{M} M_{gi}^{J}$
Regulation of gas and air	(1,1,1)	(0.25,0.5,1)	(0.25,0.5,1)	(1,1,1)	(1,3,5)	(1,1,1)	(1,3,5)	(5.5,10,15)
Regulation and water supply	(1,2,4)	(1,1,1)	(1,1,1)	(1,2,4)	(3,5,7)	(1,2,4)	(3,5,7)	(11,18,28)
Formation and maintenance of soil	(1,2,4)	(1,1,1)	(1,1,1)	(1,2,4)	(3,5,7)	(1,2,4)	(3,5,7)	(11,18,28)
Set nutrients	(1,1,1)	(0.25,0.5,1)	(0.25,0.5,1)	(1,1,1)	(1,3,5)	(1,1,1)	(1,3,5)	(5.5,10,15)

Waste disposal operations	(0.2,0.33,1)	(0.142,0.2,0.33)	(0.142,0.2,0.33)	(0.2,0.33,1)	(1,1,1)	(1,2,4)	(1,1,1)	(3.684,5.06,8.66)
Pollination	(1,1,1)	(0.25,0.5,1)	(0.25,0.5,1)	(1,1,1)	(1,2,4)	(1,1,1)	(1,2,4)	(5.5,8,13)
Biological control	(0.2,0.33,1)	(0.142,0.2,0.33)	(0.142,0.2,0.33)	(0.2,0.33,1)	(1,1,1)	(0.25,0.5,1)	(1,1,1)	(2.93,3.56,5.66)

Table 5: Large degree of each of the values of each other

$V(S_1 \geq S_2)$ =0	$V(S_2 \geq S_1)$ =1	$V(S_3 \geq S_1)$ =1	$V(S_4 \geq S_1)$ =0	$V(S_5 \geq S_1)$ =0	$V(S_6 \geq S_1)$ =0	$V(S_7 \geq S_1)$ =0
$V(S_1 \geq S_3)$ =0	$V(S_2 \geq S_3)$ =1	$V(S_3 \geq S_2)$ =1	$V(S_4 \geq S_2)$ =0	$V(S_5 \geq S_2)$ =0	$V(S_6 \geq S_2)$ =0	$V(S_7 \geq S_2)$ =0
$V(S_1 \geq S_4)$ =1	$V(S_2 \geq S_4)$ =1	$V(S_3 \geq S_4)$ =1	$V(S_4 \geq S_3)$ =1	$V(S_5 \geq S_3)$ =0	$V(S_6 \geq S_3)$ =0	$V(S_7 \geq S_3)$ =0
$V(S_1 \geq S_5)$ =1	$V(S_2 \geq S_5)$ =1	$V(S_3 \geq S_5)$ =1	$V(S_4 \geq S_5)$ =1	$V(S_5 \geq S_4)$ =0	$V(S_6 \geq S_4)$ =0	$V(S_7 \geq S_4)$ =0
$V(S_1 \geq S_6)$ =1	$V(S_2 \geq S_6)$ =1	$V(S_3 \geq S_6)$ =1	$V(S_4 \geq S_6)$ =1	$V(S_5 \geq S_6)$ =0	$V(S_6 \geq S_5)$ =1	$V(S_7 \geq S_5)$ =0
$V(S_1 \geq S_7)$ =1	$V(S_2 \geq S_7)$ =1	$V(S_3 \geq S_7)$ =1	$V(S_4 \geq S_7)$ =1	$V(S_5 \geq S_7)$ =1	$V(S_6 \geq S_6)$ =1	$V(S_7 \geq S_6)$ =0

Table 7: Fuzzy paired comparison matrix between measures of productivity

Productional	Food and raw materials	Genetic resources	Medical resources	Decorative resources and Beauty	$\sum_{j=1}^{M} M_{gi}^{j}$
Food and raw materials	(1,1,1)	(1,3,5)	(1,1,1)	(3,5,7)	(6,9,14)
Genetic resources	(0.2,0.33,1)	(1,1,1)	(0.2,0.33,1)	(1,2,4)	(2.4,3.66,7)
Medical resources	(1,1,1)	(1,3,5)	(1,1,1)	(3,5,7)	(6,9,14)
Decorative resources and Beauty	(0.142,0.2,0.33)	(0.25,0.5,1)	(0.142,0.2,0.33)	(1,1,1)	(1.53,1.9,2.66)

Table 11: Paired comparison matrix phase between measures of performance information

Information	**Information aesthetic, recreation and ecotourism**	**Cultural and artistic inspiration**	**Historical and Religious Information**	**Educational and Scientific Information**	
Information aesthetic, recreation and ecotourism	(1,1,1)	(1,3,5)	(1,3,5)	(1,2,4)	**(4,9,15)**
Cultural and artistic inspiration	(0.2,0.33,1)	(1,1,1)	(1,1,1)	(0.25,0.5,1)	**(2.45,2.83,4)**
Historical and Religious Information	(0.2,0.33,1)	(1,1,1)	(1,1,1)	(0.25,0.5,1)	**(2.45,2.83,4)**
Educational and Scientific Information	(0.25,0.5,1)	(1,2,4)	(1,2,4)	(1,1,1)	**(3.25,5.5,10)**

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