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# FUZZY SYNTHETIC EVALUATION ON RESIDENT'S PERCEPTIONS OF TOURISM IMPACTS —Case of Jiuzhaigou National Park, Sichuan Province, China

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ABSTRACT: Tourism can have both positive and negative outcomes for residents in tourism destinations. It is a good method to analyze the status of tourism impact by means of investigating residents' perceptions of it. Various methods have been used in previous authoritative studies. However, owing to inherent imprecision, difficulties always exist in some conventional methodologies when describing the interpretation of linguistic or measured uncertainties for real-world random phenomena. The purpose of this research is to present the fuzzy synthetic evaluation method to investigate residents' perceptions of tourism impacts. At first, basic attributes and a hierarchical framework of tourism impacts are defined and formed. Secondly, the weighted vectors are determined according to the knowledge and experience of experts. Thirdly, the weighted evaluation matrices are aggregated to get the fuzzy sets of tourism impacts. In the last stage, the final fuzzy sets are defuzzified to get the rank of the residents' perceptions of tourism impacts. A case study in Jiuzhaigou National Park of China is provided to demonstrate the application of this method.
KEY WORDS: residents' perceptions; tourism impacts; fuzzy synthetic evaluation; Jiuzhaigou National Park

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## 1 INTRODUCTION

Community residents form an important part of tourism destinations and play a crucial role in the protection and development of tourism resources. The Tourism Agenda 21 advocates that the development of tourism industry should consider the interests of the host residents and ensure long-term viability beneficial towards destination community (LIU, 2000). Yet in many instances tourism development proves detrimental to host communities (LANKFORD and HOWARD, 1994; LIU and VAR, 1986). Over time, the tourism industry can change host communities' society, economy, culture and environment for the worse (COOKE, 1982).

In recent years, the term "tourism impact" has been gaining increasing attention in the tourism literature (ALLEN et al., 1988; AP and CROMPTON, 1998; WILLAMS and LAWSON, 2001; CEVAT, 2002). A number of studies have examined residents' perceptions of the impacts of tourism development on their communities (CEVAT, 2002; ANTONIA et al., 2002; WEAVER and LAWTON, 2001), which continue to be an important issue. A major reason for the rising interest has been the increasing evidence that tourism can have both positive and negative impacts on local residents in a community. Different perceptions of tourism impacts from different residents can provide insight into the nature and degree of tourism impacts to the tourist destination. The perceptions of residents toward the impacts of tourism are likely to be an important planning and policy consideration for successful development, marketing, and operation of existing and future tourism programs (KO and STEWART, 2002).

Host residents' perceptions of various tourism impacts have been extensively researched since the 1960s, but most early studies featured optimism and placed particular emphasis on the positive tourism impacts, i.e. tourism promoted the economic development in the destination. During the 1970s, the negative impacts with tourism development were criticized by anthropological and sociological scholars. PIZAM (1978) suggested tourism increased the price of land and housing, and destroyed ecosystem. WILLIAMS (1979) proved that tourism increased the traffic accident and crime rate, thus a period

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of pessimistic trend appeared. After the 1980s, comprehensively recognizing tourism and synthetically evaluating tourism's positive and negative impacts were started. Take employment as an example. Employment in tourism demands flexible working patterns, which is eroding gender segregation (CROMPTON and SANSWESON, 1990) and more opportunities are for women in tourism, which provides many with a greater degree of economic independence (URRY, 1991). Employment opportunities lured younger people to areas of tourism development (SHARPLEY, 1994). At present, the study of tourism perception has attracted great attention of the international academic field of tourism, and many methods have been used in previous authoritative studies. A single-variable index is chosen to evaluate the tourism impact. For example, tourism modified the internal structure of the community (MATHIESON and WALL, 1982), tourism has colonialist characteristics robbing local population of autonomous decision-making (KRIPPENDORF, 1987). Application of single-variable often produces inconsistent results when different parameters are chosen. The results obtained from using single-variable index may easily mislead or bias the user. In recent years, the multivariable impact indices were developed. Statistics method as widely used technique for resident's perception of tourism impact is very popular (MADRIGAL, 1995; LAWSON et al., 1998; CARMICHAEL, 2000). But several problems are still inherent in this method. Firstly, the multivariable indices of tourism impact are generally very complex to model due to the underlying correlation among several impacts, therefore inconsistency and distinction impact indices will cause a vagueness or fuzziness in residents' perceptions. Statistic method is not sensitive enough, which cause the standards of tourism impact to differ. Secondly, resident's perception is correlated with resident's subjective decision, owing to inherent imprecision of decision, especially in the interpretation of linguistic or measured uncertainties for real-world random phenomena, so subjective decisions have uncertainties and discrepancies, which may affect the decision-making process adversely. Thirdly, it involves unreasonable classification standards. i.e. resident's perception index gives x=2.9 and x=3.0 different classifications, but x=2.1 and x=2.9 the same. A further problem with statistics is that different impact has its own contribution to the resident's perception. For statistics give same weights to each variable, the user will be unable to agree upon a reliable index. Such methods limit the current literature on understanding residents' behavior toward the impacts of tourism (AP, 1992).

Fuzzy set theory is an important tool for modeling uncertainty or imprecision arising from human perception. Subjectivity should be accounted for in a rational approach to decision-making (SADIQ et al., 2004). Discovered by ZADEH (1965) and, after 40 years of research and development, fuzzy set theory has extensive application. Nowadays, an immense number of studies are carried out using this method. Fuzzy set theory was designed to interpret the uncertainties of the real situations. The main source of uncertainties involving in a large-scale complex decision-making process may be properly described via fuzzy membership functions. The Fuzzy Synthetic Evaluation (FSE) method is used to assist decision-makers to solve problems of conflicting of multiple criteria. It is designed to group raw data into several different categories according to predetermined quality criteria, which can be normally described using a set of functions that are designed to reflect the absence of sharp boundaries between each pair of adjacent criteria. A well-designed FSE may be capable of covering the uncertainties existing in the sampling and analysis process, comparing the sampling results to the applied quality standards for each parameter, and summarizing all of the individual parameter values (CHANG et al., 2001; LU et al., 1999). FSE processes all the components according to weights and decreases the fuzziness by using membership functions, therefore, sensitivity is quite high compared to other index evaluation techniques. Nowadays, it has been proved very useful in medical diagnosis (LASCIO, 2002), information technology (LEE, 1996), water quality assessment (LU et al., 1999), tourist situation (LI et al., 1999), tourist satisfaction assessment (DONG and YANG, 2005), and many other industrial applications (LAWRY, 2001). The purpose of this study is to apply fuzzy synthetic evaluation method to assessing residents' perceptions of tourism impacts.

## 2 FUZZY SYNTHETIC EVALUATION PROCESS ON RESIDENT'S PERCEPTION

### 2.1 Defining Basic Attribute and Forming Hierarchical Framework

In Fuzzy Synthetic Evaluation, the attributes need to be identified. Major criteria of residents' perceptions are broken down to their sub-attributes levels. The sub-attributes are broken down until further disintegration is not possible. The management decision depends on the final score, which is a composite number obtained by grouping sub-attributes (Fig. 1).

In order to make the criteria used by FSE clearly reflect the impacts of tourism, the criteria of this study were o-

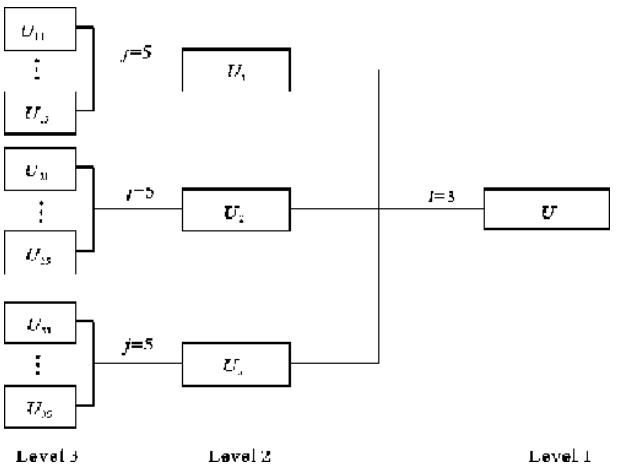


Fig. 1 Hierarchical structure for FSE

riginally derived from a comprehensive review of existing literatures about tourism impacts and residents' perceptions (BELISLE and HOY, 1980; MATHIESON and WALL, 1982; LIU and VAR, 1986; PERDUE et al., 1987; AP and CROMPTON, 1998; RYAN et al., 1998; SHELDON and TERESA, 2001; ZHANG, 2003; LEE and BACK, 2003; CAVE et al., 2003). Based on these articles, some evaluation attributes are supplied and excluded through interviewing the residents, tourism managers and tourists of some destinations while adopting the expert group's evaluating method to improve the accuracy of the description to the attributes and the reliability of the content. The evaluation attributes are classified according to three commonly used tourism impact categories: tourism economic impacts, tourism social and cultural impacts, and tourism environmental impacts, each with its own sub-attributes. Finally, 15 attributes and three hierarchies were used to evaluate the residents' perceptions of tourism impacts (Fig. 2). As is shown, the first level evaluation attribute of residents' perceptions of tourism impacts U consists of three latent attributes, which are residents' perceptions of tourism economic impacts $U_1$, residents' perceptions of social and cultural impacts $U_2$, and residents' perceptions of environmental impacts $U_3$, i.e. $U=U_i$ (i=1, 2, 3). And $U_i$ consists of the five sub-level attributes $U_{ij}$, i.e. $U_i=U_{ij}$ (j=1, 2, 3, 4, 5).

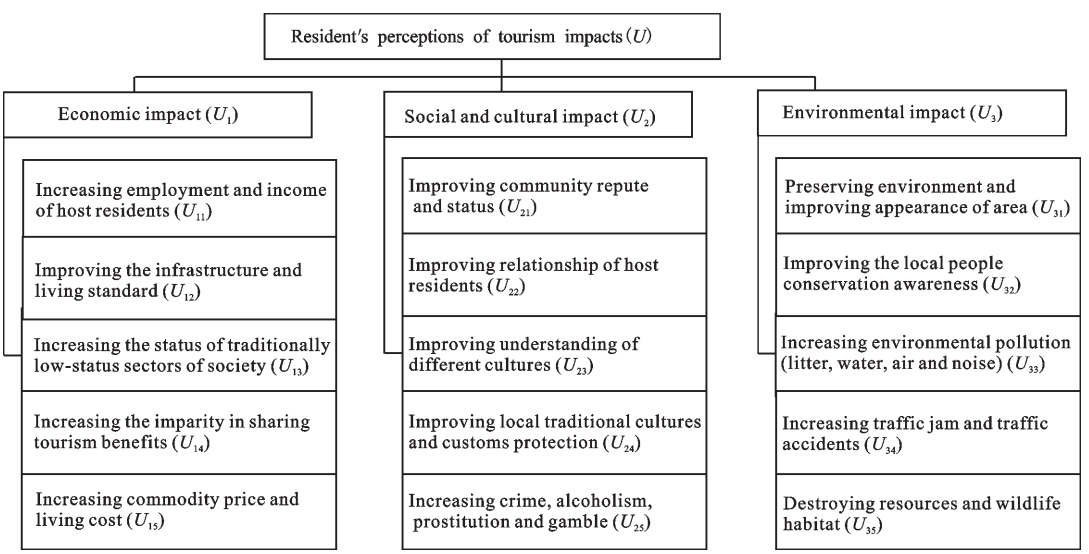


Fig. 2 Hierarchical structure of resident's perceptions of tourism impacts

## 2.2 Fuzzifying Basic Attribute

Fuzzification is the most important step in the FSE technique. The fuzzification process converts attributes into a homogeneous scale by assigning memberships with respect to predefined fuzzy subsets. Generally, 5- 11 qualitative levels are defined to express basic attributes. MADDOX (1985) recommended the use of a Likert-type scale in tourism impact research due to its superior validity. On the basis of the relevant research of residents' perceptions, a 5-point Likert-type scale of factor set was utilized in this study. $V_k=(v_1, v_2, v_3, v_4, v_5)$, with $V_k$ respectively expresses "strongly agree", "agree", "be neutral", "disagree" and "strongly disagree". The value of fuzzy membership function of each attributes related to the 5 evaluation levels can be calculated. In this study, consensus is established with the questionnaire survey on the issues of defining shapes of fuzzy sets for each basic attribute. The ratio between people belonging to evaluation $V_k$ and the total number of interviewees by questionnaire can be got. Therefore we can get the evaluation matrix $R_i$.

$$R_i=\begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} \end{bmatrix} \quad (1)$$

In the matrix, $r_{11}$ is the ratio between the numbers of interviewee under the attribute $U_{11}$ of "strongly agree" (the others like this) and the total of interviewees by questionnaires.

### 2.3 Determining Weight of Each Attribute

Fuzzy Synthetic Evaluation (FSE) requires information for relative importance of attributes (SADIQ and RODRIGNEZ, 2004). The relative importance is established by a set of preference weights, which can be normalized to a sum of 1. In the case of n attributes, a set of weights can be expressed as:

$$W=(w_1, w_2, \ldots w_n), \text{ where } \sum_{i=1}^{n} w_i=1 \quad (2)$$

Resident's perception of tourism impact cannot be ascertained according to an impact variable, each impact has its own contribution to the resident's perception, therefore, weight determination is a complex issue. SAATY (1988) proposed an analytical hierarchy process (AHP) to estimate the relative importance of each attribute using pair-wise comparisons. LU et al. (1999) and KHAN et al., (2002) also used a similar technique for calculating the weights of multiple attributes. GULEDA et al. (2004) calculated the weights for different attributes according to the knowledge and experience of experts. According to the hierarchical structure of residents' perceptions of tourism impacts, weight factors here were distributed according to expert opinion. The weight W can be determined by taking the geometric mean of each expert. The weight of each attribute can be expressed as follows:

$$W=(w_{ij})=(w_{i1}, w_{i2}, w_{i3}, w_{i4}, w_{i5}) \quad (i=1, 2, 3;\ j=1, 2, 3, 4, 5) \quad (3)$$

### 2.4 Aggregating Basic Attribute to Get Final Fuzzy Set

According to the hierarchical structure (Fig. 1), all attributes are grouped stepwise. Two sub-attributes are aggregated in this study. Making synthetic relationship calculation with $M(\cdot,+)$ model, we can get the vector $B_i$:

$$B_i=W^*R_i=b_{ij}=(b_{i1}, b_{i2}, b_{i3}, b_{i4}, b_{i5}) \quad (i=1, 2, 3;\ j=1, 2, 3, 4, 5) \quad (4)$$

$$B=[B_i]=\begin{bmatrix} B_1 \\ B_2 \\ B_3 \end{bmatrix}=\begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \end{bmatrix} \quad (5)$$

where $b_{ij}$ determines $U_i$ on the second level attributes parameter. Symbol "*" is integrated relations operator. Similarly, for other attributes at different hierarchical levels, this procedure is repeated, until the final fuzzy set A is obtained:

$$A=W^*B=(w_1, w_2, w_3)^*\begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & b_{33} & b_{34} & b_{35} \end{bmatrix} \quad (6)$$

### 2.5 Defuzzification

Defuzzification is a concept drawn from fuzzy control theory (ROSS, 1995), which emphasizes the decomposition of complex membership functions into one crisp value in response to the interpretation and implementation of the output from the fuzzy reasoning process. The crisp value can approximately represent the deterministic characteristics of the fuzzy reasoning process based on the assessment matrix, and help convert the uncertainty into an applicable action when solving real world problems (CHANG et al., 2001). Many different defuzzification methods such as "first of maximum (FOM)", "last of maximum (LOM)", and "mean of maximum (MOM)" are available (SADIQ et al., 2004). In this study, a 5-point Likert-type scale of factor set is expressed by five qualitative scales "strongly agree", "agree", "be neutral", "disagree" and "strongly disagree" (strongly agree=5, strongly disagree=1). The values of fuzzy synthetic evaluation are summed up with a resident's perception of tourism impacts ($P_i$). The $P_i$ value is calculated by the following equation:

$$P_i=5b_{i1}+4b_{i2}+3b_{i3}+2b_{i4}+b_{i5} \quad (7)$$

The coefficients are assigned referring the existing literatures in this study and guidelines may be established for the utility function $P_i$ based on expert opinions (LU et al., 1999). $P_i$ with the highest value represents the strongest resident's perception of tourism impacts.

## 3 CASE STUDY

There have been a number of case studies of tourism impacts. However, most studies directed at resident's perception of tourism impact, such as those in the west of Canada (RITCHIE, 1993), in the west of the US (AP and CROMPTON, 1993), in the west of UK (ROBSON and ROBSON, 1996) and in Australia (BROWN and GILES, 1994). Resident's perception of tourism impacts within China especially in national park is still an open point that has yet to be fully examined. This article takes Jiuzhaigou National Park in China as example to demonstrate the application of fuzzy synthetic evaluation method, in order to provide some information and expe-

rience for Chinese tourism research and Jiuzhaigou tourism manager.

### 3.1 Study Site

Jiuzhaigou National Park is situated in Jiuzhaigou County of Aba Tibetan Autonomous Prefecture of Sichuan Province, in the west of China. The whole national park is a Y-shape valley, measuring around 60km long and occupying an area of 734km$^2$, 52% of which is covered by virgin forests. There are 114 alpine barrier lakes in the Y-shaped drainage area, 17 waterfall clusters, 5 calcareous shoal streams, 47 fountains and 11 rapids in the valleys surrounded by 12 high peaks. Sceneries of water, plants, animals, mountains and peaks, and cultural interest make up the major types of landscape in Jiuzhaigou. It had long been said that Jiuzhaigou is a fairyland and the wonderland of the world. In December 1992, approved by the 16th conference of the World Heritage Committee of UNESCO, Jiuzhaigou was listed in "the World Heritage List", turning into a natural heritage site of global significance. On May 26, 1998, Jiuzhaigou was granted with the certificate of World Biosphere Reserve. And on July 4, 2002, Jiuzhaigou passed the certification process of Green Globe 21. Jiuzhaigou is one of the most popular tourism destinations keeping healthy and robust development. In 2001, 1 191 000 tourists visited Jiuzhaigou, while this was 400 000 for 1998, and in 2003 the number reached up to 1 290 000.

### 3.2 Study Method

The research was carried out from April 18 to 29 in 2004. All the data was obtained by the on site questionnaires and interviews in the park. The questionnaire was designed based on hierarchical framework of residents' perceptions of tourism impacts as described before.

The surveyed population included the residents living all year round in Jiuzhaigou National Park. By May 2004, Jiuzhaigou had held a population of 1007 in 249 households. For the purpose of the study, one fifth of the population was targeted for the sample, proportionally distributed among the park in accordance with the number of households. One questionnaire was from one household to avoid different people from the same family responded to the questionnaire. The time of interviews was selected to be evening, in order to be sure that the residents had returned home from work, most of whom involved in tourism industry. In all cases there was someone at home. The interviewed residents were asked to show their perception of the attributes listed in the questionnaire according to five ranks: "strongly agree", "agree", "be neutral", "disagree" and "strongly disagree". Finally there was 162 questionnaires were sent out at random among households. About 84.5% of response rate resulted from 137 usable questionnaires returned. The respondents consisted of 79 males (57%) and 58 females (43%). Their age ranged from 15 to 67 years old. The samples represent about 55% of the total households in Jiuzhaigou. At the same time, from interviews with Jiuzhaigou Administrative Office, information was obtained to consummate the questionnaire.

### 3.3 Results and Discussion

#### 3.3.1 Results

As described before, in this case study, the evaluation set $U=(U_1, U_2, U_3)$ contains 3 levels, $U_i$ consists of the five sub-level attributes $U_{ij}$, and the factor set V has 5 factors (strongly agree, agree, be neutral, disagree, strongly disagree). The evaluation matrix of 5 factors is $R=(r_{ij})$ and the weight set $W=(w_{ij})$.

Through analyzing the questionnaires with the above fuzzy synthetic evaluation method, evaluation matrix R is

$$R_1=\begin{bmatrix} 0.18 & 0.72 & 0.08 & 0.02 & 0.00 \\ 0.04 & 0.32 & 0.48 & 0.14 & 0.02 \\ 0.06 & 0.56 & 0.30 & 0.08 & 0.00 \\ 0.14 & 0.42 & 0.26 & 0.14 & 0.04 \\ 0.10 & 0.56 & 0.20 & 0.14 & 0.00 \end{bmatrix}$$

$$R_2=\begin{bmatrix} 0.38 & 0.42 & 0.18 & 0.02 & 0.00 \\ 0.06 & 0.38 & 0.40 & 0.14 & 0.02 \\ 0.24 & 0.48 & 0.24 & 0.04 & 0.00 \\ 0.04 & 0.24 & 0.44 & 0.22 & 0.06 \\ 0.08 & 0.22 & 0.28 & 0.32 & 0.10 \end{bmatrix}$$

$$R_3=\begin{bmatrix} 0.36 & 0.56 & 0.08 & 0.00 & 0.00 \\ 0.12 & 0.58 & 0.20 & 0.08 & 0.02 \\ 0.16 & 0.18 & 0.26 & 0.28 & 0.12 \\ 0.10 & 0.10 & 0.12 & 0.60 & 0.08 \\ 0.02 & 0.30 & 0.26 & 0.32 & 0.10 \end{bmatrix}$$

Following weight was defined according to seven tourism experts:

$W=(w_1, w_2, w_3)=(0.51, 0.21, 0.28)$

$W_1=(w_{11}, w_{12}, w_{13}, w_{14}, w_{15})=(0.38, 0.16, 0.08, 0.17, 0.21)$

$W_2=(w_{21}, w_{22}, w_{23}, w_{24}, w_{25})=(0.41, 0.15, 0.14, 0.26, 0.04)$

$W_3=(w_{31}, w_{32}, w_{33}, w_{34}, w_{35})=(0.32, 0.22, 0.14, 0.17, 0.15)$

With W and R, evaluation sets are got of second level attributes are as follow:

$B_1=W_1*R_1=(0.1244, 0.5586, 0.2174, 0.0896, 0.01)$

$B_2=W_2*R_2=(0.212, 0.3676, 0.293, 0.1048, 0.0226)$

$B_3=W_3*R_3=(0.184, 0.394, 0.1654, 0.2068, 0.0498)$

Make synthetic evaluation of the first level, and the final evaluation set is got:

$A=W*B=(0.1595, 0.4724, 0.2187, 0.1256, 0.0238)$

By defuzzification, with equation (6), the value of the membership which decides the classification of the fuzzy set $P_i$, the residents' strongest perception of tourism impacts $P_{max}$ and the residents' final synthetic perception of tourism impacts $P_{final}$ are got:

$$P_1=5b_{11}+4b_{12}+3b_{13}+2b_{14}+b_{15}=3.6978$$
$$P_2=5b_{21}+4b_{22}+3b_{23}+2b_{24}+b_{25}=3.6416$$
$$P_3=5b_{31}+4b_{32}+3b_{33}+2b_{34}+b_{35}=3.4556$$

The resident's strongest perception of tourism impacts in Jiuzhaigou $P_{max}$ is

$$P_{max}=\max(P_1, P_2, P_3)=P_1=3.6978$$

Similarly, making the defuzzification of the final fuzzy set A, we can get:

$$P_{final}=5\times0.1595+4\times0.4724+3\times0.2187+2\times0.1256+0.0238=3.6182$$

3.3.2 Discussion

From Table 1, some conclusions of resident's perception of tourism impacts in Jiuzhaigou National Park were gotten.

First, the residents in Jiuzhaigou have positive perception of tourism impacts, P=3.6182, which between 3 and 4. For in the past, local residents focused on agriculture and husbandry activities. Along with the development of tourism, changes are obvious in local farmers' production patterns. In 2000, most local residents participated in tourism management. There are 379 staffs, of which 205 are local residents in the park. Most of the personnel in the protection department, environmental sanitation department, full-time fire brigade, patrolling team, security department, ticketing office, entrance guard, and resident administrative office are local residents. This contributed to the enthusiasm and initiative of local residents in the tourism development of Jiuzhaigou. Most residents involved in the tourism development and get the benefits, which results in the high positive perception of tourism impacts. Residents are satisfied with the present development of tourism. Similar conclusion has been proved by many existing studies (PERDUE et al., 1987; AP and CROMPTON, 1998; PAULINE and TERESA, 2001; ZHANG, 2003; RYAN and PANAKERA, 2003).

Table 1 Results of Jiuzhaigou resident's perception of tourism impacts

| Attribute | Fuzzy aggregation ( $b_{ij}$) | | | Defuzzification | | |
|---|---|---|---|---|---|---|
| | SA | AG | BN | DA | SD | P |
| Resident's perception of tourist economic impacts | 0.1244 | 0.5586 | 0.2174 | 0.0896 | 0.0100 | $P_1$=3.6978 |
| Resident's perception of tourist social and cultural impacts | 0.2120 | 0.3676 | 0.2930 | 0.1048 | 0.0226 | $P_2$=3.6416 |
| Resident's perception of tourist environmental impacts | 0.1840 | 0.3940 | 0.1654 | 0.2068 | 0.0498 | $P_3$=3.4556 |
| Resident's perception of synthetic tourist impacts | 0.1595 | 0.4724 | 0.2187 | 0.1256 | 0.0238 | P=3.6182 |

Notes: SA: strongly agree; AG: agree; BN: be neutral; DA disagree; SD strongly disagree

Second, local residents get great economic benefit from the tourism development. With economic benefit increase, local resident's perception of tourism economic impact is positive. From the perception of all attributes, the degree of resident's perception of tourism impact is not balanced, among which the perceptions of economic impacts is at comparatively higher level ($P_{max}=P_1$= 3.6978). This conclusion is accordant to the status quo of Jiuzhaigou development. At present, local residents get considerable economic benefits from tourism development. Tourism booming remarkably promoted the comprehensive development of local tertiary industry. It contributes 40% to the increase of local GDP, making significant contribution to local financial revenues. The income of the local residents was a constant rise and standard of living increase. Taking the year of 2003 as an example, the total salary income of employees increased 36% against that of 2002. For local residents, economy is still the main factor to stimulate the residents in Jiuzhaigou and the residents' perceptions of the tourism positive economic impacts are much greater than that of negative impacts.

Third, resident's positive perception of tourism environmental impacts is relatively weak. Despite the fact that local resident's perception of tourism environmental impacts is high, $P_3$=3.4556, it is behind the perceptions of other impacts. Resident's perception of tourism environment impacts comparatively lower means the problems caused by tourism development on environment are bigger than that on others. The reasons are as following: firstly Jiuzhaigou is a nature reserve as well as a famous national park, and conflict often exists between resources protection and tourism development. Secondly, large numbers of visitors pose a potential threat to natural environment. In peak seasons, visitors oftentimes got off the trail into the forest, which led to vegetation loss and soil erosion. Thirdly, the behaviors of local residents (i.e. herb collecting, poaching, and collecting of forest by-products) result in damage to wildlife and their habitat. Resident's positive perception of environmental impacts is relatively weak, but local residents showed certain concern about the environmental protection of the whole national park.

## 4 CONCLUSION

Investigating resident's perception of tourism impacts is a good method to analyze the status of tourism impacts. This study focuses on the development of a Fuzzy Synthetic Evaluation framework to analyze the resident's perception of tourism impacts. The conclusions are summarized as the following:

(1) The FSE method involves identification of basic attributes, fuzzification, estimating weights, aggregation, and defuzzification. The basis attributes were fuzzified using five fuzzy subsets. The fuzzified values of each basic attribute were grouped for each discharge scenario using the hierarchical structure. The final fuzzy sets were defuzzified and utility function values were evaluated to determine the ranking order for resident's perception of tourism impact. Compared with other methods, Fuzzy Synthetic Evaluation method can be used as assessment techniques for tourism impact data having fuzziness within the data and standards. The usage of weight increases the sensitivity of the FES methods. Fuzzy Synthetic Evaluation enables the synthesis of resident's perception of tourism impacts data into a single framework. Its modular form is scalable which enables to supply the accommodation of new impacts attributes. It assigns memberships to various attributes of tourism impacts and aggregates the vagueness throughout the grouping process. Also it integrated the complex membership functions into one value, which can approximately represent the determining characteristics of resident's perception.

(2) Fuzzy Synthetic Evaluation is sensitive to the selection of weights and aggregation operators, which are usually established based on expert opinions with strong subjectivity. The framework of resident's perception of tourism impacts presented in this study is a simplified demonstration of the approach. The future study must consider a comprehensive structure with a major effort, including the collaboration of several experts in various fields.

(3) Fuzzy Synthetic Evaluation method is applied to analyzing the resident's perception of tourism impacts in Jiuzhaigou National Park of China. With Fuzzy Synthetic Evaluation, we can get that in Jiuzhaigou the residents have relatively stronger positive perception of the tourism impacts, and most residents involved in the tourism development and get the benefits, which results in the positive perception of tourism impacts. Local residents get great economic benefit from the tourism development, so their perception of tourism economic impact will be positive with economic benefit increase. Economy is still the main factor to stimulate the residents. The resident's positive perception of tourism environmental impacts is relatively weak, and local resident's understanding of the need to protect the environment and of the laws designed to protect the environment should be improved. The finding of case study clearly indicates that the Fuzzy Synthetic Evaluation may successfully analyze the resident's perception of tourism impact.

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## REFERENCES

ALLEN L R, LONG P T, PERDUE R R et al., 1988. The impact of tourism development on resident's perception of community life [J]. Journal of Travel Research, 27(1): 16- 21.

ANTONIA Besculides, MARTHA E Lee, MCCORMICK Peter J, 2002. Resident's perception of the cultural benefits of tourism [J]. Annals of Tourism Research, 29(2): 303- 319.

AP J, 1992. Resident's perception on tourism impacts [J]. Annals of Tourism Research, 19(4): 665- 690.

AP J, CROMPTON J L, 1993. Respondents' strategies for responding to tourism impacts [J]. Journal of Travel Research, 32(1): 47- 50.

AP J, CROMPTON J L, 1998. Developing and testing a tourism impact scale [J]. Journal of Travel Research, 37(2): 120- 130.

BELISLE F, HOY D, 1980. The perceived impact of tourism by residents [J]. Annals of Tourism Research, 11(1):83- 101.

BROWN G, GILES R, 1994. Resident responses to the social impact of tourism [A]. In: SEATON et al.(eds.). Tourism: as State of the Art [C]. Chichester: Wiley, 755- 764.

CARMICHAEL Barbara A, 2000. A matrix model for resident attitudes and behaviors in a rapidly changing tourist area [J]. Tourism Management, 21(6): 601- 611.

CAVE J, RYAN C, PANAKERA C, 2003. Resident's perception, migrant groups and culture as an attraction—the case of a proposed Pacific Island cultural center in New Zealand [J]. Tourism Management, 24(4): 371- 385.

CEVAT Tosun , 2002. Host perception of impacts: a comparative tourism study [J]. Annals of Tourism Research, 29(2): 231- 253.

CHANG Ni-bin, CHEN H W, NING S K, 2001. Identification of river water quality using fuzzy synthetic evaluation approach [J]. Journal of Environmental Management, 63: 293- 305.

COOKE K, 1982. Guidelines for socially appropriate tourism development in British Columbia [J]. Journal of Travel Research, 21(1): 22- 28.

CROMPTON R, SANSWESON K, 1990. Gendered Jobs and

Social Change [M]. London: Unwin Hyman.

DONG Guan-zhi, YANG Feng-ying, 2005. A study on the evaluation system of tourist satisfaction degree in tourism areas [J]. Tourism Tribune, 1: 27- 30. (in Chinese)

GULEDA Onkal-Engin, IBRAHIM Demir, HALIL Hiz, 2004. Assessment of urban air quality in Istanbul using fuzzy synthetic evaluation [J]. Atmospheric Environment, 38: 3809- 3815.

KHAN F I, SADIQ R, HUSAIN T, 2002. Green pro-I: a risk-based life cycle assessment and decision-making methodology for process plant design [J]. Environmental Modeling and Software, 17: 669- 692.

KO Dong-wan, STEWART William P, 2002. A structural equation model of resident's attitudes for tourism development [J]. Tourism Management, 23: 521- 530.

KRIPPENDORF J, 1987. The Holiday Makers. Understanding the Impact of Leisure and Travel [M]. Oxford: Butterworth Heinemann.

LANKFORD S V, HOWARD D R, 1994. Developing a tourism impacts attitude scale [J]. Annals of Tourism Research, 21(1): 121- 139.

LASCIO L D, 2002. A fuzzy-based methodology for the analysis of diabetic neuropathy [J]. Fuzzy Sets and Systems, 129: 203- 228.

LAWRY J, 2001. A methodology for computing with words [J]. International Journal of Approximate Reasoning, 28: 51- 89.

LAWSOM J Williams, YOUNG T, COSSENS J, 1998. A comparison of residents' attitudes towards tourism in 10 New Zealand destinations [J]. Tourism Management, 16(8): 247- 256.

LEE Choong-ki, BACK Ki-joon, 2003. Pre-and post-casino impact of resident's perception [J]. Annals of Tourism Research, 30 (4): 868- 885.

LEE H M, 1996. Applying fuzzy set theory to evaluate the rate of aggregative risk in software development[J]. Fuzzy Sets and Systems, 79: 323- 336.

LI Gen-chang, WANG Zi-guo, XUE Hua-cheng, 1999. Fuzzy synthetic evaluation of the tourism situation in Sanya [J]. Systems Engineering Theory and Practice, 5: 110- 113. (in Chinese)

LIU J C, VAR T, 1986. Resident attitudes toward tourism impacts in Hawaii [J]. Annals of Tourism Research, 13(2): 193- 214.

LIU Wei-hua, 2000. Some theoretical thoughts about community involved tourism development [J]. Tourism Tribune Bimonthly, 1: 47- 52. (in Chinese).

LU R S, LO S L, HUJ Y, 1999. Analysis of reservoir water quality using fuzzy synthetic evaluation [J]. Stochastic Environmental Research and Risk Assessment, 13, 327- 336.

MADDOX R N, 1985. Measuring satisfaction with tourism [J]. Journal of Travel Research, 23(3): 2- 5.

MADRIGAL Robert, 1995. Residents' perception and the role of government [J]. Annals of Tourism Research, 22(1): 86- 102.

MATHIESON A, WALL G, 1982. Tourism, Economic, Physical and Social Impacts [M]. Harlow, Essex: Longmans.

PERDUE R R, LONG P T, ALLEN L R, 1987. Rural resident of tourism perception and attitudes [J]. Annals of Tourism Research, 14(3): 420- 429.

PIZAM A, 1978. Tourism impacts: the social costs to the destination community as perceived by its residents [J]. Journal of Travel Research, 16(4): 8- 12.

RITCHIE J, 1993. Crafting a destination vision: putting the concept of resident-responsive tourism into practice [J]. Tourism Management, 14(5): 379- 389.

ROBSON J, ROBSON I, 1996. From sharchloders to stakeholders: critical issues for tourism marketers [J]. Tourism Management, 17(7): 533- 540.

ROSS T J, 1995. Fuzzy Logic with Engineering Applications [M]. New York: McGraw-Hill .

RYAN C, SCOTLAND A, MONTGOMERY D, 1998. Resident attitudes to tourism development: a comparative study between the Rangitikei, New Zealand and Bakewell, United Kingdom [J]. Progress in Tourism and Hospitality Research, 4(2): 115- 130.

SAATY T L, 1988. Multicriteria Decision-making: the Analytic Hierarchy Process [M]. Pittsburgh, PA: University of Pittsburgh.

SADIQ Rehan, HUSAIN Tahir, VEITCH Brian, 2004. Risk-based decision-making for drilling waste discharges using a fuzzy synthetic evaluation technique [J]. Ocean Engineering, 31: 1929- 1953.

SADIQ Rehan, RODRIGUEZ Manuel J, 2004. Fuzzy synthetic evaluation of disinfection by-products—a risk-based indexing system [J]. Journal of Environmental Management, 73: 1- 13.

SHARPLEY R, 1994. Tourism, Tourists and Society [M]. Huntingdon: ELM.

SHELDON Pauline J, TERESA Abenoja, 2001. Resident attitudes in a mature destination: the case of Waikiki [J]. Tourism Management, 22(5): 435- 443.

URRY J, 1991. The sociology of tourism [J]. Progress in Tourism, Recreation and Hospitality Management, 3: 48- 57.

WEAVER B David, LAWTON J Laura, 2001. Resident perception in the urban-rural fringe [J]. Annals of Tourism Research, 28(3): 439- 458.

WILLIAMS John, LAWSON Rob, 2001. Community issues and resident opinions of tourism [J]. Annals of Tourism Research, 28 (2): 269- 290.

WILLIAMS T A, 1979. Impact of domestic tourism on host population the evolution of a model [J]. Tourism Recreation Research, 14(1): 15- 21.

ZADEH L A, 1965. Fuzzy sets [J]. Information and Control, 8: 338- 353.

ZHANG Jin-he, 2003. Research on ancient village resident's perception of tourism impact—a case of village Yixian-Xidi [J]. Geography and Geo-information Science, 19(2): 105- 109. (in Chinese)