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Study on Appraising of Benefit about Zoology for Land Consolidation in Nei Jiang City

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Abstract

This article through establishes indicator-system of land arrangement assessment for ecological benefit at Baima town, land arrangement assessment for ecological benefit based on fuzzy comprehensive Assessment. The level is middling, the conclusion from land arrangement assessment for ecological benefit. The paper finally carries on the discussion on current land arrangements existence many questions, simultaneously proposed the land arrangements improvement measure.

Keywords: land arrangement, environment, pattern, mountainous region, upland

1. Introduction

In China, we have achieved remarkable results since we had measures of land exploitation and consolidation. While the soil properties will change by inappropriate ways, methods and technical measures of land consolidation, reduction of biodiversity, decline of farmland ecosystem stability, and potentially harmful effects to land productivity result in land desertification (Ye & Wu, 2001). The goals of land consolidation is increase arable land in most regions of our country, but has not made great achievements in improving ecological environments. Actually, the development trend of land consolidation currently is combine it and conservation of ecological environment. At present, in the study of relationship between land consolidation and environment, Qinghui Tang has established a evaluation index system of environmental impact of land consolidation in general sense, on the basis of analysis environmental impact of land consolidation, identified environmental factors through Leon Porter interaction matrix and analyze different levels of impact that projects to environmental factors (Tang, 2004). And Guoan Li has evaluated the benefits of land consolidation by factor and cluster analysis which include environmental benefit assessment (Li, 2005).

This article use fuzzy comprehensive assessment to evaluate ecological benefit. In this method could satisfy two characteristics of it: firstly, due to the ambiguity of this way, the judgement of index could fulfill the feature of using powers to evaluate qualitative indicators; moreover, it could obtain the objective conclusions of evaluation because the model of this method possess objective integration of multi-level index system. The landform of Baima town is a typical shallow hill zone in basin and the area of land consolidation is 1033.59hm^2, while the city of Neijiang in a hilly area, and more of the hills, shallow hill topography. From the perspective of topography and area of land consolidation, choosing the Baima town to study because it could represent the basic situation of land consolidation in Neijiang. After integral evaluation of ecological benefit by fuzzy comprehensive assessment, the mode of ecological consolidation has important practical significance to guide the land consolidation of ecotype in Neijiang city even whole hilly areas in Sichuan province based on evaluation results.

2. Study Area

2.1 Location and Scope

The study area is located in Baima town that is 7000 meters far from the downtown. It extends from 104°59′E to 105°07′E and from 29°28′N to 29°37′N, covering a total area of 1033.59 ha. And related to 5 villages and 48 groups that include Heping, Haitang, Qianzi, Zhanjia, Shuanghe.

2.2 Landform

Tuojiang river lies in study area. This area is a hilly region of red layer in south of Sichuan. Landform of there is a typical shallow hill area in basin. There are four soil types, especially purple soil possess most of study area that 60 percent of the total cultivated area. Mineral contents of purple soil nutrients is rich, higher fertility, texture is more sticky and structure is agglomerate. PH of this soil is 7.0 to 7.5. And then is paddy soil which have 30 percent in total cultivated area. Sort of this area is suitable for planting because this soil have more deeper soil layer and more fertile. In whole area, there are more slopes, less ladder ground. It has poor natural conditions.

2.3 Land Use Structure

According to the latest land accounting statistics of 2003, study area around 1033.59 ha. Take out forest land, garden land, urban mixed use land, transportation land and part of house site which are not participate in consolidation, the area of construction is 780.12 ha that occupy 75.47 percent of total area.

Table 1. Different structural of land type

Classification	Land type	Area (ha)	Total land area (%)
Agricultural land	Arable land	606.59	58.69
	Forest land	20.76	2.01
	Garden land	71.61	6.93
	Other agricultural land	146.03	5.7
Construction land	Residential and industrial land	92.82	8.98
	Transportation land	54.51	5.27
	Waters	25.59	2.48
Unused land	Grassland	15.68	1.52

3. Appraising of Benefit about Zoology for Land Consolidation in Nei Jiang City

3.1 Determination of Index

The benefit about zoology for land consolidation is in the process and completion of land consolidation activities. Ecological components, process and service function of the objects make a difference, thus have effect on human's living environment and production conditions. The ecosystem principles of land consolidation include time, location, species, interference and landscape (Dale et al., 2000).

Appraising of benefit about zoology for land consolidation is an assessment of composite system. After land consolidation, the main effect of changing of ecosystem and benefit about zoology is having impact on atmosphere, waters, soil, vegetation and organism of inside area. Selected evaluation parameters can reflect influence of status of environment and construction projects and can describe the sensitive and weak point of environment for moderate (Gao, 2003). And the evaluation is related to sustainable utilization of land in certain area. This assessment can prevent and reduce adverse effect on environment in the area after land consolidation implementation, and it's an indispensable key link in planning and design of farmland consolidation.

The index system in this paper is refer to index of ecological benefit which is suggested by Zhangchao (2003) in 'Index establishment and method application of land consolidation benefits evaluation'. And from reality of Baima town establish land arrangements ecology benefit appraisal refers (Table 2).

Table 2. Baima town land arrangements ecology benefit appraisal refers

Ecology benefit appraisal refers	Waters	Water quality index
		Water balance index
		Soil and water loss
		Irrigation assurance probability
	Soil	Soil fertility index
		Degree of soil erosion
		Soil pollution situation
		The control rate of soil degradation
	Vegetation and Organism	Forest coverage rate
		Biodiversity
	Ecology landscape	Landscape fragmentation
		Landscape diversity

3.2 Ecology Benefit Evaluation Based on Fuzzy Comprehensive Assessment

3.2.1 Selection of Appraisal Factor Set U

Based on this article through the Delphi method to establish the weight, the weight set in Table 3 and Table 4.

Table 3. Land arrangements ecology benefit appraisal target - weight

Basic evaluation factors	Weight	Secondary factors	Weight
Waters	0.15	Water quality index	0.15
		Water balance index	0.2
		Soil and water loss	0.4
Soil	0.15	Irrigation assurance probability	0.25
		Soil fertility index	0.15
		Degree of soil erosion	0.3
		The control rate of soil degradation	0.3
Vegetation and Organism	0.4	Soil pollution situation	0.25
		Forest coverage rate	0.5
		Biodiversity	0.5
Ecological landscape	0.3	Landscape fragmentation	0.5
		Landscape diversity	0.5

Table 4. Land arrangements ecological environment weight

Basic evaluation factors	Weight	Secondary factors	90-100	75-90	60-75	0-60
Water	0.15	Water quality index	0	0.4	0.4	0.2
		Water balance index	0	0.3	0.4	0.3
		Soil and water loss	0	0.1	0.4	0.5
		Irrigation assurance probability	0	0.3	0.5	0.2
Soil	0.15	Soil fertility index	0.1	0.3	0.4	0.2
		Degree of soil erosion	0	0.1	0.4	0.5
		The control rate of soil degradation	0	0.1	0.5	0.4
		Soil pollution situation	0	0.5	0.4	0.1
Vegetation and Organism	0.4	Forest coverage rate	0.1	0.2	0.3	0.4
		Biodiversity	0	0.2	0.3	0.4
Ecological landscape	0.3	Landscape fragmentation	0	0.2	0.4	0.4
		Landscape diversity	0	0.3	0.4	0.3

3.2.2 Establish Comments Set V

For appraising each evaluation factors and final result need establish comments set $v = \{v1, v2, -, vn\}$. According to the current level of evaluation which is often used, establish comments set below such as: v = {excellent, good, favorable and poor}.

3.2.3 Determination Weight Set a of Each Evaluation Factors

From table of land arrangements ecological environment weight set with multilayer appraisal factors, to the ecological environment of Neijiang city, reflects its ecological condition factor is varied and each factor of this evaluation is indispensable. In order to express importance of each factor in evaluation and effect of ecological quality, it becomes essential to establish the weight set like $A = (a_1, a_2, ..., a_m)$ to show the function of each factor and difference of impact. In this way, it could make objective and fair evaluation to ecological status of Neijiang after land consolidation. So far there are common methods of determining the weight distribution, such as expert experience method, statistics, close degree law, etc. And we use expert experience method to determine weight in this article. According to ecological appraisal experts by long-term accumulated experience, on the basis standard of this country and territory and combining the ecological environment of the evaluation work practice, the determination of each weight factor in Table 3.

3.2.4 Single Factor Evaluation and Establish Fuzzy Evaluation Matrix R

To determine membership of each factor for each assessment rate by single factor evaluation. For a sake, establish a evaluation group with l people, each member in the group assess V_1, V_2,… for each U_i $(i = 1,2,....m)$, everyone in V_p is only a level. If there are l_{ij} members evaluate U_i is V_j, then $\sum l_{ij} = l$. And the evaluation result of V_t is a fuzzy subset of $F(V)$. When expert scoring, steps of determining membership of each comment as follows:

Firstly, take the defect of each factor as same as in the traditional method, according to the degree and amount of defect, take off points in accordance with the standard. Then obtain the total take-off-points of this factor by add all points which have been took off in this method.

Second, using expert to score the part that some factors' quality information are not enough to the part of defects for evaluation and determine the membership by this way. For instance, as to a non-defect part of appraisal factor, if there are 50 percent of experts scoring in the excellent level range or rated excellent, 35 percent of experts in good scores range or rated good grade and 15 percent of experts scoring in the limited range or awarded grade qualified, the non-defective part of the factor to the comments membership is {0.5, 0.35, 0.15, 0}.

In addition, take each factor's corresponding scores of the expert in various grades minus the defective scores as final result of the factor in different levels. Namely each factor final score is the basic quality evaluation value

minus the take-off-score with defects. In terms of these results to reassure quality grade of the factor owned. And the membership should be adjust to the membership that basic quality information corresponding to each level scores

No matter use what methods for single factor evaluation, it must have a fuzzy mapping from U to V, $f:(u)\to j(v)$, $U_i \to (v_i) = R = (r_{i1}, r_{i2},..... r_{ip}) \in j(v), (i = 1,2,..... m)$. The fuzzy mapping f could induce the fuzzy relationship: $R_f \in J(U * V)$, that is $R_f(U_i,U_j) = f(U_i)(V_i) = R$.

Therefore, R_f could represent by fuzzy matrix $R \in Umxp$,

$$R = (R_1, R_2,....., R_n)^T = \begin{bmatrix} r_{11} & r_{12} & ..... & r_{1p} \\ r_{21} & r_{22} & ..... & r_{2p} \\ & & ..... & \\ r_{m1} & r_{m2} & ..... & r_{mp} \end{bmatrix}_{mxp}$$

R is a single factor evaluation matrix, r_{ij} is the subordination relationship that the factor u_i which in u corresponding to the level v_{ij} which in v. And all of this constitute basis of fuzzy comprehensive assessment.

3.2.5 Mathematical Model Selection

According to the references (Wang et al., 2003), there are four main evaluation models. In this study we use one of them.

$M(\bullet,V)$, correspondingly $b_j = \frac{m}{i=1}(a_i \bullet r_{ij})$, and "•" represent ordinary multiplication of real numbers.

In this model, the factor play a major role is highlighted. As the consequence, this model have an advantage when we need prominent the main factor. In this evaluation we need to make factor of ecology stand out, so we choose this mode l.

3.2.6 Fuzzy Evaluation

3.2.6.1 Second layer calculation first

Firstly, take the second floor of the first factor to assessment operations.

The weight set of second floor of the first factor: $A_{12} = (0.15 \quad 0.2 \quad 0.4 \quad 0.25)$

The membership degree of second floor of the first factor:

$$R_{12} = \begin{bmatrix} 0 & 0.4 & 0.4 & 0.2 \\ 0 & 0.3 & 0.4 & 0.3 \\ 0 & 0.1 & 0.4 & 0.5 \\ 0 & 0.3 & 0.5 & 0.2 \end{bmatrix}$$

By the model obtained the membership degree of first floor of the first factor.

$B_1 = A_{22} * R_{12} = (0 \quad 0.235 \quad 0.425 \quad 0.34)$

Similarly to

$$B_2 = A_{22} * R_{22} = (0.15 \quad 0.3 \quad 0.3 \quad 0.25) * \begin{bmatrix} 0.1 & 0.3 & 0.4 & 0.2 \\ 0 & 0.1 & 0.4 & 0.5 \\ 0 & 0.1 & 0.5 & 0.4 \\ 0 & 0.5 & 0.4 & 0.1 \end{bmatrix}$$

$$= (0.015 \quad 0.23 \quad 0.43 \quad 0.325)$$

$$B_3 = A_{32} * R_{32} = (0.5 \quad 0.5) * \begin{bmatrix} 0.1 & 0.2 & 0.3 & 0.4 \\ 0 & 0.2 & 0.3 & 0.4 \end{bmatrix}$$

$$= (0.05 \quad 0.2 \quad 0.3 \quad 0.4)$$

$$B_4 = A_{42} * R_{42} = (0.5 \quad 0.5) * \begin{bmatrix} 0 & 0.2 & 0.4 & 0.4 \\ 0 & 0.3 & 0.4 & 0.3 \end{bmatrix}$$

$$= (0 \quad 0.25 \quad 0.4 \quad 0.35)$$

3.2.6.2 First floor calculation

$$B = A_1 * R_1 = (0.15 \quad 0.15 \quad 0.3 \quad 0.4) * (B_1 \quad B_2 \quad B_3 \quad B_4)\mathrm{T}$$

$$= (0.15 \quad 0.15 \quad 0.3 \quad 0.4) * \begin{bmatrix} 0 & 0.015 & 0.05 & 0 \\ 0.235 & 0.23 & 0.2 & 0.25 \\ 0.425 & 0.43 & 0.3 & 0.4 \\ 0.34 & 0.325 & 0.4 & 0.35 \end{bmatrix}$$

$$= (0.34 \quad 0.325 \quad 0.4 \quad 0.325)$$

3.2.6.3 Evaluation results

The total evaluation results of land consolidation benefit are based on each membership degree of aggregate V. That the membership degree of excellent is 0.34, the membership degree of good is 0.325, the membership degree of limited is 0.4 and the membership degree of poor is 0.35. On the basis of the principle of maximum membership degree, the ecological benefit of land consolidation of study area that Baima town in Neijiang city is limited level. Furthermore, there is still having some ecological instable factors of land consolidation in this area.

4. Discussion and Results

(1) There is lack of ecological landscape in process of land consolidation. From Table 4 we could get the information that proportion of vegetation and organism is 40 percent, the proportion of ecological landscape is 30 percent. Actually they have the lower scores. The forest coverage rate and biodiversity are accounted for 30 percent in 60-70 column, while accounted for 40 percent in lower than 60 column. In the result of fuzzy appraisement, the membership degree of vegetation and organism, landscape fragmentation and landscape biodiversity, all of them are accounted for 40 percent in 60-70 column and also accounted for 40 percent in lower than 60, while landscape biodiversity is accounted for 30 percent in lower than 60.These data illustrate that current land consolidation is to sacrifice the cost of organism, vegetation and original landscape, and yet forest could effectively prevent affecting and flushing of precipitation directly to ground soil, reduce soil erosion (Lin et al., 2002). The way of planting in study area is longitudinal planting, the soil there is loose after farming and water and soil easily loss after scouring of rainstorm. Because of that the overall function of ecological system of agriculture is fragile. However, the protection of ecological environment in land consolidation of Baima town only reflected in planting trees at both sides of field road and ditches. Instead of assessing the environmental impact early in the project, after the project not consider the eco-efficiency assessment and ecological restoration. There is no technical solution proposed and only a preliminary analysis of the ecological benefits.

(2) There are some problems in planning and designing of land consolidation project. The mainly effect is that road works and terracing looks completed the requirement of road accessibility, but at the expense of ecological balance. Especially, more than 95 percent of engineering materials using cast. Lack of necessary vegetation protection measures, have effect on biodiversity of organism and caused the soil and water pollution. As the project according to a fixed standard, there have been some high ridge ladder and the ladder of narrow staircase, ladder ridge have poor stability through adoption of deep-fried rock fill, and retaining water and fertilizer is not ideal.

5. Advice and Suggestions

(1) Land consolidation should not rigidly adhere to the existing fixed pattern and should take full account of local conditions of the actual situation of local. Such as the terracing project, because there are more sloping fields and less ground ladder in Neijiang city. In the traditional model of land consolidation is a commonly used method terrace. In a certain extent this method although improved conditions for agricultural production, reduce erosion but also to a certain extent it would destroy the microclimate and agricultural ecological environment. The way of changing a hillside fields to a ladder for shorter slope of cultivated land consolidation useful, but for a longer arable land consolidation slope is not effective (Zhou et al., 2001). While slope longer arable land consolidation can combine with soil and water conservation project, using slope-canal-ladder engineering model and determine the retention ratio of slope and terrace area by designing according to different slope surface runoff and achieve crop production potential water when the balance of the relationship. Plant protective shelter belts and economic forest in hill slope and breed cash crops and food crops in terrace field. The construction of canals inside is to regulate the irrigation and from top to bottom slope after a period for a terrace. Generally the same in the case of ground slope, the longer the slope, the erosion is stronger and the more serious soil erosion. Reduce the slope length of slope is conducive to control water loss and soil erosion, consequently, the formation of the slope, ditches, terraces combined and agriculture, forestry, water comprehensive management model

(Jiang, 2001). The slope-canal-ladder engineering model effectively maintain and use of sloping land and water resources, also conducive to soil conservation, improved soil structure and texture. It helps to improve the regional agricultural environment and maintain the ecological stability of hillsides and the sustainable use of land resources.

(2) Planning and design of land consolidation project is to increase soil and water conservation measures to solve the ecological problems. Embodied in the design of typical field, on the slope, the direction of field has effect on the size of surface runoff and the likelihood of erosion processes. In order to reduce amounts of surface runoff and soil erosion should take cross-sectional slope planting on the slope. In the study area, the long side of fields with 3°-6° along the contour lines. There are three kind of alternation of slope and terrace (Li, 1997): ①The level terraces is on the slope that take a method of semi-filling- semi-excavating along the contour lines and build the level field, uniformed ridge on farmland; ②The sloping terraces that slope at regular intervals in the distance, along the ridge contour trenching construction, the slope is divided into a number of the sloping contour strip plots section; ③The alternation of slope and terrace it means there is a slope which maintains the status between two horizontal steps, it's a combination of level terraces and sloping terraces. Design to grass for slope protection or plant shrubs, legumes on the ridge. Achieving ridge green can prevent water and soil loss, protect ridge security, but also to increase income (Zhang & Long, 2005).

(3) In the process of land consolidation should protect arable land, combined with the sustainable use of land resources, comprehensive prevention and control of land degradation. To increase arable land through land consolidation requires additional grain production capacity in essence (Li & Huang, 2001). But the ability to increase food production should be the amount of cultivated land, both the quality and ecological protection (Zheng, 2003). At the same time should be organized and unified planning forest, village, ditch, furrow, field, water and road. For existing farming methods to reform that is the change longitudinal farming for cross-sectional slope farming. And according to local vegetation coverage of poor situation should increase forest planting.

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