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Natural Disaster Risk Assessment of Grain Production in Dongting Lake Area, China

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Abstract

Dongting Lake area is one of the primary commodity grain bases in China, while the grain production there is suffering from serious harm of natural disaster such as flood, drought, pests and mouse damage. In general, the historical data recorded of natural disasters in small region are not enough to be used for estimating the probability distribution in risk assessment, because the size of the sample observed is smal1. In this study, the method “Information Diffusion” is used to change limited sample observations into fuzzy sets, and a quantitative analyzing model for natural disasters risk assessment is proposed. Based on the statistical data of grain planting area and hazard area during the period of 1986-2006 in Dongting Lake area, the probability of natural disaster risk of grain production was calculated by using the Information Diffusion Theory in each county. The results showed that the probabilities of natural disaster risk of the area hazard ratio (AHR) of grain production over 10% , 20%, 30%, 40% were between 0.3576～0.9344, 0.0880～0.8618, 0.0080～0.7757, 0～0.6569 respectively in different county. Meanwhile, the natural disaster risk assessment maps of grain production were obtained based on GIS. The spatial distribution characteristics of natural disasters risk of grain production were analyzed. Finally, the strategies and measures were put forward to reduce natural disaster risk of grain production in Dongting Lake area.

Key words: Information Diffusion Theory ; Grain Production; Natural Disaster; Risk assessment; Dongting Lake Area.

1. Introduction

Risk assessment is the foundation of the risk management program. A properly done risk assessment allows program elements to be based on a realistic appraisal of the types of risks a community is likely to face. Risk assessment is an important part of natural disaster risk management. Due to many factors, human beings cannot accurately predict many incidents. Uncertainty always exists, and therefore, risk is inevitable [1]. Risk assessment of natural disasters is defined as the assessment on both the probability of natural disaster occurrence and the degree of damage caused by natural disasters. In recent years, an increasing number of studies focus on natural disaster risk analysis and assessment of flooding, earthquakes and droughts among others [2]. However, the data that can be used in the risk assessment for natural disaster are rather limited. This makes the risk assessment being an issue under the

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small sample condition. One of the methods of dealing with this small sample issue regards is to regard the small sample as fuzzy information, and then optimally treat the information using information diffusion technology [3]. Fuzzy mathematics is a powerful tool for dealing with uncertainty problems [4]. After the fuzzy set theory was established by Zadeh [5], many scholars started to perform risk analysis by applying fuzzy set methods. A less common approach is the risk calculation model by which fuzzy treatment is dealt with [6]. Huang and Shi [7] proposed the theory of fuzzy risk together with its mathematical model through the use of information diffusion technology, highlighting its effectiveness in small sample optimization in connection with the fuzzy uncertainty of risk values. Information diffusion is widely used when insufficient information is available for estimating the probability distributions of uncertain parameters. As a fuzzy mathematics method, information diffusion can offset the information deficiency in small sample event through transforming an observation sample into a fuzzy set [8]. Luo Bo-liang [9] calculated the probability of flooding risk of rice production by using the theory of the fuzzy Mathematics and information diffusion, based on the statistical data of rice planting area and flooding damaged area during the period of 1987-2006 in Hunan Province. The flooding risk assessment of rice production and its regionalization were obtained based on GIS. Zhang Xing [10, 11] analyzed the features of meteorological disasters and their effect on the grain production. Li Chunhua [12] estimated the loss amount of grain yield due to natural disaster using grey prediction model in Jiangsu province. However less attention has been focused on risk assessment of grain production to natural disasters as a whole. Main natural disasters in grain production are droughts, floods, wind hail, frost and crop pests. Frequent natural disasters have been become the important factor affecting stable development of agriculture in China, and restricted seriously promoting land productivity and stably increasing of grain production, and becoming the risk factor of food security in China [13]. Dongting Lake area is the major grain production area in Hunan Province, and also is one of the primary commodity grain production bases in China. Meanwhile, it is one of the most serious areas suffered from floods, droughts, pests and other natural disasters. In order to manage natural disaster risk of grain production and reduce losses effectively, it is important to obtain the probability and losses of natural disasters at different risk levels. The purposes of this study are to: 1) analyze the situation of recurrent natural disasters, 2) obtain the probabilities of natural disasters risk of the AHR of grain production at different levels, 3) put forward the strategies and measures to prevent natural disaster risk of grain production.

2. Methods

Information diffusion is an available integrated assessment method based on fuzzy sets which are formed by fuzzy numbers. It can be described as a method which can diffuse a traditional data sample point into a fuzzy set [14, 15]. The principle of information diffusion is an affirmation: when a knowledge sample is given, it can be used to compute a relationship. The result deduced directly from this sample is called “non-diffusion estimation.” When and only when this sample is incomplete, there must be an appropriate diffusion function and a corresponding arithmetic formula, which makes the diffusion estimation closer to the real relationship than the non-diffusion estimation. As the purpose of information diffusion is to search for useful information and enhance the identification precision of the system, technology of this kind is thus called Fuzzy Information Optimization Processing Technology [16]. In a point of view of the information diffusion, a small sample provides incomplete data to estimate a probability distribution. To partly fill the gap caused by incomplete data, the simplest technique is to change observations into normal fuzzy sets [17].

Information diffusion is a processing method of abstract mathematics that can deal with the sample using a set numerical method [18]. A single-valued sample can be transformed into a set numerical-valued sample through this technology. The simplest model is the normal diffusion model. If the index field of natural disaster can be represented as $U=\{u_1,u_2,\ldots,u_m\}$, then the information carried by a single-valued observation sample of y_i can be diffused into each point in the field U according to the following equation:

$$f_i(u_j)=\frac{1}{h\sqrt{2\pi}}e^{-\frac{(y_i-u_j)^2}{2h^2}}\quad, j=1,2,\cdots,m \qquad (1)$$

Where h is called normal diffusion coefficient, which can be obtained according to the sample number (n) in the set.

$$h = \begin{cases} 0.4560(b-a), n=7 \\ 0.3860(b-a), n=8 \\ 0.3362(b-a), n=9 \\ 0.2986(b-a), n=10 \\ 2.6851(b-a)/(n-1), n \geq 11 \end{cases} \quad (2)$$

Where b and a is the maximum values and the minimum values of the sample in the set respectively.

Let:

$$C_i = \sum_{j=1}^{m} f_i(u_j) \quad (3)$$

Then the related attaching function of the fuzzy subset can be represented as follows:

$$\mu_{y_i}(u_j) = f_i(u_j) \quad C_i \quad (4)$$

The function of $\mu_{y_i}(u_j)$ can be called the normalized information distribution of sample y_i. A good result for risk analysis can be obtained through treatment of the function of $\mu_{y_i}(u_j)$. If we let $y_1, y_2, \cdots, y_n$ to be the n specified observation values, then the function can be called the information quantum diffused from the sample of $Y=\{y_1, y_2, \cdots, y_n\}$ to the observation point of u_j. This can be represented as follows:

$$q(u_j) = \sum_{i=1}^{n} \mu_{y_i}(u_j) \quad (5)$$

The physical meaning of the above function is that if the observation value of natural disaster can only be chosen as one of the values in the series of $u_1, u_2, \ldots, u_m$, then the sample number with the observation value of u_j can be determined to be $q(u_j)$ through the information diffusion from the observation set of $y_1, y_2, \cdots, y_n$, in regards to all values of y_i as the representatives of the samples. It is obvious that the value of $q(u_j)$ is generally not a positive integer, but it is sure to be a number no less than zero. Furthermore, let:

$$Q = \sum_{j=1}^{m} q(u_j) \quad (6)$$

In fact, Q should be the summation of the sample number on each point of u_j. It is easy to know that the function should be the frequency value of the sample appeared on the point of u_j, and the value can be taken as the estimated value of the probability. This can be represented as follows:

$$P(u_j) = q(u_j) / Q \quad (7)$$

The surpass probability value should be as follows:

$$P(u \square u_j) = \sum_{k=j}^{m} P(u_k) \quad (8)$$

The value of $P(u \square u_j)$ should be the required value for the risk assessment.

3. Natural Disaster Risk Analyses

3.1, Study area description

In this study, the Dongting Lake Area (110°29′~114°15′E and 26°03′~30°08′N) is located in the north of Hunan Province, China. It covers an area of about 73500 km^2, with humid climate and abundant light and heat resources. It has long been a primary base of grain production in China. However, due to being located in the area of semi-tropical monsoon climate zone and the precipitation varying significantly during the year and between years, it suffers from serious flood and drought. Rainy season is from the end of March or early April to early July in this area, this is the result of direction change of wind with seasons, and is the monsoon climate characteristics. Because the time of change of monsoon direction often varies between years, the rainy seasons come early or delayed, and the period of rainy season extend or shorten, which causes flood or drought. Annual maximum precipitation is 1500~2500mm and minimum precipitation is 800~1300mm generally. The spatial temporal distribution nonuniformity of the precipitation is the main root of flood and drought disasters.

Dongting Lake area includes Changsha City, Zhuzhou City, Xiangtan City, Changde City, Yueyang City and Yiyang City in this study. In 2006, its total arable area covers 1.68 million hectares, accounting for 44% of the total arable area and total grain output is 1.48×10^3 million tons, accounting for 51% of the total grain output in Hunan province. Dongting Lake area is a natural disaster-prone areas, flood, drought, pests and other natural disasters occurred frequently, Those threat severely grain production. Therefore, it is necessary to assess the natural disaster risk of grain production to ensure national food security and regional sustainable economic development.

3.2, Data and processing

The AHR is a objective index reflecting natural disasters. The natural disaster hazard area, grain-sown area and other data over years from 1986 to 2006 were cited from "Hunan Province Agricultural Statistical Yearbook". The AHR of the natural disaster is an index reflecting the natural disaster risk of grain production. Each county was a unit, the AHR of grain is to be a single value of the sample y_i (i = 1, 2, ... , 21). A set of [0, 1] on one-dimensional real number space can be regarded as the field of y_i according to the actual information of the AHR over 21 years from 1986 to 2006 measured in Dongting Lake area. The continuous field of [0, 1] can be transformed into a discrete field through equidistantly selecting the points representing different risk levels. Considering the requirement of calculating accuracy, 21 points (m=21) were selected to form the discrete field, which can be represented as follows, $U=\{0, 0.05, 0.1, 0.15, \ldots, 1\}$, this time the number of samples n = 21. According to the formula (1)~(8), the surpass probability of natural disaster risk of grain production can be obtained.

3.3 Results

According to the method described above and the historical data of Dongting Lake area, the probabilities of natural disaster risk of the AHR in 35 counties are calculated (shown in Table 1). The natural disaster risk assessment maps of grain production were obtained based on GIS. The results of spatial distribution are illustrated (Fig. 1, 2, 3 and 4) to show the probabilities of natural disaster risk of the AHR at different levels.

The probability of natural disaster risk of the AHR over 10% was between 0.3576 and 0.9344 (Table 1). The probabilities of natural disaster risk in most counties were more than 0.5, namely most counties suffered from disaster biyearly or annually. The most value was higher than 0.9, it means almost the disaster occurred annually in Taoyuan County and Anhua County. The probability values were less than 0.5 only in Zhuzhou County, Zhuzhou Popedom and Pingjiang County, which means the disaster occurred about biyearly to once every three years.

The probability of natural disaster risk would fall when the AHR increased. When the AHR was up to 20%, the probability of natural disaster of the grain crops was between 0.0880 and 0.8618 in each county. The probability values in majority counties were between 0.2000 and 0.5000, the frequencies of the disaster occurred were biyearly or once every five years. The counties with higher probability values reached 0.6667~0.8000 suffered from more than twice disasters every three years, such as Nan County, Taoyuan County and Anhua County.

When the AHR was over 30%, the natural disaster risk probability of the grain crops was between 0.0080 and 0.7757, the probabilities of natural disaster risk in most counties were between 0.1 and 0.3333, the frequencies of the disasters occurred were about once every three to ten years. The probability values in Taoyuan County and Anhua County had the highest, which were 0.5433 and 0.7757 respectively, the frequency of the disasters occurred were biyearly or twice every three years.

When the AHR was over 40%, the natural disaster risk probabilities of the grain crops were between 0 and 0.6569, the probability values in most counties were less than 0.3333, the disaster occurred about more than once every three years. The probability values in Taoyuan County and Anhua County had highest, which was 0.3562 and 0.6569 respectively, the disasters of two counties suffered from once or twice every three years.

From Fig.1-4, we can see that the hill and mountain areas in the western and southern had high risk, while the central area had lower risk. It is chiefly because of the backward economic and the poor agricultural infrastructure in the hill and mountain areas, it was mainly rain-fed agriculture during grain production, the risks of grain production suffered from drought and pests were higher. But in the central and eastern areas, it had developed economy and good agricultural production conditions, and had better facilities for preventing drought and controlling pests, and so the risk of grain production was relatively low. In the northern plain area of Dongting Lake area, the risk was higher because of the flood disaster.

Table 1 Risk assessment value for natural disaster of grain production in Dongting Lake area

County	the AHR of natural disaster									
	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
CSP	0.8463	0.6815	0.5297	0.4066	0.3152	0.2493	0.2005	0.1616	0.1287	0.1009
CSC	0.8461	0.6469	0.4377	0.2562	0.1459	0.0963	0.0610	0.0234	0.0040	0.0003
WCC	0.8783	0.7237	0.5635	0.3914	0.2329	0.1237	0.0643	0.0328	0.0117	0.0021
NXC	0.8932	0.7519	0.5988	0.4604	0.3536	0.2803	0.2301	0.1905	0.1549	0.1229
LYC	0.8417	0.6537	0.4771	0.3368	0.2389	0.1781	0.1414	0.1138	0.0879	0.0649
ZZP	0.7204	0.4323	0.2413	0.1429	0.1018	0.0804	0.0588	0.0368	0.0163	0.0040
ZZC	0.6762	0.3576	0.2240	0.0880	0.0383	0.0080	0.0002	0.0000	0.0000	0.0000
YC	0.9118	0.7548	0.5405	0.3335	0.1968	0.1198	0.0741	0.0472	0.0267	0.0099
CLC	0.8326	0.6689	0.5585	0.4822	0.4043	0.3042	0.2001	0.1104	0.0433	0.0099
YLC	0.8568	0.6783	0.4935	0.3343	0.2198	0.1510	0.1165	0.1020	0.0970	0.0954
LLC②	0.8201	0.6200	0.4438	0.3163	0.2401	0.2011	0.1784	0.1557	0.1280	0.0979
XTP	0.8720	0.7309	0.5978	0.4861	0.3989	0.3335	0.2844	0.2453	0.2108	0.1786
XTC	0.8399	0.6706	0.5166	0.3935	0.3038	0.2416	0.1980	0.1658	0.1395	0.1162
XXC	0.8559	0.6924	0.5327	0.3972	0.2955	0.2250	0.1764	0.1402	0.1110	0.0874
SSC	0.8149	0.6327	0.4864	0.3866	0.3245	0.2855	0.2591	0.2388	0.2203	0.2007
YYP②	0.7566	0.5030	0.3008	0.1720	0.1024	0.0689	0.0545	0.0494	0.0477	0.0462
NC	0.9501	0.8771	0.7814	0.6682	0.5460	0.4257	0.3177	0.2305	0.1682	0.1294
TJC	0.9050	0.7890	0.6621	0.5363	0.4225	0.3280	0.2547	0.2001	0.1593	0.1273
AHC	0.9689	0.9344	0.8988	0.8618	0.8216	0.7757	0.7215	0.6569	0.5828	0.5034
YJC	0.8547	0.6983	0.5547	0.4334	0.3342	0.2561	0.1989	0.1592	0.1308	0.1073
CDP	0.8867	0.7540	0.6176	0.4931	0.3902	0.3109	0.2513	0.2051	0.1668	0.1337
AXC	0.9148	0.8130	0.7045	0.6003	0.5080	0.4314	0.3702	0.3218	0.2827	0.2495
HSC	0.8777	0.6940	0.5459	0.4345	0.2977	0.1452	0.0362	0.0032	0.0001	0.0000
LC	0.9196	0.8062	0.6721	0.5367	0.4190	0.3305	0.2713	0.2315	0.1991	0.1675
LLC①	0.9086	0.8003	0.6837	0.5682	0.4617	0.3693	0.2931	0.2331	0.1879	0.1551
TYC	0.9625	0.9007	0.8224	0.7339	0.6388	0.5433	0.4501	0.3562	0.2607	0.1701
SMC	0.9358	0.8470	0.7438	0.6383	0.5370	0.4409	0.3507	0.2691	0.2002	0.1466
JSC	0.9207	0.8117	0.6790	0.5369	0.4085	0.3115	0.2469	0.2044	0.1707	0.1346
YYP①	0.8763	0.7284	0.5820	0.4591	0.3688	0.3079	0.2674	0.2374	0.2103	0.1817
YYC	0.8315	0.6318	0.4477	0.3001	0.1951	0.1334	0.1052	0.0930	0.0807	0.0603
HRC	0.9029	0.7912	0.6777	0.5736	0.4847	0.4114	0.3512	0.3016	0.2613	0.2296
XYC	0.8227	0.6354	0.4673	0.3367	0.2468	0.1898	0.1548	0.1326	0.1175	0.1065
PJC	0.7554	0.4684	0.2517	0.1364	0.0834	0.0594	0.0502	0.0471	0.0433	0.0343
MLC	0.8418	0.6247	0.4208	0.2673	0.1596	0.0919	0.0586	0.0433	0.0284	0.0124
LXC	0.8902	0.7633	0.6341	0.5171	0.4219	0.3507	0.2999	0.2631	0.2337	0.2072

CSP-Changsha Popedom, CSC-Changsha County, WCC-Wangcheng County, NXC-Ningxiang County, LYC-Liuyan County, ZZP-Zhuzhou Popedom, ZZC-Zhuzhou County, YC-You County, CLC-Chaling County, YLC-Yanling County, LLC②-Liling County, XTP-Xiangtang Popedom, XTC-Xiangtang County, XXC-Xiangxiang City, SSC-Shaoshan City, YYP②-Yiyang Popedom, NC-Nan County, TJC-Taojiang County, AHC-Anhua County, YJC-Yuanjiang County, CDP-Changde Popedom, AXC-Anxiang County, HSC-Hanshou County, LC-Li County, LLC①-Linli County, TYC-Taoyuan County, SMC-Shimen County, JSC-Jinshi City, YYP①-Yueyang Popedom, YYC-Yueyang County, HRC-Huarong County, XYC-Xiangying County, PJC-Pingjiang County, MLC-Miluo County, LXC-Linxiang City.

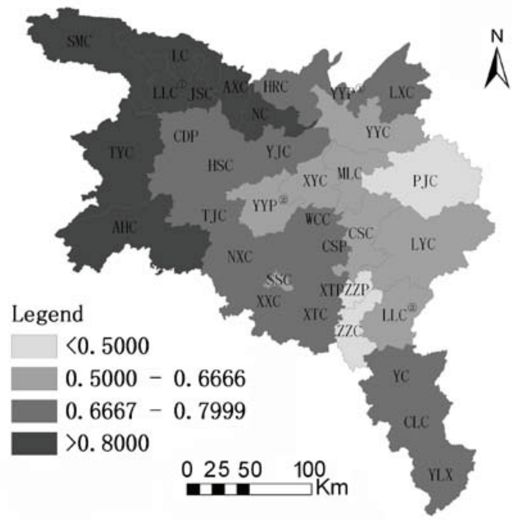

Fig 1 The probability of the AHR over 10%

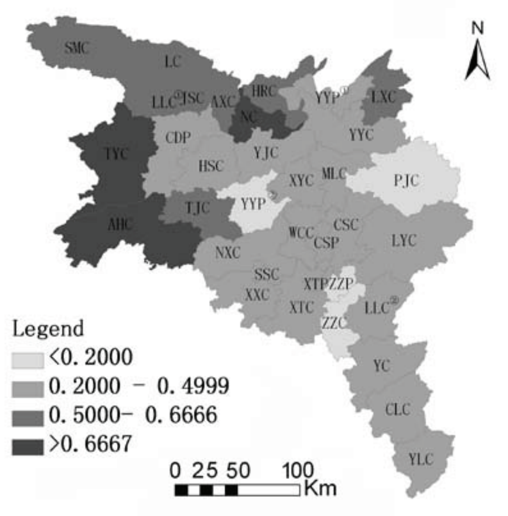

Fig 2 The probability of the AHR over 20%

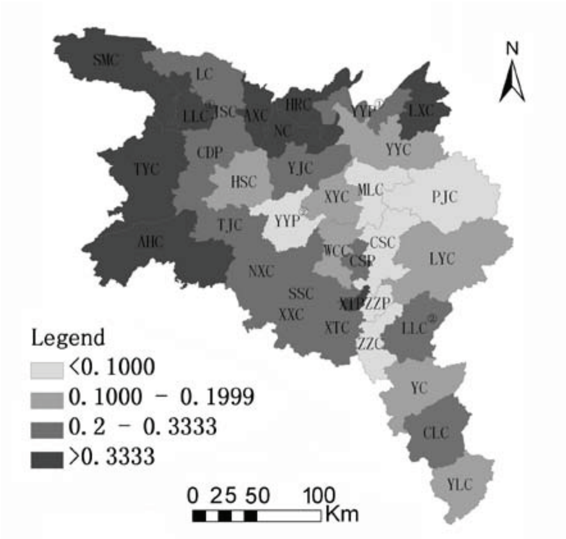

Fig 3 The probability of the AHR over 30%

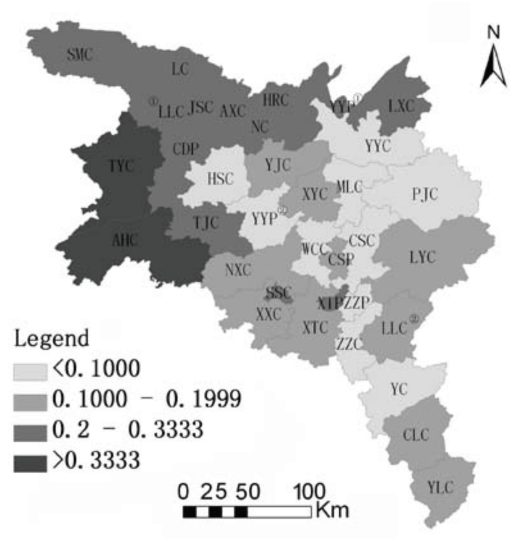

Fig 4 The probability of the AHR over 40%

4. The strategies and measures to prevent natural disaster risk of grain production

4.1 Establishing perfectly early-warning system of natural disaster

As regards the intensity of natural disasters, there are strong indications that climate change will continue to have an increasing impact in the decades to come [19]. Global climate change poses an even greater threat to grain production. Even though there are many uncertainties in the prediction of future climate change, global climate change is widely accepted. Global warming could accelerate the global hydrological cycle, and therefore change the frequency of drought and flood disasters [20]. A comprehensive and integrated approach is essential to monitor natural disasters more effectively in Dongting Lake area and provide early warning to reduce the impact of this common natural hazard on grain production. The early-warning system of natural disaster should include the disaster monitoring, the risk assessment, the implementation of mitigation, and the preparedness activities before the occurrence of disaster. In order to prevent the natural disaster risk of grain production effectively in Dongting Lake area, a better understanding of the spatial and temporal dimensions where is at highest risk should be developed. Natural disaster risk analysis can provide probabilities and scenarios where would be the greatest affected, in what specific way they would be affected, and at what frequency.

4.2 Increasing public investment for improving agricultural infrastructures

Since the household contract responsibility system with remuneration linked to output, the agricultural productive forces were greatly liberated, and the grain production had great development. But with the rapid development of China's economy, the comparative benefit of the grain production was decreased gradually. The production of grain was based on the household contract responsibility system with remuneration linked to output. It would not form an effective disaster management capacity. Because of the lack of capacities of scattered farmers and the restriction of their economic conditions, the disaster preventions and mitigation measures were inefficient. Coupled with agricultural disasters were sudden and random, and the endangering area was large, so it was impossible for individual farmer to resist the disaster. A single family farm would not invest in agricultural infrastructures, while many irrigation facilities built in 1960s-1970s had been worn down by the years without repair. Therefore, in order to strengthen the prevention capability of natural disaster risk of grain production in the Dongting Lake area, the public investment in agricultural infrastructures must be increased.

The irrigation project construction should be strengthened and water-saving agricultural technology should be popularized vigorously in order to improve the ability to withstand drought in the high-risk areas of drought in the western and southern areas. The construction of levees and the drainage project construction in the low-lying areas should be reinforced to improve the ability to flood control in the higher risk areas of floods in Dongting Lake plain. Specific measures included dredging flood road, reinforcing levees, constructing the flood diversion areas, implementing “Grain for Lake” policy and planning reasonable structure of land use.

4.3 Increasing public investment in agricultural research and technology

As grain production is also particularly vulnerable to disaster risk, measures to reduce this vulnerability are vital for maintaining food security. Appropriate agricultural technologies can play a key role in damage reduction. Therefore, practices of land use for agriculture including the management of related natural resources (such as water and biodiversity) need to be adopted to make them less vulnerable to extreme weather events. Public investment in research and technology is needed to develop the kind of technology needed by low-income producers, and to help them gain access to such technology. Less-favoured areas, i.e. areas with irregular rainfall, fragile soils and low agricultural potential, are particularly susceptible to natural resources degradation. Public investments in agricultural research and technology, as well as rural education, are urgently needed for those areas. Development policy and disaster management strategies would benefit from mutual integration of basic principles with a view to building resilience against disasters into all development efforts in hazard-prone locations. This will help maintain the farmers' grain production incentive and the future grain production capability. Such investments will lead to further improvement in agricultural technology and provide grain producers with better production conditions. With demand for food rising continuously in China in the near future, measures like public investment in agricultural research, which strengthen domestic production capability , will be even more important to achieve the nation's long-term food security.

Diversifying agricultural systems is another key entry point to reduce vulnerability. There are a number of measures through which cropping systems can be made more resistant to extreme weather-related hazards, whether it is flood, or drought. Some short-term popular and seriously endangering disasters can be avoided or mitigated by increasing agricultural technology inputs, developing "Avoiding disaster agriculture", adjusting planting structure of grain production. For example the new rice varieties with strong capacity of waterlogging-enduring should be cultivated and promoted.in the low-lying areas of the Dongting Lake plain. In the western and southern of high-risk areas, drought-tolerant varieties should be cultivated and promoted.

4.4 Building resilience to disasters

The aim of disaster risk management is to reduce the natural disaster risk and build resilience. Resilience is the ability of a system, community, or society to adapt to fluctuation in order to maintain an acceptable level in function. Resilience against disasters should be built as much as possible ‘ex ante’ into development efforts in locations with striking hazard, instead of repairing the damage ‘ex post’ only. It is very critical to integrate disaster risk management into grain production strategies and make it to be a part of food security and development policies. In any case, investment in resilience needs to be seriously considered and the benefit and cost should be assessed. Resilience requires social, institutional, and informational resources that enable a community to respond effectively to a hazard effect. Public investments have increasingly been neglected in agriculture and rural areas of underdevelopment counties, in spite that it is the importance sector's key for the poor and for the entire economies of most of these regions. Food security strategies are particularly suitable framework for building resilience against risks of natural disasters of grain production. Given the current nascent political will to step up such investment, the opportunity should be seized to explicitly include investments in greater disaster resilience in development plans.

4.5. Establishing the system of agricultural disaster insurance

The agricultural insurance system, established by market economy countries, was a kind of special economic compensation system for decreasing and dispersing agricultural natural disaster risk. To evade risk, the country, the social, the collective and the farmer must work together to establish a series mechanism and system, which realize transfer of agricultural risk to socialization, ensuring maximize interests of farmers, to restore production as quickly as possible and providing an institutional guarantee of economic development for the affected rural areas.

5. Conclusions

Due to the fact that the natural disasters data series of grain production are relatively in short, available data are often not sufficient for disaster risk analysis. Considering the imprecise or incomplete information of grain production disaster, and the limits of the existing technique and experiment method, the analysis result could be inefficient and imprecise by applying only the traditional accurate model. One method that can be applied is to take the available small samples as fuzzy information and optimize them by using information diffusion technology to gain reliable analytical results. In this study, one method based on Information Diffusion Theory for risk analysis is applied to establish a new natural disaster risk analysis model of grain production. Application of the model is illustrated taking Dongting Lake Area as example. The results showed that the probabilities of natural disaster risk of the AHR over 10% , 20%, 30%, 40% of grain production were between 0.3576～0.9344, 0.0880～0.8618, 0.0080～0.7757, 0～0.6569 respectively on different county. Meanwhile, the natural disaster risk assessment maps of grain production were obtained based on GIS. The spatial distribution characteristics of natural disasters risk of grain production showed that the hill and mountain areas in the western and southern had high risk being suffered drought disaster, and the northern plain area had higher risk being suffered flood disaster.

Our results indicated that the very stable analytical results can be yielded using the model mentioned above even when analyzing a small set of sample data. The results also indicated that information diffusion technology is highly capable of extracting useful information and improves the accuracy of system recognition. This method can be applied easily and the analytical results produced are easy to understand. Results are accurate enough to be a guide in disaster reduction information management.

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