Fuzzy Analysis on Water Resources of Heilongjiang State Farms

Yongsheng Ma

(School of Water Conservancy & Civil Engineering, Northeast Agricultural University, Harbin, Heilongjiang 150030, China, ysma66@yahoo.com.cn)

Abstract: Fuzzy clustering deals with many topics. Applying Fuzzy clustering, the article analyzed water resources distribution and optimum utilization in State farms. The article studied 9 administration bureaus of State Farms, selected 10 fuzzy factors according to hydrological, meteorological and geographic conditions, and classified them into 3 different districts. The results proposed by the article basically accord with the cases of water resources distribution and agricultural practice in each district. The article can be a reference to agricultural planning and opening water resources decision making. [Nature and Science, 2004,2(1):44-47].

Key words: Fuzzy Analysis; Water Resources; State Farm

1 Introduction

In Heilongjiang State Farms, there are 9 administration bureaus, are located in vast area of Three River Plain, Xing An Maintain areas and Song Nen Plain (Wu, 1986). Owing to different location and hydrological conditions, agricultural productions in every administration bureau are different (Ma, 1993). In order to understand the situation of agricultural production and water resources effect on agriculture, it is important to study the characteristics of water resources and agriculture of the bureaus, so that take measures and decisions of water conservancy fundament construction.

2 Fuzzy Clustering Analysis

Applying Fuzzy clustering methyods the article analyzed agricultural and natural conditions of 9 administration bureaus and then classified districts. The model includes 10 fuzzy factors that are roughly divided into three types: (1) definite factors, (2) Overall index, (3) Non-definite factors (Ma, 1993).

2.1 Definite factors

Grain production, annual average principal, annual average evaporation, accumulate heat, the water quantity in unit farmland are all the definite factors.

2.2 Overall indexes

The overall indexes are concerning with those comprehensive factors including the rate of land using, drought coefficient etc. For example, the drought coefficient is a comprehensive coefficient to show the annual drought level. It is a time product by spring drought, summer drought and the dry hazard.

Based on agricultural climate types, the drought indexes and dry hazard appearances of the 9 bureaus have shown in Table 1. The comprehensive drought factors shown in table 3 and calculated by formula 1.

$$Y = (K_{Spr} + K_{Sum})V_{dr} / 2 \quad (1)$$

In which:

Y = drought comprehensive coefficient;
K_{spr} = Drought index in spring season;
K_{Sum}= Drought index in summer season;
V_{dr} = The rate of arid hazard appearance.

2.3 Non-definite factors

Non-definite factors are factors without definite values. Such as, soil and soil erosion indexes which the value should be given by evaluation. The soil quality indexes are given by soil types time the weighted value of soil distribution. In the article, the black clay soil has been taken as the best quality soil and the value is assumed as 1.0. Folium white slurry soil (Baijiang Soil) is lowest quality soil and the value is assumed as 0.2. Then the soils have been arranged as the series Black loamy clay, brown loamy clay, peat duck brown loamy clay, marshland soil, and Folium white slurry soil (Baijiang Soil) (Ma, 2003). The Figure 1 showed the value of each soil. The data of agriculture and natural

condition of State Farms have been shown in Table 1, and soil classified factors have been shown in Table 3.The soil erosion indexes are also non-definite factors. According to soil erosion degree, the article classified the soil erosion in three classes: very strong erosion, strong erosion and general erosion. The index value is determined also by Fuzzy clustering method and shown in Table 2 and Table 3. The Quantitative analyses of drought factors have been calculate in Table 4.

In the article, the grain productivity was average of 1985 and 1990 two years production per Mu*. The data of annual precipitation and annual evaporation were obtained from Heilongjiang hydrological isograms (Ma, 1991).

Calculate resembling coefficient and set up resemble matrix:

$$R = (r_{ij}) \tag{2}$$

The resembling coefficient is calculated with the formula (3).

$$r_{ij} = \frac{|\sum_{k=1}^{n} X_{ik} X_{jk}|}{\sqrt{\sum_{k=1}^{n} (x_{ik}^2) \sum_{k=1}^{n} (x_{jk}^2)}} \tag{3}$$

To run the matrix model on computer to calculate equal value matrix (Fu, 2003) as shown in Table 5.

Table 1 The agricultural and natural factors

No	Bureau	Yield / Mu	Water / Mu	Land Use (%)	Ann. Prec. (mm)	Ann. Evap. (mm)	Non-Frost	Accum. Heat
1	Jiusan	222	280	35.9	491.6	381	121	2183
2	Bei'an	173	260	26.9	543	417	112	2164
3	Nenjiang	244	300	43.4	445.3	449	121	2610
4	Suihua	160	275	31.7	554.8	500	129	2206
5	Harbin	194	270	43.2	604.6	442	145	2600
6	Hongxinglong	221	204	45.7	534	539	142	2545
7	Baoquanling	180	331	45.5	553	485	129	2445
8	Jiansanjiang	160	346	31	592	446	130	2402
9	Mudanjiang	215	341	31.6	566	454	148	2517

Table 2 Soil component, Erosion and Land use factors

No.	Bureau	Type of soil	Land Use %	Soil erosion	Fuzzy value
1	Jiusan	Bl, Br, DB	35.9	HS	1.0
2	Bei'an	Bl, Br, DBr	26.9	HS	1.0
3	Nenjiang	BGr , Gr, Sd	43.4	HS	1.0
4	Suihua	Bl, Gr, Ml	31.7	S	0.6
5	Harbin	Bl, Gr, Ml	43.2	S	0.6
6	Hongxinglong	Bl, Gr, Ml, Ws	45.7	G	0.3
7	Baoquanling	Br, Db, Gr, Ml	45.5	G	0.3
8	Jiansanjiang	Bl,Br,Gr,Ml	31	G	0.3
9	Mudanjiang	Br,Gr,Ml,Ws	31.6	HS	1.0

Table 3 Soil type and soil quality evaluation

Bureaus	Black soil (Blk) (%)	brown soil (Br) (%)	Eroded dark & brown soil (DB) (%)	Gully latent raised meadow soil (Gr, Ml) (%)	Folium white slurry soil (Ws) (%)	Degree of Soil quality (%)
Jiusan	73.5	23	3.5			94
Bei'an	60	30.2	9.8			90
Nenjiang			72.3 (chernozem soil)	25 (Saline Soil)	3 (Arenaceous meadow soil)	68.4
Suihua	57			35.9	7.1	74.2
Harbin	51.1			35.9	13	70.3
Hongxinglong	41.6			39.6	18.8	61.2
Baoquanling		45	10	36	9	58.2
Jiansanjiang	6	34.6		35	19	51.5
Mudanjiang		22		28	50	38.8

Table 4 Quantitative analysis of drought indexes and coefficient

No	Bureaus	Ann. Precip. (mm)	Ann. Evap. (mm)	Drought Index		Drought Appr (%)	Logging Appr. (%)	Drought Coef.
				Spr	Sum			
1	Jiusan	491.6	1181	1.37	2.58	30	60	0.59
2	Bei'an	543	1117	1.18	1.89	30	58.6	0.46
3	Nenjiang	445.3	1449	2.04	3.6	80	52	2.26
4	Suihua	554.8	1200	1.33	2.29	40	64	0.72
5	Harbin	604.6	1142	1.17	1.82	60	58	0.9
6	Hongxinglong	534	1239	1.34	1.94	30	70	0.49
7	Baoquanling	553	1185	1.23	1.8	30	70	0.45
8	Jiansanjiang	592	1146	1.19	1.17	20	78	0.29
9	Mudanjiang	566	1134	1.23	1.69	30	80	0.44

Table 5 The Fuzzy similarity matrix of farm bureaus

		Farm Bureaus							
Farm Bureaus	1	0.917	0.947	0.917	0.944	0.904	0.904	0.904	0.904
	0.917	1	0.917	0.96	0.904	0.904	0.904	0.904	0.904
	0.947	0.917	1	0.917	0.96	0.904	0.904	0.904	0.904
	0.917	0.96	0.917	1	0.904	0.904	0.904	0.904	0.904
	0.944	0.904	0.904	0.904	1	0.924	0.924	0.924	0.924
	0.904	0.904	0.904	0.904	0.924	1	0.963	0.963	0.93
	0.904	0.904	0.904	0.904	0.904	0.924	1	0.966	0.93
	0.904	0.904	0.904	0.904	0.924	0.963	0.966	1	0.93
	0.904	0.904	0.904	0.904	0.924	0.963	0.93	0.93	1

According to natural condition of each administration bureau and matrix analysis, the threshold value l was calculated into 3 levels by statistical quantity, and 9 farm bureaus are divided into 3 groups they have similar agricultural, natural conditions to open water resources respectively, that are:

The threshold value is: l=0.94;
Second class group: II (6,7,8,9)
The threshold value is: l= 0.93
Third class group: III (2,4,5)
The threshold value is: l = 0.92
First class group: I (1, 3)

3 The Results of Fuzzy Clustering

Upon classification are basically fit to the agricultural production, geographic condition, hydrology and meteorological characteristic of local bureaus. The results show that Jiusan and Nenjian farm bureau have same geographic and meteorologycal condition owing to be located in the western of the province; the second group is three river plain districts.

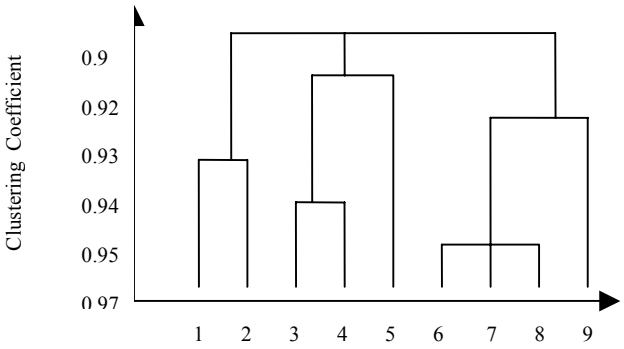

Figure 1 Fuzzy Clustering of Agricultural Water resources of State Farms

By means of Fuzzy clustering, those eastern 4 bureaus (Hongxinglong (6), Baoquanling (7), Jiansanjiang (8) and Mudanjiang (9) Bureaus) have been cl- assified into one group is reasonable result; Bei An (2), Suihua (4) and Harbin (5) bureaus are all located in Songnen Plain and Xing An Hilly area, they have similar weather conditions, the annual precipitation, drought and water logging problems are basically same, therefore belong to one group.

4 Conclusion

Fuzzy clustering analysis has been applied broadly to system demarcating problems. There are many different methods may demarcating the system data. Since Fuzzy method systematically takes consideration of factors, the results are closed to practice. According to State farm natural and agricultural conditions, the article applied Fuzzy clustering method analyzed water resources of 9 Farm administration bureaus and classified them into three groups. The results conform to the local practice situation.

References

[1] Wu Y. China watwer resources utilization, Hydraulic and Electric Planning and Design Academy of China, 1986, 30-32.

[2] Ma X. Heilongjiang Water Resources Research, Heilongjiang Hydrology Bureau, 1991.

[3] Fu Q, Xie Y. Application of projection pursuit evaluation model based on real-coded accelerating genetic algorithm in evaluating wetland soil quality variation in the Sanjiang Plain. China Pedosphere, 2003,13(3):249-56.

[4] Ma Y. Water Resources Analysis of Heilongjiang State Farms. The journal of economic management of state farms, ISSN 1002-2635, 45-47.

[5] Ma X, Fu Q. Applying Self-Organizing Competition Artificial Neural Networks to Classify the soil. Nature and Science, 2003,1(1):75-81.