REGIONAL CLASSIFICATION OF SHIZUOKA PREFECTURE WITH GIS BASED ON THE DATA OF WEATHER DISASTERS

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ABSTRACT:

In order for effective disaster prevention, it is necessary to have some idea of when, where, why and what kind of weather disasters may occur, and how large they may be. But the regional characteristics of Shizuoka Prefecture from the viewpoint of weather disasters have not been studied before.
In this study, the authors gathered the data which represent how many times weather disasters occurred in Shizuoka Prefecture in the last fourteen years, and then divided it into some regions using a multivariate analysis. The authors adopted principal component analysis on this data, and then adopted cluster analysis with principal component scores which must be significant in the previous analysis. Finally the authors set the regional division based on these clusters and described the regional characteristics. This study could contribute to the weather disaster prevention in Shizuoka Prefecture.

KEY WORDS: Weather disasters, GIS, Multivariate analysis

1. INTRODUCTION

Shizuoka Prefecture in Japan has a mild climate and a plentiful sunshine and precipitation. Beautiful forests in mountain areas, cultivations of green tea and mikan (a kind of orange) in plateau areas and cultivations of melon and strawberry in plain areas are dependent on this fortunate climate. On the other hand, it also has many breaks of natural disasters caused by typhoons, local severe rain, or approaching of cyclones. These influence lives of residents and industry in this prefecture. So in order for effective disaster prevention, it is necessary to have some idea of when, where, why and what kind of weather disasters may occur, and how large they may be.

Until now, we had made a database which can be used for GIS to put presently available data for Shizuoka Prefecture to practical use. It is constructed with the data offered by Japan Meteorological Agency. This data is gathered only for Shizuoka Prefecture from the information of weather disasters in Japan. We used the data ranging from January 1990 to July 2003 and put values following the headings based on this data. This database has the number of times of weather observation when a weather disaster occurred and observed value of precipitation or temperature etc. at each climate stations.

In this study, we adopted multivariate analysis for the data which is in the database to set the regional classification from the view point of weather disaster. We adopted principal component analysis on this data, then adopted cluster analysis with principal component scores which are picked out from the previous analysis. And then we set the regional classification based on these clusters and presented it on the GIS. Finally we described the regional characteristics. There are some former studies in meteorology that adopted multivariate analysis to set regional divisions, but no former studies based on weather disasters. This study could contribute to the weather disaster prevention in Shizuoka Prefecture.

2. ABOUT SHIZUOKA PREFECTURE

2.1 The terrain

Shizuoka prefecture is located between 34degrees 30minutes to 35degrees 30minutes N. latitude and 137degrees 30minutes to 139degrees 30minutes E. longitude, in almost center of Japan on the Pacific coast. It has 7,779km2 in area.

To the north, it has the Akaishi Mountains, and the elevation is more than 3,000m. And it also has Kiso Mountains and Hida Mountains in the further north part and Mt. Fuji and Mt. Hakone in the northeast.

To the west, there are Makinohara Plateau and Iwata Plateau, with evaluations at about 200m, there are a coastal dune facing Ensyu Bay and Hamanako Lake, which borders Aichi prefecture. The Fuji River, Abe River, Ohi River and Tenryu River start from Akaishi

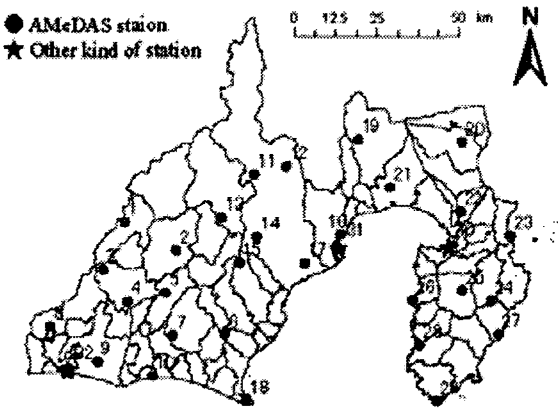

Fig. 1. The climatic stations in Shizuoka Pref.

Mountains are vital rivers that flow rapidly, and form alluvial plains in the lower reaches of them.

To the southeast, Izu Peninsula is located beyond Suruga Bay, with the Amagi Mountains. The evaluation is about 1,400m along the center of the peninsula. Its coastline forms cliff.

2.2 The climatic stations

In Shizuoka prefecture, there are 33 climatic stations, 2 9 AMeDAS[1] stations and 4 other kind of stations where a mount of rainfall is not observed. In this study, one of the other kind of station, *Fujisan-sokkojo* (it is set on the top of Mt.Fuji.), is excluded because its elevation is 3775m a nd can be judged as a peculiar station. As a result we use d 32 climatic stations except it.

Their locations are shown as Fig.1

3. SYSTEM AND DATA

3.2 About the computer system

The computer system of a hardware and a software in this study is as Table.1.

We mainly used ArcMap, a part of ArcGIS made by ESRI, as GIS software. This is the main application of ArcGIS, it is used for works with maps such as making, analyzing, or editing them. ArcGIS is an integrated collection of GIS software products for building a complete GIS. Its framework enables users to deploy GIS functionality and business logic. This architecture gives users the tools to assemble intelligent geographic information systems.

Table 1. The computer system in this study

TYPE		Made by ourselves
CPU		PentiumIII 1GHz
CAPACITY	Momory	768MB
	HDD	80GB

CLASSIFICATION	MAKER	THE NAME OF THE ARTIC	VERSION
OS	Microsoft	Windows 2000	Service Pack 4
GIS	ESRI	ArcGIS	8.2
CALCULATION TABLE	Microsoft	Microsoft(R) Excel 2000	

3.2 About the data

In this study, the data is based on *Shizuokaken kisho saigai houkoku* offered by Japan Meteorological Agency(JMA). This is a report of weather disasters occurred in Shizuoka Prefecture contained observed values at each climate stations, factors, extents of damage and so on. We used the last fourteen year's data, ranging from January 1990 to July 2003.

4. SETTING REGIONAL CLASSIFICATION

4.1 The summary

To set regional classification in Shizuoka Prefecture, we took these three steps.

(1) Constructing a database with the report by JMA.
(2) Analysing the data adopting multivariate analysis.
(3) Presenting the results on the GIS.

Step(1) has been already presented in a previous paper, so we make a report from Step(2) now.

4.2 Analysing the data adopting multivariate analysis

Based on the data of the database constructed before, we adopted multivariate analysis. The method is consists of two steps. (1) Using principal component analysis to find outstanding patterns concerning factors of weather disaster occurrence, we obtain the principal component values. (2) With the similarity of the values, we do cluster analysis for grouping.

Table 2. Variables in the principal component analysis

VARIABLE
Much of rain
Lack of rain
Days of no rain continuation
High temperature
Low temperature
Much of sunshine
Lack of sunshine
Low humidity

[1] Automated Meteorological Data Acquisition System

Table 3. Factor loadings

<Factor loadings>

Variable	Factor1	Factor2	Factor3
Much of rain	-0.11222	0.521668	-0.75316
Lack of rain	0.006883	-0.71769	0.196653
Days of no rain continuation	0.407146	-0.47255	-0.58539
High temperature	0.592929	0.3656	-0.0041
Low temperature	-0.04469	0.634762	0.392491
Much of sunshine	-0.9508	-0.0287	0.042721
Lack of sunshine	-0.87395	-0.05992	-0.19328
Low humidity	-0.95699	0.012724	-0.04613
Eigenvalue	3.115626	1.551685	1.143978
Contribution	38.94532	19.39607	14.29972
Total contribution	38.94532	58.34139	72.64111

4.2.1 Methods and results of principal component analysis

Doing the principal component analysis, we adopted eight variables which explain factors of weather disaster occurrences shown as Table2. These values mention the number of disaster occurrence times per their factors. As a sample-data, we adopted thirty-two climatic stations.

As a result, factor loadings mentioned as Table3 were gotten. The total contribution of Factor1(38.9%), Factor2(19.4%) and Factor3(14.3%) is 72.6%, thus these explain almost the circumstance of weather disaster occurrence. These Factors signify degrees of weather disaster occurrence categorised seasons. Factor1 mentions the degree of occurrence in summer. Factor2 mentions the degree of occurrence in winter. Factor3 mentions the degree of occurrence in rigorous winter. With these

Table 4. Principal component scores

<Principal component scores>

Station num.	Factor1	Factor2	Factor3
1	1.022603	3.300577	1.259291
2	-1.60238	0.270887	-0.68706
3	-1.60238	0.270887	-0.68706
4	-1.60238	0.270887	-0.68706
5	-1.60238	0.270887	-0.68706
6	-0.90378	0.233886	-0.54509
7	1.715678	-2.85935	-2.70776
8	-1.60238	0.270887	-0.68706
9	1.910602	-0.03626	0.000299
10	3.300768	-1.019	-1.52412
11	-0.29156	1.080621	0.243842
12	-1.08677	0.248337	-0.5902
13	-1.24476	1.26317	0.112156
14	-1.60238	0.270887	-0.68706
15	-1.60238	0.270887	-0.68706
16	-0.00434	0.042118	-0.12247
17	2.195071	2.049113	0.931015
18	3.346378	0.487563	1.427511
19	-0.10665	0.087028	-0.20898
20	0.462271	1.20857	0.847702
21	0.29925	0.833122	-0.46699
22	2.689991	-0.19194	-1.55598
23	4.57951	-0.5928	-0.14804
24	-1.60238	0.270887	-0.68706
25	-0.07222	0.073632	-0.18272
26	-1.40628	-4.06866	2.263828
27	-1.60238	0.270887	-0.68706
28	0.136938	-0.10961	0.146265
29	2.209203	-0.89069	1.75722
30	-1.42787	-0.87865	1.24583
31	-1.42787	-0.87865	1.24583
32	-1.42787	-0.87865	1.24583

Factors, we obtained principal component scores at each sample-data. They are shown as Table4. These scores explain how disasters on each stations are concerned with occurrence factors.

4.2.2 Methods and results of cluster analysis

If there is a resemblance about the number of times of disaster occurrences per factor among some stations, there is also a resemblance about the principal component scores among them. Therefore we did cluster analysis for grouping them. The process of organizing clusters can be shown as dendrogram(Fig.2). The Clusters hard to unite near its distance 0.028. In such a case, distributions are similar in each cluster but not similar among clusters. As the result, we adopted four clusters on the distance 0.028 and add the grouping numbers(from I to IV) each of them.

4.3 How to present results on the GIS

After that, we created thiessen polygons[2] by a series of climatic station points and did dissolve[3] for them based on the grouping numbers with GIS. With this method we can set the classification objectively based on the data. Furthermore, the dividing lines created by the method above were described smoothly.

5. Regional characteristics

Here is the map with the regional classification set by the method above, Fig.3. The numbers I, II, III, and IV are followed the results of cluster analysis. The characteristics of each four clusters are described below.

I : This area has larger scores of Factor2(from the principal component analysis). It can be said that weather disasters are liable to occur in winter in this area.

II : This area has larger scores of Factor1(from the principal component analysis). It can be said that weather disasters are liable to occur in summer in this area.

III : This area has neither so larger scores nor so smaller scores. This can be determined as a moderate type.

IV : This area has almost same scores of Factor1 and Factor2(from the principal component analysis). It can be said that weather disasters are liable to occur in summer and winter at the same rate.

[2] Thiessen polygons are constructed by connecting a series of point locations with line segments, erecting perpendiculars to those line segments at their midpoints, and then extending those perpendiculars until they intersect.

[3] Dissolve is used when you want to aggregate features based on a specified attribute.

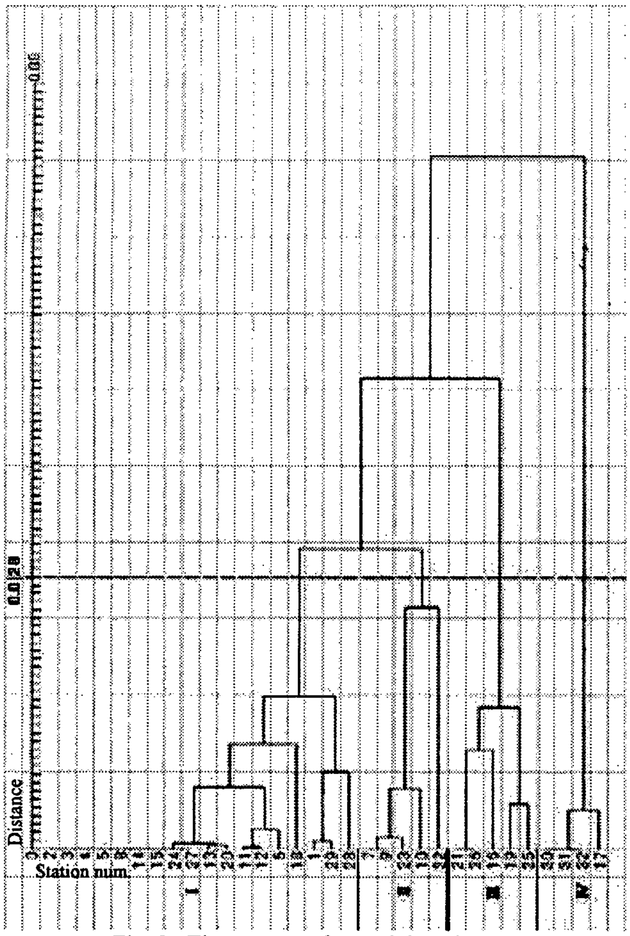

Fig. 2. The process of organizing clusters

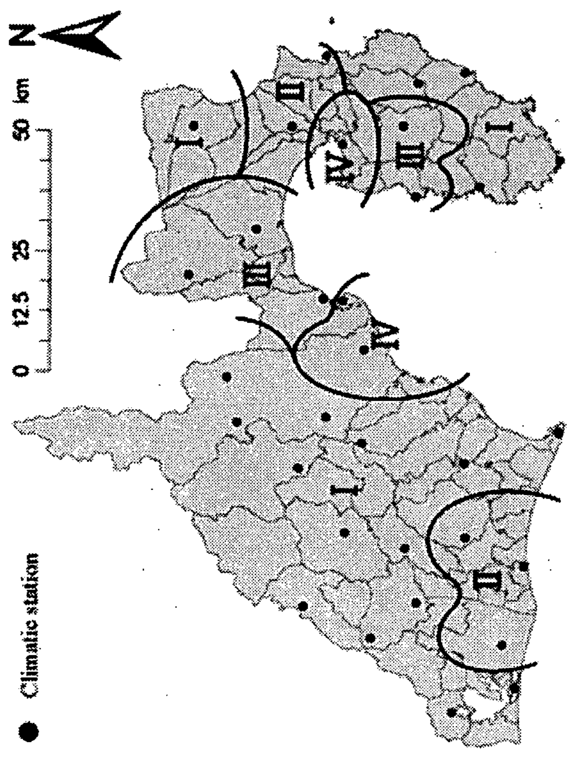

Fig. 3. Regional classification in Shizuoka Pref.

6. CONCLUSIONS

In this study, we set the regional classification from the viewpoint of weather disasters. During the process of that, we did multivariate analysis using the number of disaster occurrence times per their factors as variables. Moreover we created thiessen polygons by a series of climate stations. With this method we could set the classification objectively based on the data which represent the disaster factors.

The Factors followed by the principal component analysis signified degrees of weather disaster occurrence categorised seasons. As a result, the four divisions mention where and in which season disasters are liable to occur. How this result applies concretely to regional disaster measures is open to further studying.

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