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APPLICATION OF MAP AND FILE INFORMATION VISUALIZATION SYSTEM TO COMPREHENSIVE DIVISION OF NATURAL DISASTERS
—Taking the Changjiang Valley as an Example

HU Bao-qing[1,4], JIANG Mei-xin[2], JUN Su-lan[3], ZENG Qiao-song[4]

(*1. Department of Geography, Guangxi Normal College, Nanning 530001, P. R. China; 2. Department of Resource and Environment Sciences, Jiangxi Normal University, Nanchang 330000, P. R. China; 3. Shangrao Normal College, Shangrao Jiangxi 334001, P. R. China; 4. Changsha Institute of Geotectonics, the Chinese Academy of Sciences, Changsha 410013, P. R. China*)

ABSTRACT: This paper generalizes the makeup and forming dynamic mechanism of natural disaster systems, principles and methods of comprehensive division of natural disasters, as well as structure, function and up-build routes of map and file information visualization system (MFIVS). Taking the Changjiang(Yangtze) Valley as an example, on the basis of revealing up the integrated mechanism on the formations of its natural disasters and its distributing law, thereafter, the paper relies on the MFIVS technique, adopts two top-down and bottom-up approaches to study a comprehensive division of natural disasters. It is relatively objective and precise that the required division results include three natural disaster sections and nine natural disaster sub-sections, which can not only provide a scientific basis for utilizing natural resources and controlling natural disaster and environmental degradation, but also be illuminated to a concise, practical and effective technique on comprehensive division.

KEY WORDS: map and file information visualization system (MFIVS); natural disaster systems; damage evaluation; comprehensive division; the Changjiang Valley

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In recent years, scholars at home and abroad have synthetically studied natural disasters theoretically and methodologically, as well as its cases analyses(CND, 1987; MA *et al.*, 1990; MARBLE, 1990; NE *et al.*, 1999; PATAK *et al.*, 1982; SHI, 1991; VAN *et al.*, 1990; WANG, 1994; WANG *et al.*, 1999; WANG, 1992; ZHANG *et al.*, 1992; ZHANG *et al.*, 1997; BI, 1998). Thereinto, MA Zong-jin *et al.* (1990) pointed out that a calamity study has to rely on integrate thinking manner, introduce a systematical science method, and that various disasters would be analyzed as an integral. SHI Pei-jun (1991) put forward a scientific term — regional disaster system, which indicates that the situation of a disaster (calamity loss) results from the reciprocity among disaster-breeding setting (DBS), hazards-inducing factor (HIF) and calamity-bearing body (CBB), and the degrees are determined by the three ingredients comprising of stability of disaster-breeding setting, risk of disaster-inducing factor and frangibility of hazards-bearing body.

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Biography: HU Bao-qing(1966 -), male, a native of Linchuan, Jiangxi Province, Ph. D. His main research interests include environmental geology, mountain study, earth system science and sustainable development.

1 NATURAL DISASTER SYSTEM AND ITS DYNAMIC MECHANISM

1.1 Natural Disasters System

Natural disasters system is one component of the whole earth system. As a system, it may be divided into two aspects: entity M and process F(WANG, 1994) (Table 1). The former indicates the substance of the system, i.e., the structure and component, which includes disasters incubator (DBS), dispatcher (HIF) and embracer (CBB); while the latter is driving behavior and relationship among the various components, and also a medium by which the components have relations each other. On condition that mass components of two systems are the same, but their processes unlike, the two systems' functions are unequal, either. The particularities of natural disasters system lie in that it embodies its function through multiperiodic fluctuations and pulses. The entity part involves two aspects in a contradiction: HIF & CBB, whose corresponding attribute and process are natural course and social behavior process. The two processes become true by disaster-causing course. The course is an intense snippet in course of human-land relationship. Moreover, disaster -breeding setting is the course's material base, as well as the destroying objective of disasters.

1.2 Dynamic Mechanism for Formation and Evolution of Natural Disasters System

In master of certain astronomic-atmospheric-vegetation conditions, any disaster's occurrence is the result of terrestrial energy centralizing and releasing. From the viewpoint of interaction among geo-spheres, disaster occurrence mechanism study, especially probing into dynamic mechanism of disasters system, must rely on earth system science(YANG *et al.*, 2000; LIU, 2000). Seen from the earth's integral movement, dynamic mechanism of natural disasters system bears the following characteristics: essentially, disaster occurrence process is energy centralizing, migrating and releasing course, also one part of earth system's integral change. It is under the influence and domination of energy sources from sky, earth, gas and sea etc. One important process of the calamity begins with energy congregation of base cover (underground, ocean), subsequently, affects or changes atmospheric and crustal movements; under the effect of outside factors (e.g., gravitation of the sun or the moon), eventually comes out by flood, typhoon or earthquake. Acting on various characteristics or structural base bodies, the same catastrophic process can bring out diverse natural variation types. Energy congregating course is likely to last a few months or several years, while energy releasing process is currently no other than a few minutes for earthquake, a few days for typhoon or volcano eruption, or several months for flood or drought. Energy's normal or abnormal of base cover is not only a power fountain of breeding-catastrophe, but quite likely one of factors controlling the atmosphere movement route.

Table 1 Sketch on structures of natural disaster systems (WANG, 1994)

Natural disasters system (I)	Entity (M)	Disaster-inducing factor (m_1)	Flood, drought, earthquake, insect's plague, desertification, snowstorm
		Disaster-breeding setting(m_2)	Relief, weather, hydrology, soil, vegetation ... Stratum, rock, structure, physical geography ... Astronomic factor, dissipation tectonics ...
		Hazards-bearing body(m_3)	Human, house, traffic, possessions, natural environment ...
	Process (F)	Natural process (f_1)	Occurrence, course, relating, intensity, frequency, spatial prevalence
		Social behavior course (f_2)	Dwell, circulation, development, producing action, social organization
		Disaster-causing course (f_3)	Effect and hazards degree on bearing-hazards body

2 PRINCIPLES AND METHODS OF NATURAL DISASTER COMPREHENSIVE DIVISION

Regarding geodynamics as the theoretic basis, and through regional differentiation law of cataclysm and catastrophism study, natural disasters comprehensive division relies on geographic information system (GIS) and information visibility system (IVS), sums up main disastrous types spatially, analyzes the phenomena for main disaster occurring in flock and together, calamity intensity and frequency, and provides advanced means and implements in search, inquire, simulation, analysis, forecast and prediction for disaster-protecting and calamity-rescuing macro decision-making departments. Thus, combining basic theories on geosciences, traditional regional measures and up-to-date new technique, natural disasters comprehensive division work is enhanced from understanding natural law to exercisable special natural division, with possessing important theoretic meaning and practical value.

In the essence, natural disaster comprehensive division belongs to natural division, whose general principles and methods can be used for reference, but it has its own characteristics. Acting natural disasters system in a specific area as the division object, and regional differential law and pertinent mechanism of disaster formation as its theoretic basis, the comprehensive division principles includes relative consistencies of natural environment and social-economic conditions (disaster-breeding setting and calamity-bearing body), natural disasters assembly (hazards-inducing factor), evaluation of synthetic hazards' degree and evolution trend of natural disasters system etc., combining macro-area frame and regional disaster-cluster type, as well as area conjugating(LIU, 2000; MARBLE, 1990; NE *et al.*, 1999; YANG *et al.*, 2000). High-grade units of the comprehensive division rest with distinguishing and understanding the main diversity of area disasters' formation mechanism, therefore, its division should introduce up-down deducing approach. Whereas, its low-grade units synthetically reflect development degree of various natural disasters, which are the quantitative indexes of revealing their destroy powers. Its purpose lies in establishing regional disaster-preventing and hazards-reducing, so the bottom-up induction approach should be adopted. In a word, only if integrating the bottom-up and up-down approaches, natural disasters comprehensive division could become perfect comparatively. In the bottom-up inducing approach, the methods including gray clustering analysis and fuzzy synthetic analysis may be adopted, and quantitative indexes for comprehensive evaluation are acted as its division index system. The practical operation relies on the map and file information visvalization system(MFIVS). Otherwise, the up-down deducing approach selects synthetic qualitative indexes.

3 MFIVS

3. 1 Structure and Function of MFIVS

One intact geo-spatial information system should include the following subsystems(LI *et al.*, 1999): 1) Data input subsystem (DIS), collection and process of various existing maps and drawings, and RS information. 2) Storage and retrieval subsystem (SRS), which organizes data correctly so that user can acquire them swiftly, and renovates and corrects speedily and truly data received from database. 3) Data manipulation and analysis subsystem (DMAS), which performs various tasks, for instance, changes data format or produces parameter estimation through clustering principle defined by consumer, and limits condition or simulates matrix of various space-time optimization. 4) Result report subsystem (RRS), which shows full or partial original database or manipulative data, besides, exports space model in form of tabulation, map and screen dynamic simulation. Thereinto, the key problem is mathematical base of establishing analytic matrix, spatial analyzing method, and instructs designing structure of space database, in converse. it is an inexorable trend to found an easily operative, friendly interface and strong visible space information system in different synthetic studies.

MFIVS reserves the convenient retrieval and pick-up of traditional database as well as exhibits digital inherent meanings of geographic space. Made up of GIS & IVS(YANG *et al.*, 2000), it makes information mapificative and data visible via its functions including digital map, database management and spatial data connection disposal. These functions are based on GIS visualization, i. e., through GIS-supporting system, impose computer graph software and hardware techniques, as well as integrate graph displaying and analysis of geo-spatial data. As for the progress of GIS and its visualization, GIS visualization stress visualizing means, e.g. spatial-temporal digital model design and data management of supporting visualization, visualization means of distributing settings, etc. Its aim is that using appropriate technique, a great number of spatial data deposited in database is disposed, and presented by graphics with the geo-disposal and analysis' result (MEJIE *et al.*, 1994; YU *et al.*, 1999). Anyhow, the MFIVS technique is making use of advisable means that spatial data in database is implemented geo-spatial data visualization. And then, visualization in geo-sciences is defined as "no matter how they are expresses in paper, display or other mediums by material vision, space environment and issue are visualized, so as to profit person's information disposal ability by maximum"(MACEACHREN,1995).

3.2 Visualization Design on Distributed-type Spatial Data

By means of spatial data visualized analysis, distributing law of various components in natural disasters system of the Changjiang Valley is discovered very easily, which provides a solid basis for establishing database of natural disasters comprehensive evaluation. Implementing the visualization requires three terms, i.e., spatial data, spatial visualization method and operation by geo-researchers. The spatial data required can be classified into three types, i.e., geometrical-type, non-geometrical-type expressed in isoline or histogram plot and non-geometrical-type shown in interpolation. Researcher usually only possess a little data by self-measuring. General consumer can't acquire easily the reconnaissance survey data, which want expensive cost of production and mass professional power. Moreover, these data are certain currency, which interpolation needs the special background in quite strong spatial analysis, which commonly accomplished by GIS professional(LIU, 2000).

Spatial data required by geo-researchers, who are non-GIS experts, can be acquired very easily through distributed spatial data visualization method. Except for data analysis, all other currency data are disposed of and stored at server end, the codes actualizing data to visualize at client end are compiled in JAVA program, are inset into net-page, only visiting the net-page, user can unload automatically and run. Program at client end automatically acquires the content of spatial data from server. User merely needs to choose the indicatory spatial data and pattern, needn't know data depositing location and existing format, and can denote these spatial data. Subsequently, inputting their own sampling data at client end, users can express these data and those gained from the server simultaneously. If the coordinate of sampling spot has been already deposited in server, data input at client end is just analytic data in tabulation. Merely geological researchers need several simple operations can this drawing course be over: browsing web-page, choosing requisite data floor by directory, inputting measure data. The software implementing this function is mobile codes unloaded free only to carrying out the function for data visualization(LIU, 2000).

Thus, GIS software can be entirely divided into two segments: management and applications of spatial data. The former is accomplished by professionals on spatial data disposal, and needn't understand for geoscience knowledge; the latter is directly used for geological researchers, nor need data managing knowledge. Acquiring quite large spatial data visualized in the internet via the method, geological researchers can implement accessing manifold long-distance spatial data sources by an easy and simple fashion, and gain low-cost spatial information service. This let georesearchers extricate from pondering how to express spatial data, concentrate attention on data themselves and solution to the problem basing on data analysis(CHEN *et al.*, 1999; VAN *et al.*, 1990).

4 NATURAL DISASTERS COMPREHENSIVE DIVISION FOR BOTTOM-UP APPROACH

In the course of natural disasters comprehensive division for bottom-up approach, quantitative indexes are selected for comprehensive evaluation, regional disaster-group types are classified for type-cluster and division. The steps of comprehensive division introducing

MFIVS means lies in the following: database-establishing of indexes system for comprehensive evaluation, confirmation of estimating means model, construction of visualization system of comprehensive evaluation, and data conversion and visualization.

4.1 Database-establishing of Indexes System for Comprehensive Evaluation

Disasters are classified by their origins. In the light of the calamity's intension and frequency as well as hazards' influence degree on human and risk degree, evaluation index values are defined. As mentioned above, the entity of natural disasters system is composed of disaster-breeding setting and calamity-bearing body and hazards-inducing factor. Generalized natural disasters system is an intricate system combining BDS, HIF and CBB. BDS indexes include the characteristics of basic elements (geology, relief, climate, hydrology, soil and vegetation etc.) of regional geo-ecologic environment. They reflect the stabilization of regional BDS (stability degree). HIF comprises the traits of intensity, frequency and incidence of various natural disasters, which reflects of area hazard-inducing calamity status (hazards degree). CBB indexes involve population density, economic density and preventing and resisting disasters capability, reflecting frailty situation of area CBB (frail degree). Comprehensive evaluation indexes system of natural disasters is shown in Fig. 1.

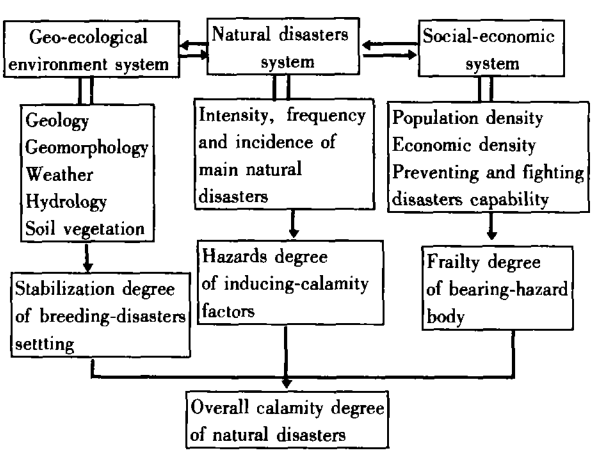

Fig. 1 The chart of comprehensive evaluation index system of natural disaster's calamity degree

4.2 Confirmation of Estimating Means Model

4.2.1 Ascertaining means of index's weights

Ascertaining indexes' weights of this evolution unit is a highly important as well as abnormal hot potato. In allusion to the actual situation of the Changjiang Valley, and the influence on synthetic hazards' degrees, the index's weights all levels are ascertained by uniting 3-IAHP and experience estimate means from consulting correlative data (Table 2).

4.2.2 Non-dimensionization model of single index getting-value

Each index has its own dimension, and quantity differences among indexes are rather bigger. For easy to comparison, indexes are standardized, whose calculating formula are as the follows:

$$Y_{ij} = [X_{ij} - X_{ij}\min] / [X_{ij}\max - X_{ij}\min], \quad j \in I_1,$$

$$Y_{ij} = [X_{ij}\max - X_{ij}] / [X_{ij}\max - X_{ij}\min], \quad j \in I_2,$$

$$Y_{ij} = |X_{ij} - \beta_j| / \max|X_{ij} - \beta_j|, \quad j \in I_3,$$

where I_1 is the aggregate of benefit-type indexes (the bigger, the better), I_2 is that of cost-type indexes (the smaller, the better); I_3 is that of the indexes (the nearer to one fixation value β_j, the better); X_{ij} is various evaluation indexes, Y_{ij} is their corresponding standardization indexes.

On the basis of the acquired research results of various natural disasters in the Changjiang Valley, especially intensity, frequency and incidence of various natural disasters recorded historically, as well as disaster-breeding settings, subjection function models, classified into two continuous and dispersal types, are adopted in non-dimensionization of single index getting-value, so as that the hazard grades of main natural disasters of each evaluation unit are elicited.

4.2.3 Indexes and models of clustering analysis

There are a lot of comprehensive evaluation methods nowadays. During the comprehensive evaluation of natural disasters, gray clustering analysis and fuzzy comprehensive judge methods are adopted (LI *et al.*, 1999; YANG *et al.*, 2000), whose comprehensive results validate each other, so as to make the results more precise and objective. Among them, gray clustering is indicated that whitified number possessed by different clustering indexes for clustering object is induced in

Table 2 Grades of hazards, index's weights and synthetic hazards degrees of various natural disasters

Evolution units	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	B_1	B_2	B_3	A_1	A_2	A_3
Index weight	0.9	0.6	0.35	0.7	0.5	0.3	0.25	0.2	0.13	0.25	...	...	...	...	...	...
......	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1. S-Qinghai Plateau	1	2	1	0	1	4	1	1	0	0	0.40	0.34	0.18	2	0.92	3
2. W-Sichuan Plateau	3	4	1	2	1	3	4	4	0	0	0.91	0.56	0.54	1	2.01	1
3. Hengduan Mts.	4	4	4	0	0	2	3	3	0	0	1.03	0.12	0.72	1	1.87	1
4. S-Shanxi Hills	4	4	3	3	3	0	2	2	0	0	0.87	0.72	0.72	1	2.31	1
5. SE-Sichuan Hills	0	3	3	1	4	1	0	0	0	0	0.57	0.60	0	1	1.17	2
6. Yunnan Plateau	3	3	3	2	3	3	2	2	2	0	0.81	0.76	0.54	1	2.11	1
7. Qingba Mts.	0	4	2	4	2	1	2	2	0	0	0.80	0.82	0	2	1.62	2
8. Shichuan Basin	0	3	3	3	3	0	0	0	0	0	0.57	0.72	0	2	1.29	2
9. W-Hunan Hills	1	4	3	3	4	0	0	0	0	0	0.69	0.82	0.18	2	1.69	2
10. W-Hubei Mts.	0	2	3	1	4	0	0	0	2	0	0.51	0.54	0	2	1.05	3
11. Guizhou Plateau	0	2	3	2	3	0	2	2	0	0	0.63	0.58	0	2	1.21	2
12. Huaiyang Hills	0	0	3	1	2	0	0	0	0	0	0.21	0.34	0	3	0.55	3
13. Jianghan-Dongting Plain	0	2	1	4	3	0	0	0	0	0	0.31	0.86	0	3	1.17	2
14. Poyang Lake Plain	0	2	1	4	3	0	0	0	0	2	0.31	0.86	0.10	3	1.27	2
15. Jianghuai Plain	0	0	1	4	2	0	0	0	0	3	0.07	0.76	0.15	3	0.98	3
16. Changjiang Delta	0	0	1	4	1	0	0	0	0	4	0.07	0.66	0.20	3	0.93	3
17. Jiangxi Hills	0	1	2	2	3	0	0	0	2	0	0.32	0.58	0	3	0.90	3
18. SE-Hunan Hills	0	1	2	1	1	0	0	0	1	0	0.29	0.24	0	3	0.53	3

Note: W—West, S—South, E—East, N—North. The first row "code names" stand for inducing-disaster factors or comprehensive evaluation indexes, namely: C_1— seismic hazard, C_2—landslide, mud-rock flow and collapse, C_3— water and soil erosion, C_4— flood hazards, C_5—drought hazards, C_6— freeze and thaw disasters, C_7—fracture, C_8—surface collapse, C_9 —soil compress-dilation, C_{10} — typhoon and storm surge, B_1—geological disasters, B_2—climate calamity, B_3—other disasters, A_1— clustering types A_2 — synthetic hazards' degrees, A_3— grades of hazards.

link of n gray-kind, so as to judge which gray the clustering object belongs to. Calculating process of gray clustering model generally is the following six steps: 1) presenting clustering whitified number x_{ij}; 2) ascertaining gray whitified number $f_{jk}(x_{ij})$; 3) counting index clustering weight η_{jk}; 4) calculating clustering coefficient δ_{ik}; 5) structuring clustering vectors $\delta_i = (\delta_i, \delta_i, \ldots, \delta_i)$; 6) clustering.

4.3 Construction of Visualization System of Comprehensive Evaluation

Visualization system of comprehensive evaluation for natural disasters (VS CEND), is indicated that on applying visualization information technique, graph and attribute databank and its indexes database is set up, can implement information to share and display, output, analyze in multi-track, graphs dynamic, as well as browse among manifold date volume and observe the correlation and trend of multifold databank. In combination with synthesis and dominance principle, and in term of natural disasters units, all data are deposited in computer by tabulation via digitalizing instrument (for map), DBMS and text editor (LUO *et al.*, 1998), which forms the integrate database on comprehensive evaluation's indexes system of natural disasters system in the Changjiang Valley. The above various spatial graphics are shown in WINDOWS operation system by menu. Among them, the evaluation units are divided in term of rather big landform section and referring to district. In whose interior, disaster-breeding setting is relative consistent, calamity-inducing factors are comparatively singular and hazards-bearing body is relative uniform. As a result, the situation of a disaster also is similar(CHEN *et al.*, 1998).

4.4 Data Transition and Visualization

In the VS CEND, Logic skeleton diagram on model operation for comprehensive evaluation GIS of natural disasters see Fig. 2(YU *et al.*, 1999). In matrix, user must originally input one variable — Location, which stands for the evaluation unit corresponding to this evaluation object. In the spatial database, there is also a same field "Location" in its corresponding geographic database. Therefore, through operation "Hotlink" uniting evaluation result and geographic position database in evaluation information system, the evaluation result and its corresponding evaluation area can be combined commendably together, so as to juncture statistical data and spatial data. Users may obtain the evaluation results via mutual operation in the VS CEND. The "joint" function of the model is implemented with ArcView Script language. In evaluation model, composite indexes assuming-value and two appraising methods of natural disasters comprehensive evaluation are operated. Using IVS software to draw, regional disaster-type assembles map and synthetic hazards' degrees of natural disasters map can be obtained. By operating through composite index assuming-value for comprehensive evaluation of natural disasters and calculating models of two evaluation methods, and drawing with the aid of Excel Software etc., disaster-clustering type chart and synthetic hazards grade figure of natural disasters may be acquired(Table 2) . The former is in line with gray clustering analysis, while the latter is through fuzzy comprehensive judge. Synthetic values' scopes of large type is divided into three sections: > 1.7, 1.69 – 1.10 and <1.09, respectively. Hereby, two levels and nine subtypes can be classified. Two evaluation methods for classifying are verified each other, whose results are generally unanimous. However, due to some reasons, for instance, index's weight, source material insufficiency, etc., there exist some discrepancy.

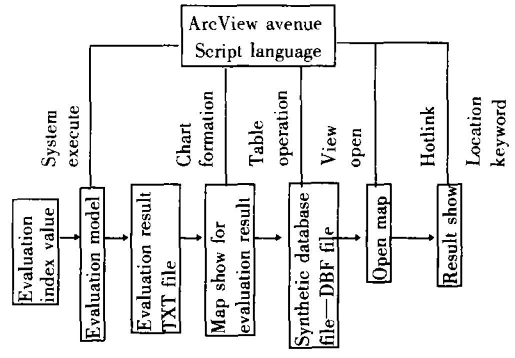

Fig. 2 Logic skeleton diagram on model operation for comprehensive evaluation GIS of natural disasters

5 INTEGRATED MECHANISM ON FORMATION AND OCCURRENCE OF NATURAL DISASTERS AND THEIR DISTRIBUTING LAW

With multiple physical geographical conditions and complicated geotectonic setting in vast Changjiang Valley area, manifold geo-ecological environment types have been come into being, which decides the formation and distributing of numerous natural resources, also controls the formation and occurrence of numerous natural disasters(WANG, 1994; ZHANG *et al.*, 1997). Here, the authors only discuss the integrated mechanism on formation and occurrence of natural disasters and their distributing law in the Changjiang Valley, which are the basic facts of the up-down approach.

5.1 Integrated Mechanism on Formation and Occurrence of the Natural Disasters

Natural disaster system is a multi-level, varied-ingredient complicated dynamic system. Apiece natural disaster doesn't all exist and occur in isolation. Regardless of spatial distribution (disaster cluster), temporal rhythm (calamity chain) and the cause of formation, there exist intimated relativities(WANG, 1994; ZHANG *et al.*, 1997), namely, they have pertinent dynamical system, evolvement process and distributing law. Since the Pliocene epoch, on account of the collision between India plate and Eurasian plate at Himalaya orogenic zone and the subduction of Pacific plate at Japanese island arc, the tectonic movement in the Changjiang Valley has a general characteristic—the western violently uplift and gradually weakened eastwardly. Structural uplift belts are master of formation and distributing of mountains, and there may often occur disaster clusters including mountainous geological disasters, seismic hazards, forest calamities and rainstorm floods. Moreover, they induced mutually to pose calamity chain. In the plains and basins controlled by structural depression belt, there may often appear plain disaster swarms comprising drought, flood, agricultural damage and plain geological disasters. In mountain region—transitional tectonic belt, there frequently occur earthquake catastrophe, geological disasters and drought damage. Sea-continent regions of convergence occur severe ocean calamity and climatic hazards.

5.2 Distributing Law of Natural Disasters

Outline of geotectonics in the Changjiang Valley is not only the elemental conditions of seismic hazard and geological disasters, but also makes relief and climate become into two huge EW-trending contrasts, and turns into a general macro-controlling factor. Contrast and gradient change of relief dominate cold, freezing damage and physical denudation in the western plateau mountain, and then, strong erosion and dissected are accompanied by large-scale landslip and mud-rock flow collapse in the relief-gradient belt, as well as sediment and flood damage in the eastern subside zone. Due to contrast of climate and its governing over edatope and ecotope, ES air-flow and ocean weather deeply stroke the middle-down reaches, so as to induce frequent storm and flood damage etc. On the basis of this, local factors, for instance, deep-seated geologic process and thermodynamic, may also bring about partial crust deformation and seismic region. These local conditions often complicate overall terrain law.

6 NATURAL DISASTERS COMPREHENSIVE DIVISION FOR THE CHANGJIANG VALLEY

On the basis of the result of comprehensive natural disasters division adopting bottom-up approach, combining with the distributing law in the Changjiang Valley, acted as the basic facts of the up-down approach, and consulting natural environment and social-economic setting(MACEACHREN, 1995; YU *et al.*, 1999), three natural disaster sections and nine natural disaster sub-sections are divided into in the comprehensive natural disasters division of the Changjiang Valley. Their regional characteristics and the division map can be seen in Table 3 and Fig. 3, respectively.

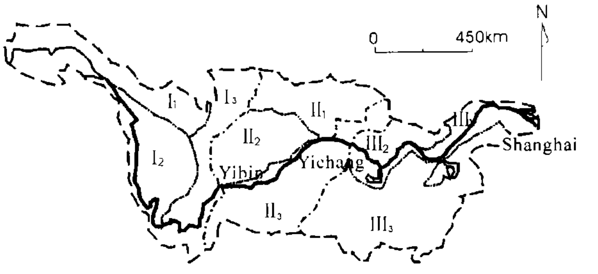

Fig. 3 Comprehensive division of the natural disasters in the Changjiang Valley
(Legend demostrations see Table 3)

7 CONCLUSIONS

Tectonic movement characterized by western violent elevation and lessening gradually eastwards in the Changjiang Valley has formed its "three big steps" topography and three great geological regions, determined the evolutionary law of four-dimension space-time geo-ecological environment, also controlled the occurrence and distributing of numerous natural disasters. With a vast field, on account of intricate natural disasters and deficient data, quantitative study is insufficient, and there exist some difficults in real simulation. Whereas, it is good for more discuss that disaster division study comes from evolvement trend of geo-ecological environment, so as to provide scientific foundation for establishing the measure of preventing and fighting calamity.

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Table 3 Divisional features of comprehensive natural disasters in the Changjiang Valley

Region name	Disaster subregion code and its name	Disaster subregional scope	Characters of assembled disaster (calamity-inducing factors)	Characteristics of natural environment (disasters-breeding setting)	Influence of human activity (hazards-bearing body)
Qinghai-Xizang-Sichuan-Yunnan mts. and plateau disaster region I	I₁ S-Qinghai and W-Sichuan plateau disaster subregion	North to Bayan Har Mts. Belonging to Hengduan Mts. N-segment	Snow and wind calamity, soil freeze-melt, landslip and geo-fracture, land desertification, grassplot plague of insects	Alt. 3.5 – 5km, hills and plateau, chilly and dry, much ice-snow and strong wind, wide and shallow river valley, smooth and slow stream, WN-rupture and multiple drapes belt make-up, Quaternary active fault belt, sand-slate rock, deep frozen earth in cover-top	Vast territory and sparse population, gently economic activity, mostly railroading, fighting calamity capability weak
	I₂ Hengduan Mts. disaster subregion	Shichuan Basin and W-Yunnan Plateau, E-Tibet region	Seismic high-intensity area, landslide, mud-rock flow and collapse, ice-hail, karst seepage	Alp-canyon area, Alt. 4 – 5km, obvious alp. climate, torrential current, violent neo-tectonic motion, deep rupture and multiple drapes belt make-up, sand-slate rock nipping phyllite	Relative rare population, undeveloped economy, railroading, fighting calamity capability weak
	I₃ S-Shaanxi, Sichuan-Yunnan disaster subregion	S-Shanxi Mt., Longmin Mt. and Wumong Mt.	Severe drought, frost, landslide, mud-rock flow, active rupture, loess damp trap, water-soil erosion	Alp-canyon area, Alt 1 – 3.5km, range-valley relative-height 1 – 2k m, clear alp. climate, relative torrential current, S-segment of NS-tectonic belt, Quaternary active fault belt and strong shock belt	Population density not too, destroy virgin forest cosmically, , mining and railroading, F. C. C. weak
Shannxi-Sichuan-Hubei-Guizhou mid-low hills disaster region II	II₁ Qingba Mts. disaster subregion	N-margin of Qinling Mts., S-edge Daba Mts., N-side Henan Yi-E Hills, W. to Long-S Mts.	Landslide, collapse, mud-rock flow, flash flood, drought, karst leakage, reservoir-inducing earth-shock	Mid-low range and narrow defile area, Alt. 1 – 2km, high-range, deep-valley and steep-slope, rainy, great intension and variability of precipitation, low forest cover, in Qinling-daba folded Mts., moderate seismic activity, metamorphose, carbonatite and granite	Increasingly population, railroading, highway and, mining, severe forest destroying, F. C. C. weaker
	II₂ Sichuan basin disaster subregion	N-edge Muchuang Mts.. SE- or S-edge Daba Mts, Dalou Mts. , E-or SW-edge Longmun Mts.	Frequent drought, more flood, landslide and collapse everywhere and severe water-soil erosion, karst subside in partial area	Low mts. and hilly area, Alt. 250 – 700m, enclosed by mid-mts., mostly continuously undulant hilly area in the basin base, moderate sub-tropical wet climate, marked disastrous climate, Sichuan syneclise, feeble neo-tectonic movement, most red-bed clastic rock	Large population and little land, over-reclaim hill-side cultivated land, railroading, economy better, F. C. C, stronger
	II₃ Hunan-Hubei-Guizhou mts. disaster subregion	North bordering on Daba Mts. Including Xue-feng Mts., Wuling Mts. and Guizhou Plateau	Landslide, collapse, mud-rock flow, karst leakage or subside , partial water-soil erosion, reservoir-inducing earth-shock, endemic	Mid-low mts. plateau and gorge area, Alt. 500 – 2000m, big undulate, under interleaving belt of SE and SW monsoon, instable precipitation, Huangling anticline and EN anticlinoriu, faint neo-tectonic motion, mostly carbonatite and detrital rock	Destroying forest and slope vegetation, reckless digging soil-stone, cluttered dump, undeveloped economy, F. C. C. not strong
Hunan-Jiangxi-Hubei-Anhui low-mts hills and plain disaster region III	III₁ Huaiyang hilly disaster subregion	W-on-Nanyang Basin, including Tongbo Mts. Dabie Mts. and Zhangbaling Mts.	Soil compression-dilatation, side-slope slide, water-soil erosion, drought, endemic etc.	Low mts. and hilly area, Alt. 200 – 800m, north sub-tropical climate, big variability of precipitation, Nanyang depression and Huaiyang doming, W-intense and E-gentle neo-tectonic motion, WWN and EN rupture	Population density no big, low econo-mic productivity, forest destroy, reclaiming steep -slope, F. C. C. weaker
	III₂ the middle-lower reaches of the Changjiang River Plain disaster subregion	E-to-Yichang, S-to-Daba Mts. and Tongbe Mts. N-to-Guizhuo Plateau and Jingnan hilly belt	Severe flood calamity, surface subsidence, under-cliff, riverway upfill, polluting water-soil, rat surge plant disease and pests insect	Vast alluvial and lacustrine plain, Alt. under 200m, typical monsoon climate , huge difference in temp. , concentrating precipitation, calm and gentle stream, in syneclise belt of Changjiang paraplatform, marked regional difference of seismic activity, Quaternary loose soil	Population denseness, economic upgrowth, reclaim land from lake, absurd exploiture and use, but F. C. C. strong
	III₃ Jiangnan low-mts. and hilly disaster subregion	S-to-Riverside plain of Changjiang Valley, No-to-Nanling Mts. E-to-Guizhou Plateau, W-to-Wuyi Mts.	Frequent drought and flood, marked dog days, grave water-soil erosion, karst subside, mini-type landslipe soil compression-dilatation, reservoir-inducing earth-shock	Low mts. and hilly area, Alt. 200 – 600m, few mts. reaching 1000 – 1500m, sub-tropical monsoon climate, on the anteclise and syneclise of South China fold belt and Changjiang paraplatform, metamorphose and granite rock in hilly area, redstone in basin and carbinaite in M-Hunan	Bigger population density, unreasonably exploiting slope-land, severely destroying vegetation, F. C. C. stronger

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