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On The Spatial and Temporal Patterns of Flood and Drought Hazards of China

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1. Introduction

1.1 Background

- China is a typical monsoon climate country as well as an agricultural country with the world's largest population. The instability of monsoon climate leads to frequent flood and drought, causing 55% of total natural disasters loss.
- In summer of 1998, Flood in the Yangtze River, Nenjiang - Songhua River basin,

  affected area:22.27 million hm^2 affected population 18 million

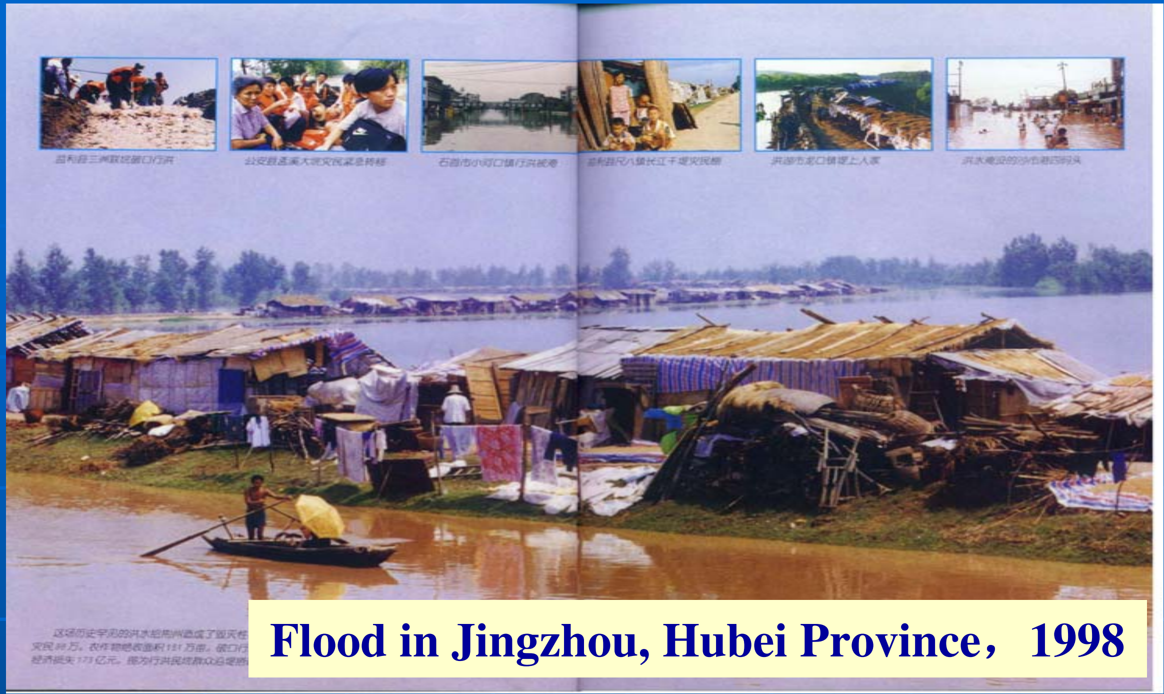
  killed 4,150 people direct economic losses 255.09 billion RMB

  indirect economic losses 100 billion RMB
- In summer of 2006, Drought disaster in the city of Chongqing

  total direct economic loss :8.15 billion RMB

  affected crop area had been nearly 1.33 million hm^2

  crops economic losses : 6.031 billion RMB



Flood in Jingzhou, Hubei Province，1998

The most severe summer drought since 1951 hit Sichuan and Chongqing,2006.

1.2 Research Review

- The major information sources are the meteorological sites information, historical events records or the disaster data taking the province as the statistical unit, for less disaster information taking the county as a unit.
- Study on temporal and spatial patterns of floods and temporal patterns of droughts: (Pan Yaozhong, 1996; Wang Jing-ai,2001; Wang Jing-ai,2002; SHI Pei-jun,2003.)
- Complete sequence of combining floods and droughts was about five hundred years (1470 ~ 1990) (China meteorological administration,1981; Zhang De'er, 1993.)

1.3 Key Problems

- Statistical unit: 2,359 counties
- Hazard assessment index: disasters frequency

Through hazard digital mapping, the spatial and temporal patterns were analyzed, and hence understood the flood-drought high hazard zone and the transfer causing factors, presented disaster prevention measures for the high-hazard zones.

2. Data and Method

2.1 Data Source

Taking the county as the assessment unit, we collected 25430 data totally including 17,232 flood records and 8198 drought records from 1949-2005, trying to rebuild the spatial and temporal patterns on flood and drought hazards of China.

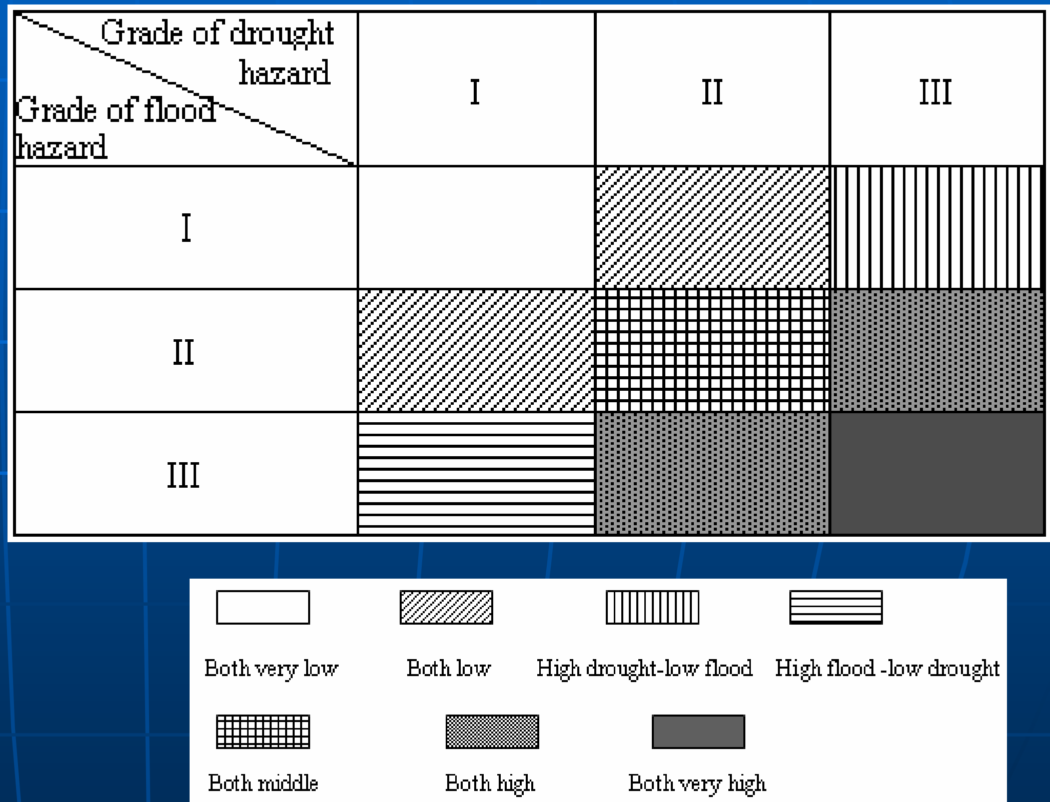
Database	Sub-database	Content	Data sources
Hazard-formative factors database from Newspaper & Journal Database for Natural Disasters in China	Flood database in China	Time,place and type of flood disasters of county level in 1949-2005	Newspaper & Journal of provinces, cities and districts in China in 1949-2005
	Drought database in China	Time,place and type of drought disasters of county level in 1949-2005	
Map database of natural disasters in China	County boundary database	Administrative county region map in China(Administrative region code of 2000)	<Atlas of natural disasters of China> (digital edition),2003

2.2 Hazard Assessment

- We selected frequency as the index of hazard-formative factors
- **F=*m*/Y**
- In this formula,

m stands for times of natural disasters of some county, Y stands for the total year number.

- After the respective assessment of flood and drought hazards, ***2D relational tables method*** was selected to assess the integrated hazard of flood and drought disaster.



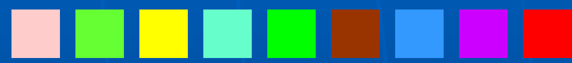
2.3 Hazard Cartography

- Four time scales :total 57 years, 10 years scale, season scale and month scale
- Three basic principles of legend cartographic design:

1. More thicker of the color with the higher of hazard, highlighting the high-hazard degree;

2. The color system of flood hazard is mainly blue, drought hazard is mainly yellow, highlighting the visual sense;

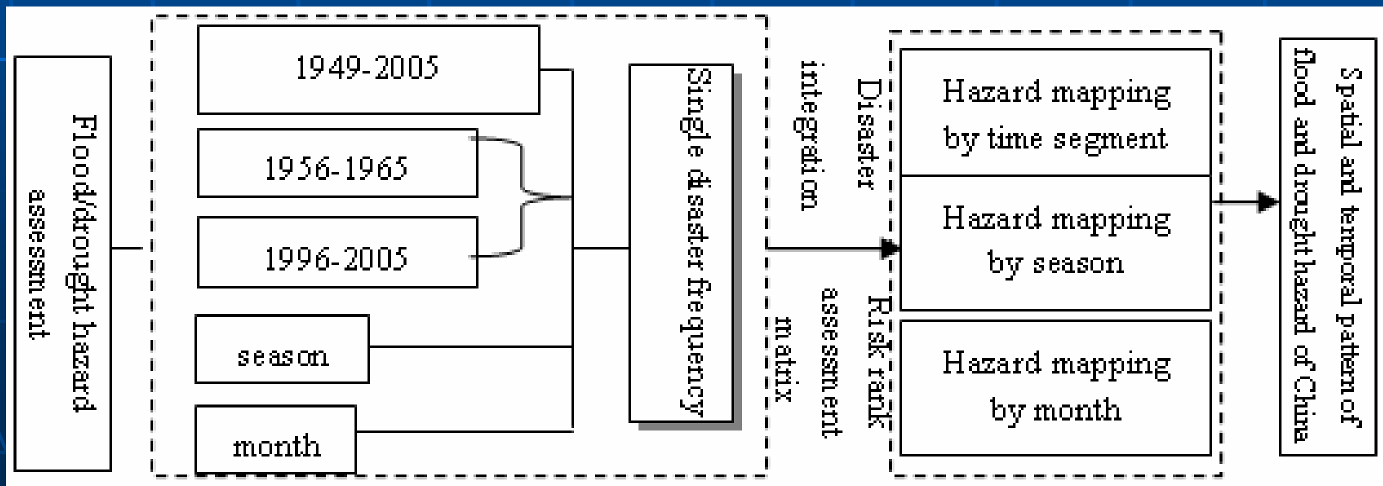
3. Two number is used to further explain drought and flood hazard group relations.



11 12 13 21 22 23 31 32 33

Left number:flood

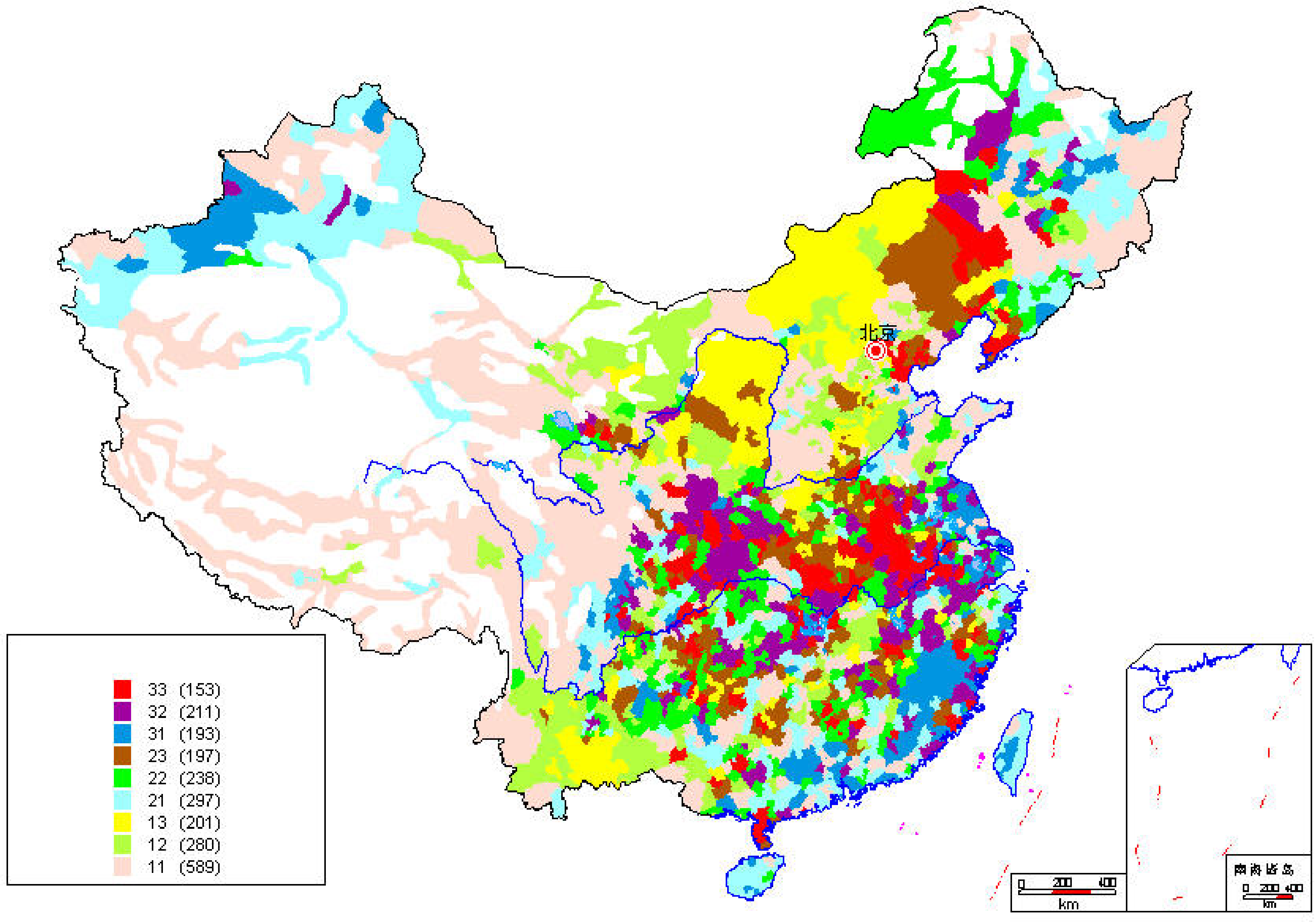
Right number:drought



Cartography flow chart of flood and drought hazard assessment of China

3. Integrated Pattern of Flood and Drought Hazards of China

Spatial pattern of flood and drought hazards of China (1949-2005)



Statistical table of each hazard grade

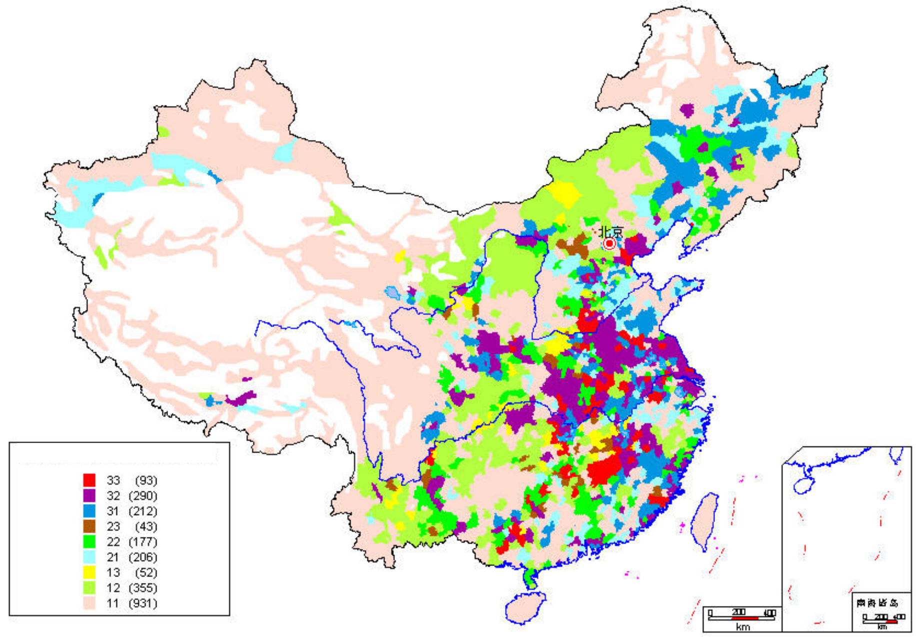
Grade	Both very low	Both low	High drought-low flood	High flood –low drought	Both middle	Both high	Both very high
Number of county	589	577	201	193	238	408	153
Percent accounting for all the counties （%）	24.96	24.46	8.52	8.81	10.89	17.29	6.48

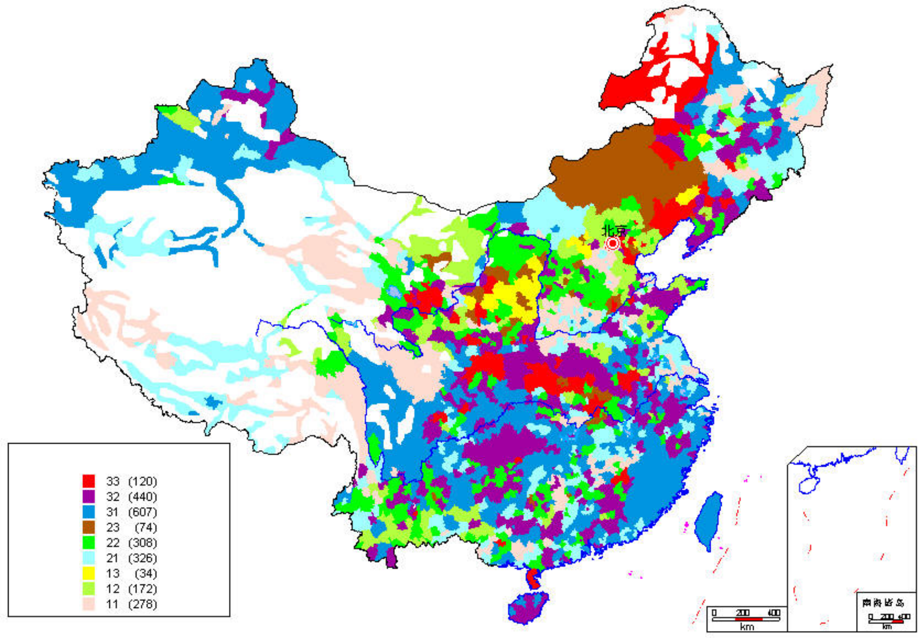
Spatial pattern of flood and drought hazards of China (1949-2005)

- Recent 57 years, the integrated pattern of flood and drought hazard shows the East -West differentiation ,East is far higher than West, which is the climate-landscape-human interaction product. The high-value areas show a clear South-North differentiation and high value counties (at degree 3) reach 955, accounting for 40.5% of the total county number.
- There are 153 both very high flood and drought hazard counties, accounting for 6.5% of the total county number of China, mainly located in the west of Northeast Plains, 25° ~35° north latitude (roughly between the Huanghe - Huaihe River basin and the Yangtze River-Huaihe River basin).

4. Spatial and Temporal Patterns Variation of Flood and Drought Hazards of China

4.1 Spatial and temporal patterns variation from time-segment



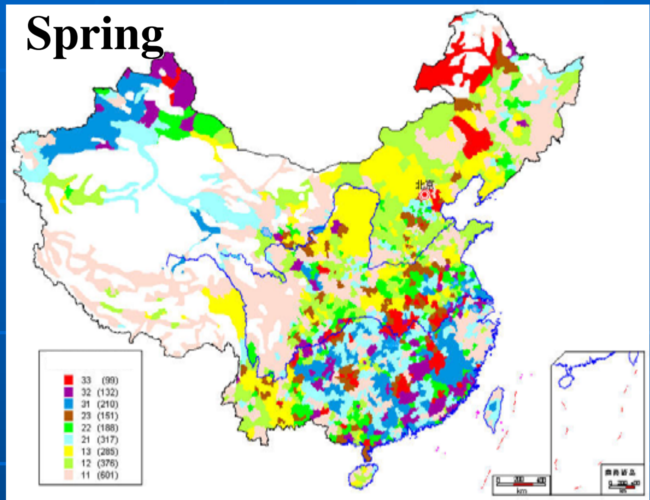


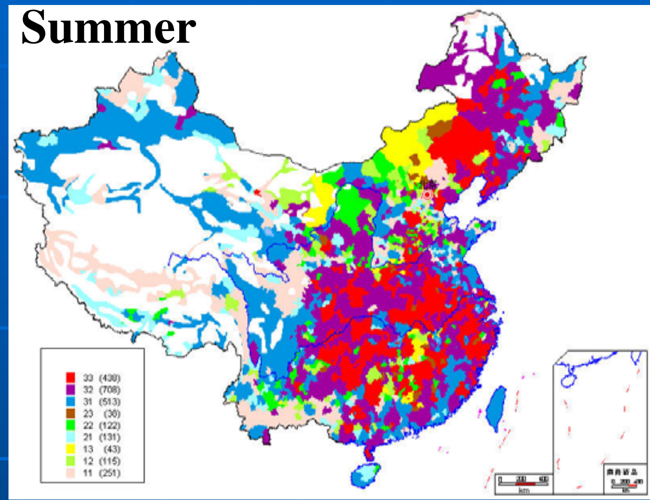
Flood/drought hazards pattern of China (1956-1965)

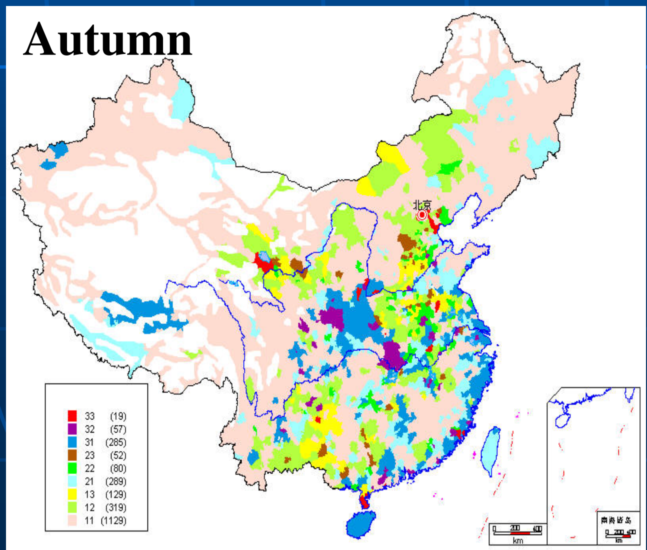
Flood/drought hazards pattern of China (1996-2005)

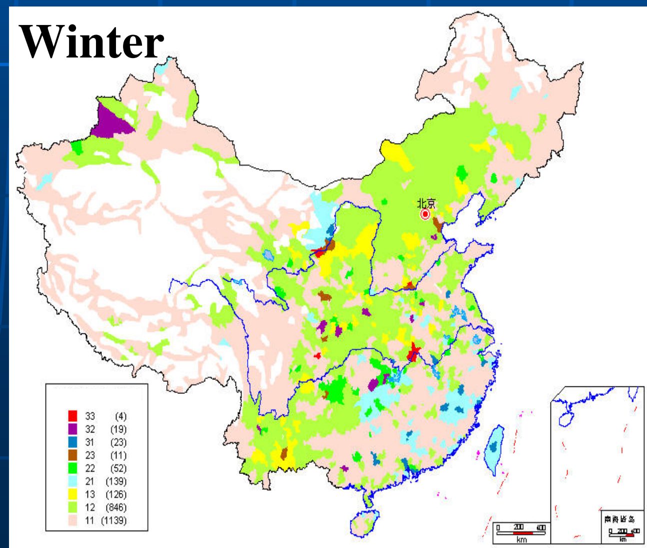
- In 1956-1965, the pattern of flood and drought hazards of China showed an obvious East-West differentia. Both very high flood and drought hazard areas were scattered, mainly in the Yangtze River-Huaihe River basin and the middle and lower reaches of Yangtze River.
- In 1996-2005, high value area increased evidently, further expanded to the northeast, northwest and south. This was related to the process of land reclamation by human activity. High flood hazard areas increased rapidly, mainly in the southern part of China, Northeast and Northwest regions. High drought hazard areas extended to northern China, Both very high flood and drought hazard counties increased obviously, especially west of Daxing'anling, south of Liaohe River Basin and south of Qinling becoming new both very high hazard areas.

4.2 Seasonal variation of spatial and temporal patterns of China







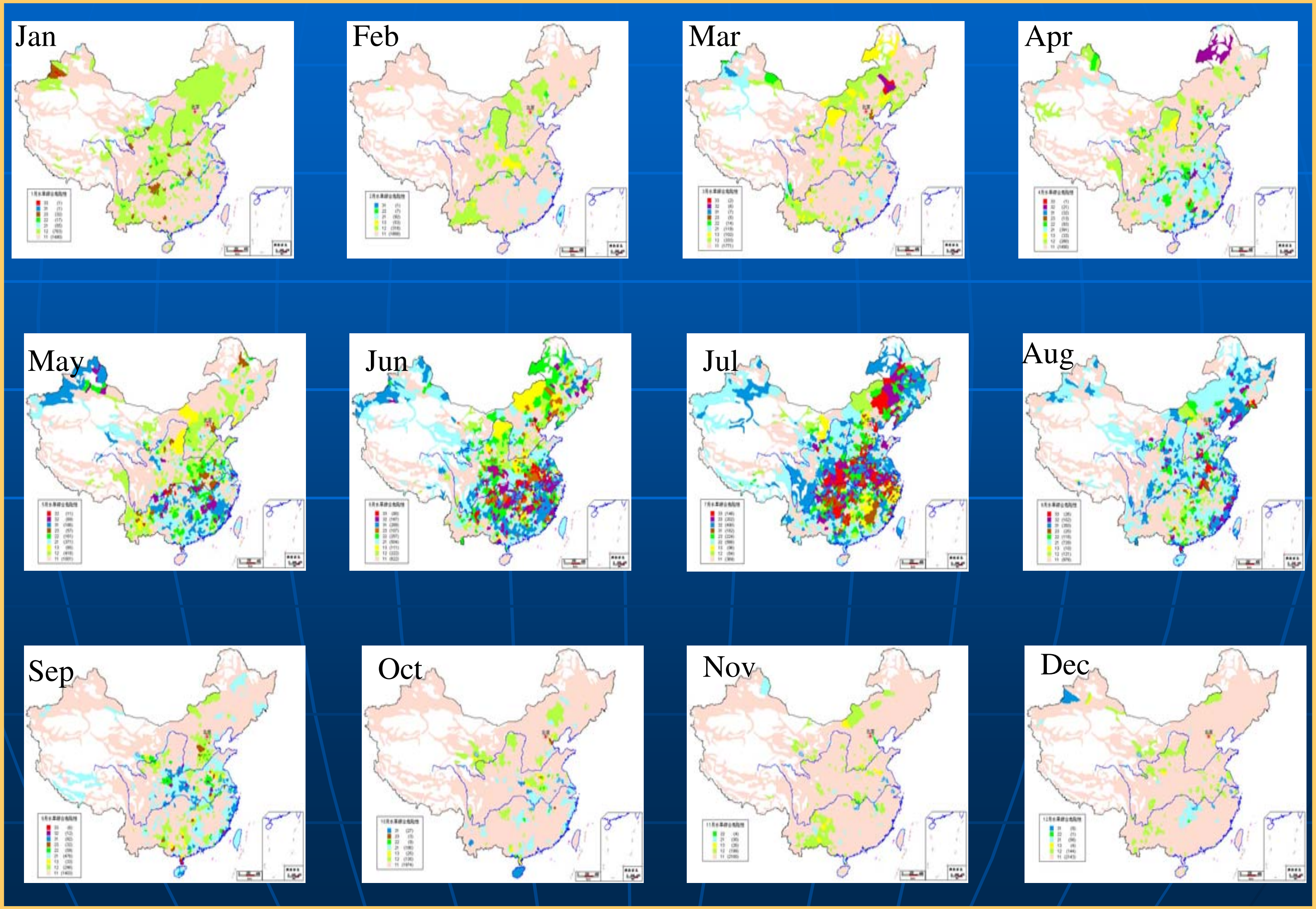


Statistical table of each hazard grade

Grade	Season	Both very low	Both low	High drought-low flood	High flood – low drought	Both middle	Both high	Both very high
Number of county	Spring	601	693	285	210	188	283	99
	Summer	251	246	43	513	122	746	438
	Autumn	1129	608	129	285	80	109	19
	Winter	1139	985	126	23	52	30	4
Percent accounting for all the counties(%)	Spring	25.47	29.37	12.08	8.90	7.96	11.99	4.19
	Summer	10.64	10.42	1.82	21.74	5.17	31.62	18.56
	Autumn	47.85	25.77	5.46	12.08	3.39	4.62	0.80
	Winter	48.28	41.75	5.34	0.97	2.20	1.27	0.16

- Seasonal variation of spatial and temporal pattern was very significant.
- The overall pattern showed that high flood hazard were mainly in summer and high-value range was wide; Spring took the second place representing the distribution of Drought in the North, Flood in the South; Very low drought hazard were mainly in autumn, flood hazard was even higher in the southeastern coastal regions; minimum flood/drought hazard in winter.
- Summer could be seen as the key time segment of preventing both flood and drought. The key time of preventing drought disaster was spring. Summer is the key time to prevent and control flood.

4.3 Month variation of spatial and temporal patterns of China



- Month variation of flood and drought hazards pattern of China was closely related to the variation process of precipitation belt and month change of hazard-affected body. Low-hazard stage was October to March of the following year; high flood/drought hazard areas had large distribution in the other six months, and high-value areas transferred with the season change.
- The area of high value was largest in July and both high number of counties reached 146, accounting for 6.2% of the total counties, mainly located in central and eastern Inner Mongolia region and the middle and lower reaches of the Yangtze River.

5.Conclusion and Discussion

Conclusion

- Based on the county units of flood and drought information, dividing by total time (1949-2005), time-segment (1956-1965,1996-2005), season and month scales, we selected disaster frequency of 2359 counties as the index and discussed spatial and temporal hazard patterns of flood, drought and integrated flood-drought disaster.
- Recent 57 years, the integrated pattern of flood and drought hazard show the East -West differentiation, East is far higher than West, which is the climate-landscape-human interaction product. The high-value areas show a clear South-North differentiation.

Conclusion

- In 1996-2005, the pattern of flood and drought hazard of China showed an obvious East-West differentia, high value area increased evidently, further expanded to the northeast, northwest and south comparative to 1956-1965. Flood and drought both high-hazard counties increased obviously, especially west of Daxing’anling, south of Liaohe Basin and south of Qinling becoming new both high hazard areas.
- Seasonal variation of spatial and temporal pattern of flood and drought hazard of China was obvious. Both high flood/drought hazard concentrates in summer, spring takes the second place, and low hazard in autumn and winter.
- Month variation of flood and drought hazard pattern of China was closely related to the variation of precipitation belt and month change of hazard-affected body. The peak appears in July, the key prevention areas were central and eastern Inner Mongolia region and the middle and lower reaches of the Yangtze River.

Discussion

- The basic data of this paper comes from the provincial newspaper & journal, belonging to disaster events with disaster effects, which is more comprehensive than the records of meteorological disasters information. This is the advantage of the paper information lies on, but it will be more meaningful for flood and drought risk and hazard research if integrating the newspaper and meteorological data.

Thank you for your attention！