Flash Floods Risk Management in China – A Long Way to Go

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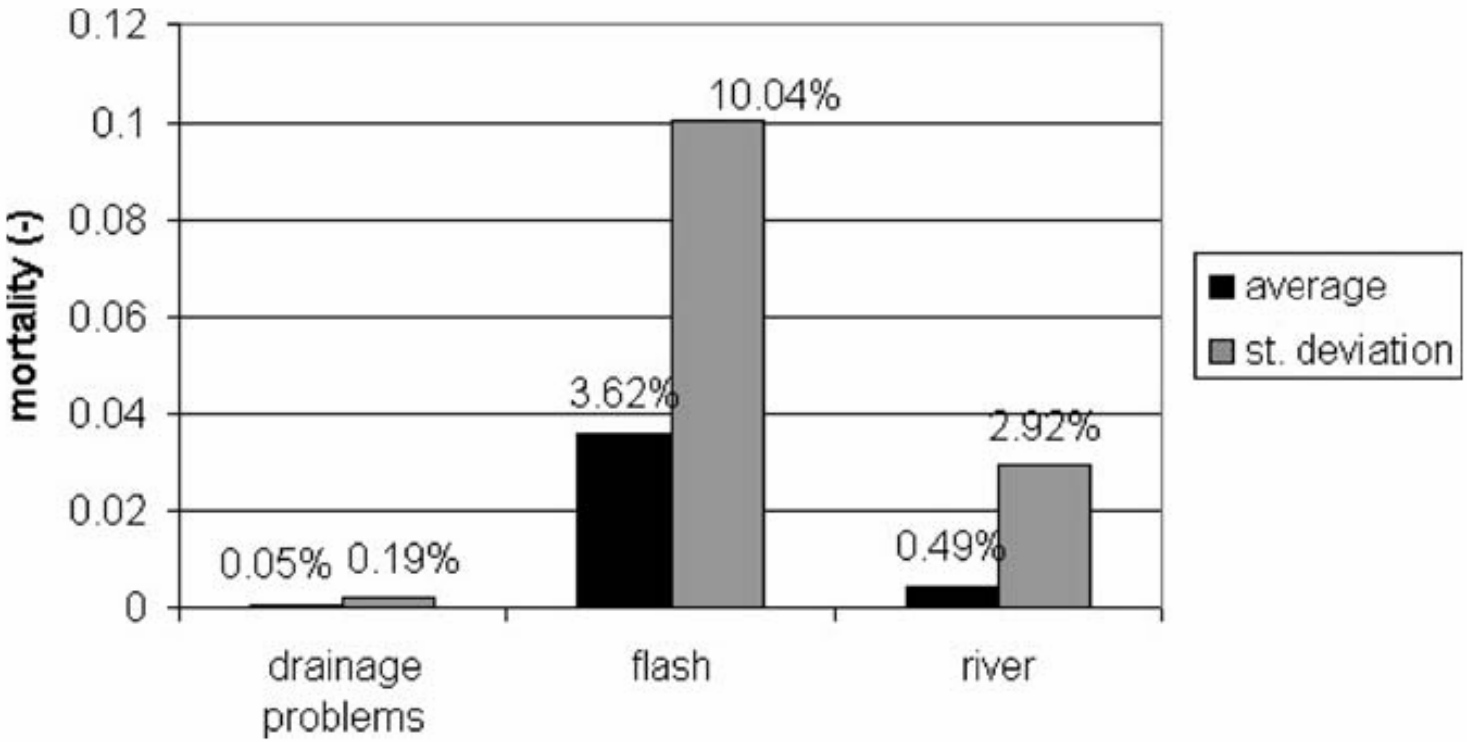
Introduction

- Floods are the most common and widespread of all weather-related natural disasters;
- Flash floods are the deadliest type of floods, because they combine the destructive power of a flood with incredible speed and unpredictability.
- Study shows that flash floods result in the highest average mortality per event (the number of fatalities divided by the number of affected persons).

Introduction



Average and standard deviation of mortality per flood event for different types of floods (S. N. JONKMAN, 2005)

Introduction

- In China, 48% (4,630,000km²) of its land is flash flood prone;
- More than 76 million people live in flash flood prone areas;
- Death toll as a result of flash floods is in the order of 60% of all persons killed by floods

Resent Flash Floods

- June 26, 2006 Flash Flood Kills 11, Leaves 15 Missing in Central China
- June 19, 2006 Flash Flood Death Toll in Southwestern China Hits 52
- July 31, 2006 Death toll in SW China flash flood rises to 18
- August 1, 2006 Flash Flood Kills 18 Highway Builders

Typhoon Bilis, Southern China

July 14 - 21, 2006

- Killed 612 people, 208 people are still missing
- Direct economic loss: 26.6 billion RMB (about 2.7 billion Euro)

Contents of Integrated Flash Flood Risk Management

Hazard mapping
Land use planning
Structural mitigation
Disaster education
Flood insurance
Disaster planning

Forecasting and warning
Real-time observation
Hydrometeorological modeling
Real-time hazard risk mapping
Communication of flood information
Evacuation

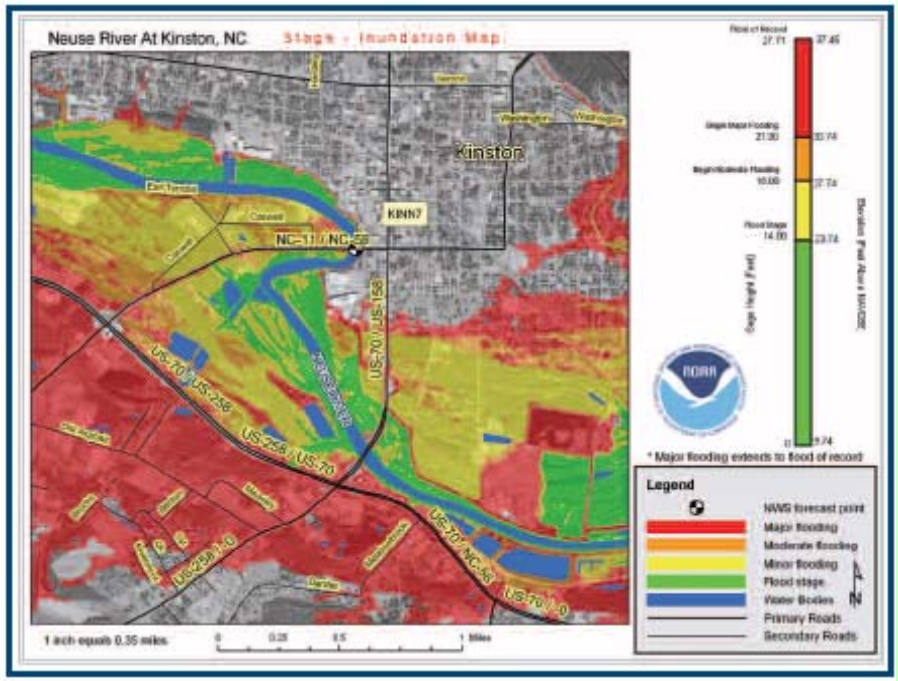
Relief
Restoration

Time

Pro Disaster | In Disaster | Post Disaster

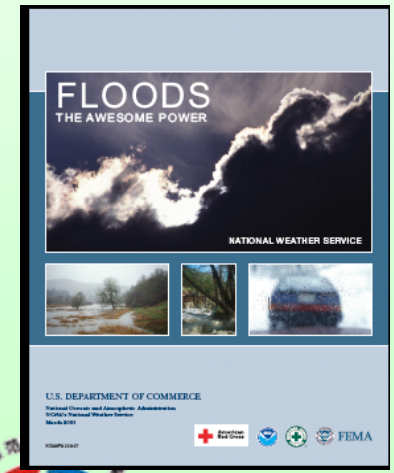
American Experiences (1)

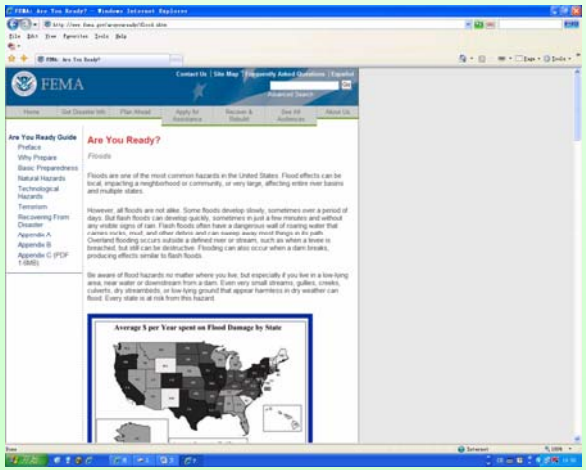
- Geographic analysis/risk mapping
  - Flood Hazard Map information available at the Federal Emergency Management Agency web page



American Experiences (2)

- Disaster Education
  - National Disaster Education Coalition: American Red Cross, FEMA, IAEM, IBHS, NFPA, NWS, USDA/CSREES, and USGS.

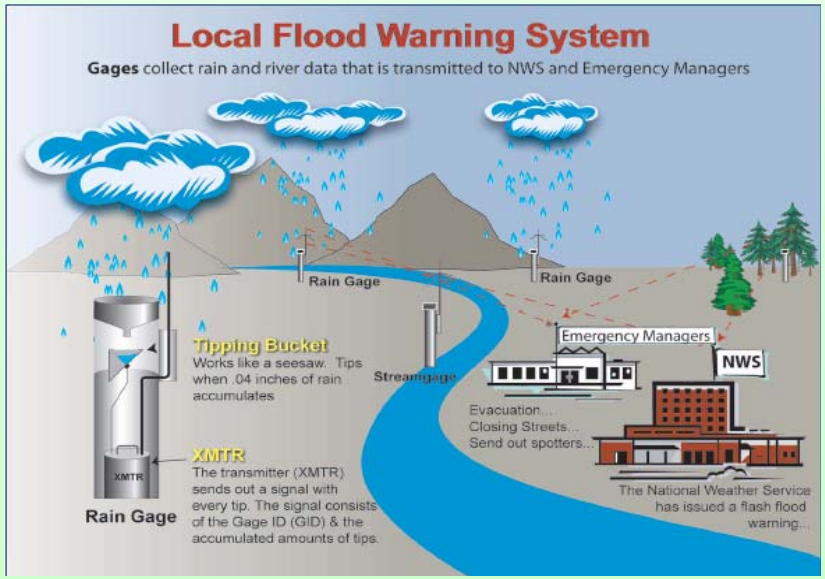




American Experiences (3)

- Flood insurance
  - National Flood Insurance Program

    People are eligible to purchase flood insurance even after home, apartment, or business has been flooded
- Forecasting and warning system



American Experiences (4)

- Real-time observation
  - Nowcasting techniques using RS and GIS
    - Mapping of convective storm initiation in a 0-2 h prediction mode
- Communication of flood information
  - NOAA Weather Radio All Hazards, commercial radio, television, Internet;
  - The Advanced Hydrologic Prediction Service (AHPS) provides improved river and flood forecasting and water information.
    - graphical Internet products also available

Current Researches in U.S.

- Advance of the first moment of recognition
- Best use of excellent technology in prediction of flash floods
- Better understanding of people's behavior
- Training of local planners/officials
- Analysis on the roles of history, lack of knowledge and people's acceptance of risk
- Public education process

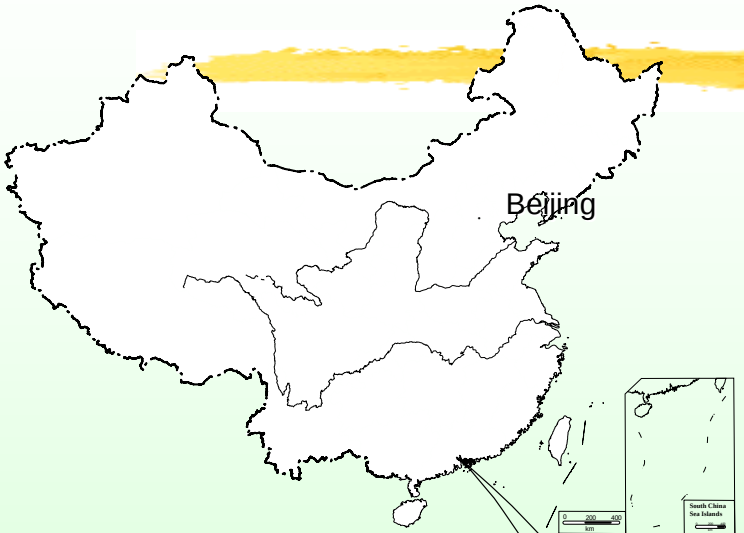
What is lacking in China's flash flood risk management?

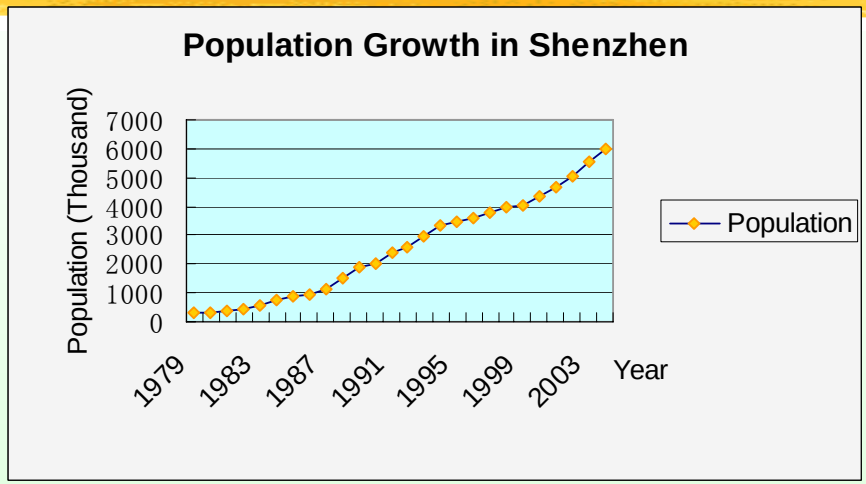
Hazard mapping	×
Land use planning/control	×
Structural Mitigation	√
Disaster education	×
Flood insurance	×
Disaster/emergency planning	√
Forecasting and warning	√
Real-time observation	√
Hydrometeorological modeling	×
Real-time flood risk mapping	×
Communication of flood information	√
Effective evacuation plan	√
Relief	√
Restoration	√

Suggested Improvements

- Hazard mapping on regional/local scale
- Better land use planning
- Public disaster education campaign
- Development of national/regional flood insurance program
- Development of early warning system for flash floods
- Improvement of real-time hydrometeorological modeling and hazard mapping
- Improvement of flood information communication

Case station: Shenzhen, China





Background

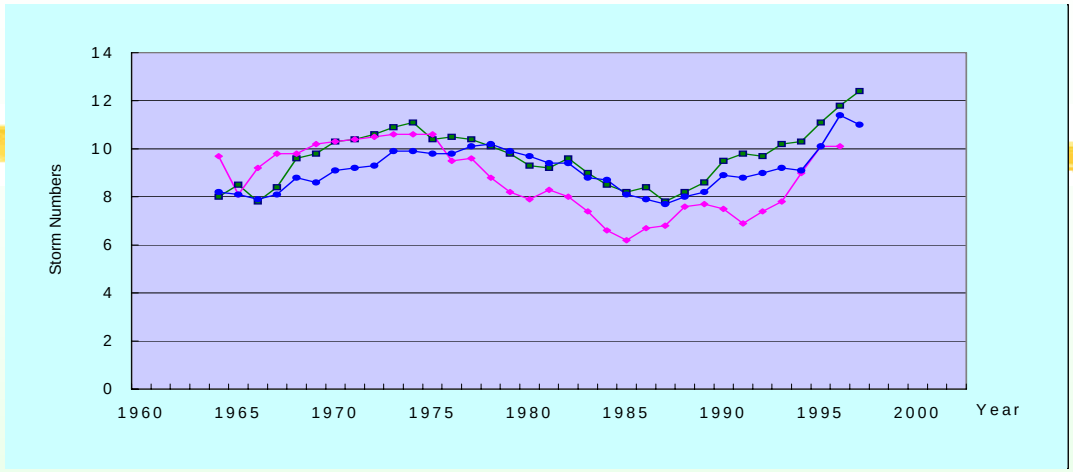
- Locating in the southern tropical costal area, Shenzhen is at the peril of both flash floods and coastal floods.
- Fast urbanization in this region has made the situation even worse because of higher flood risk and potential losses.

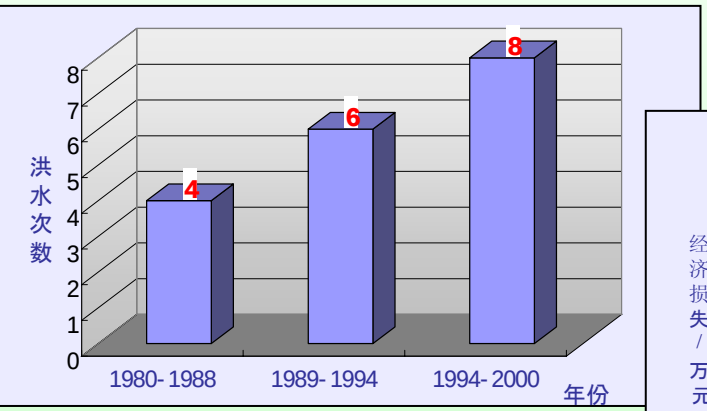

Farm land along the railway


Buji River

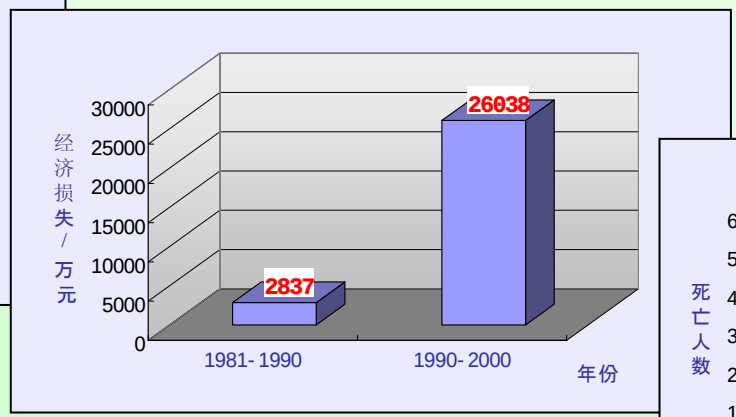

Disappearing South Mountain

Precipitation in Shenzhen Region
（1953－2000）

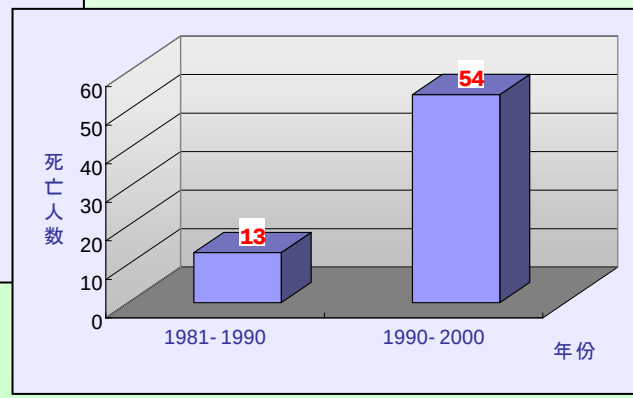




Number of Floods



Economic Loss

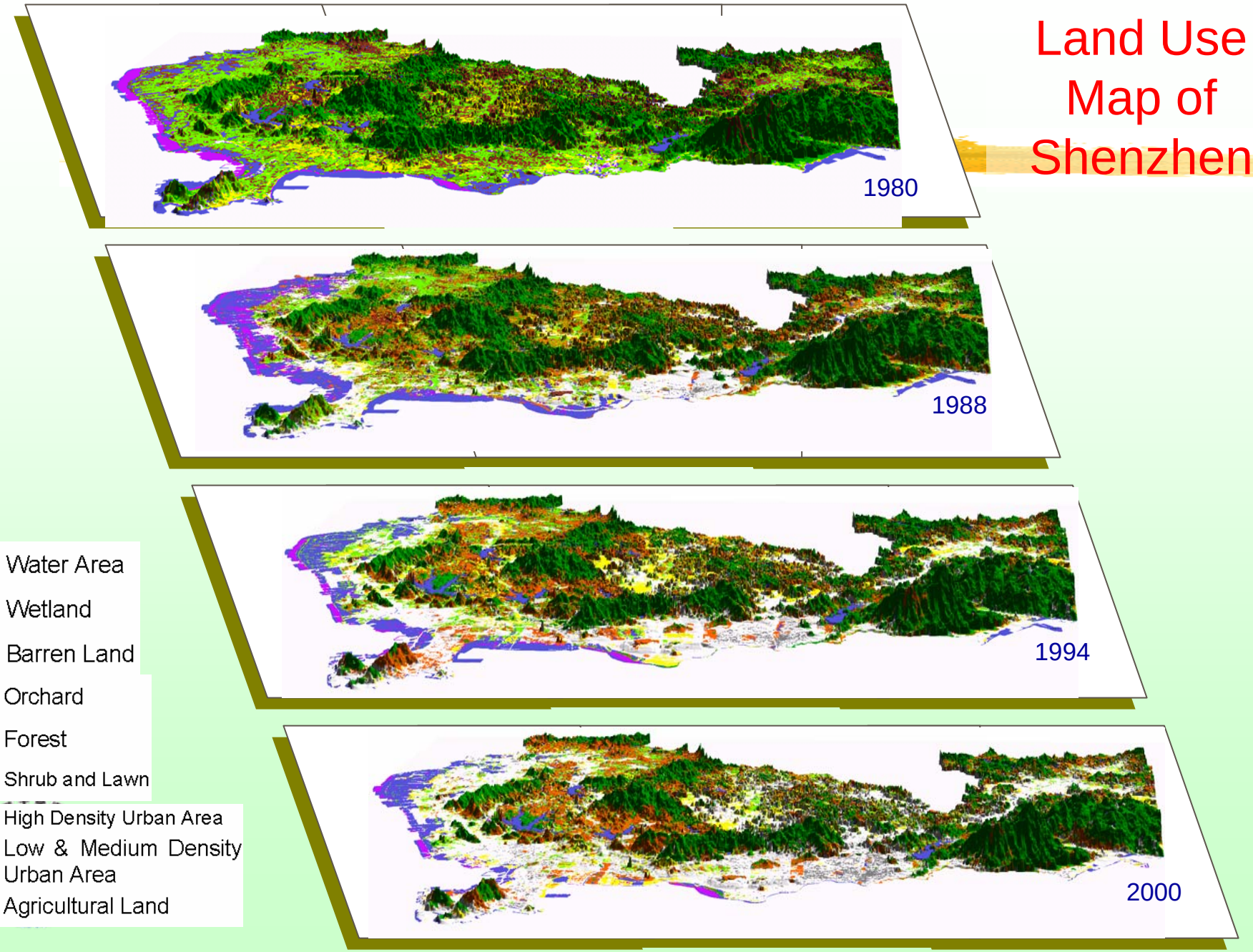


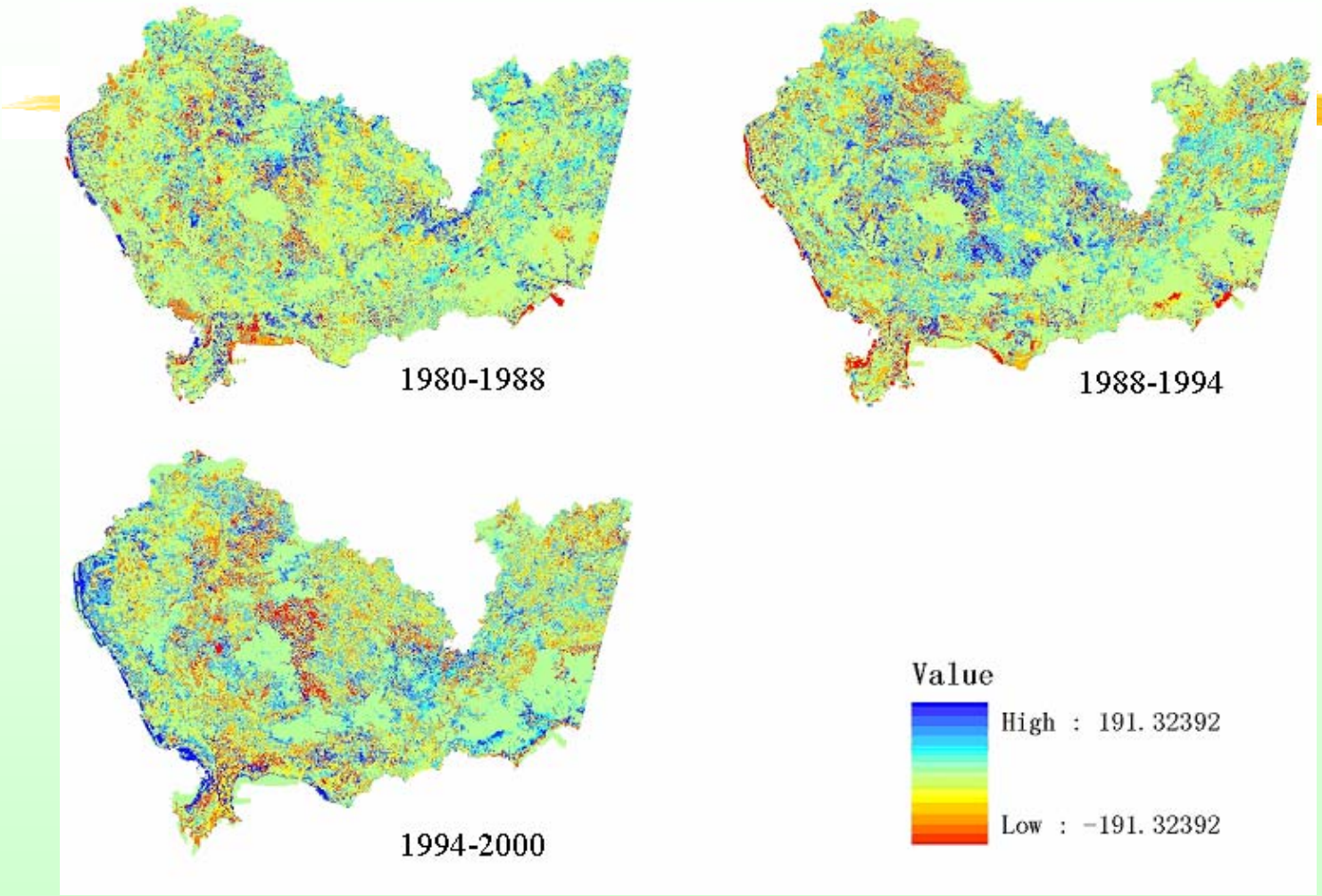
Death Toll

Background

- It is therefore chosen as one of the case stations in China, so as to examine the effect of human activities, as well as disaster risk management in this region.
- Past studies mainly focused on the effect of land use change on hydrological process, esp. flood process.

Land Use Map of Shenzhen

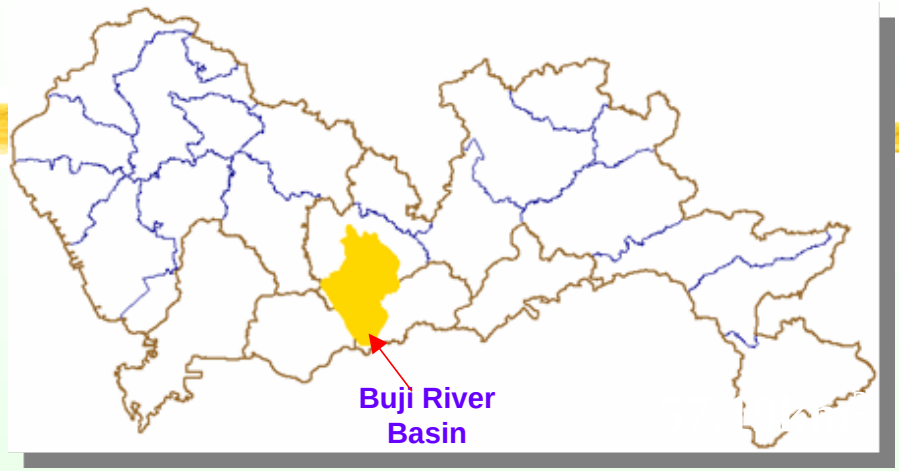




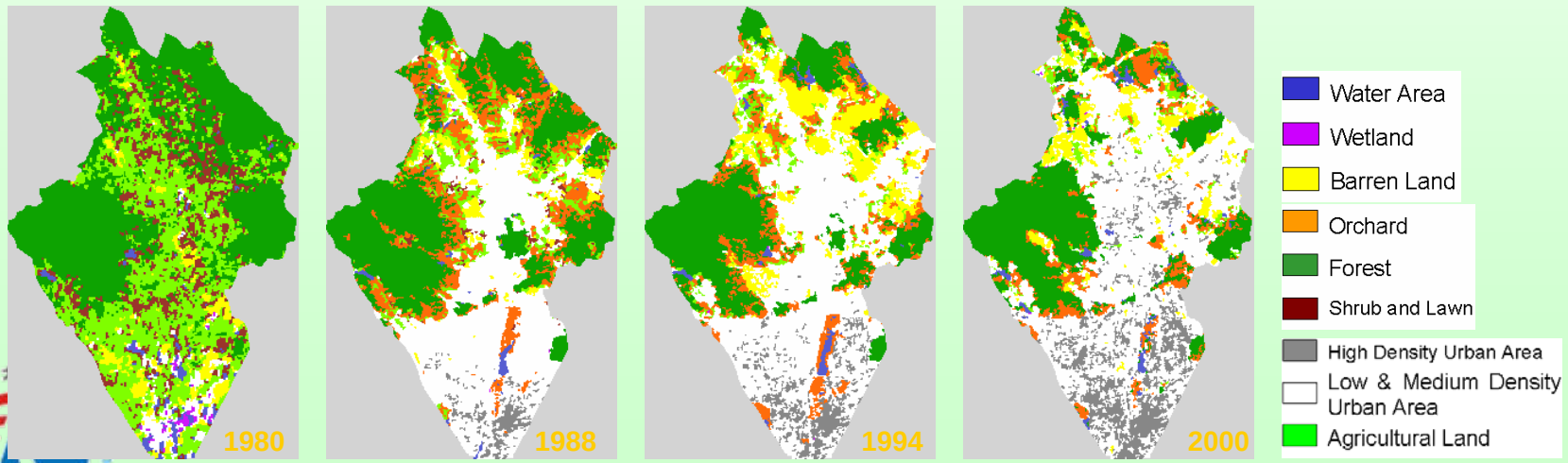
Surface Runoff Change at Different Stages of Urbanization

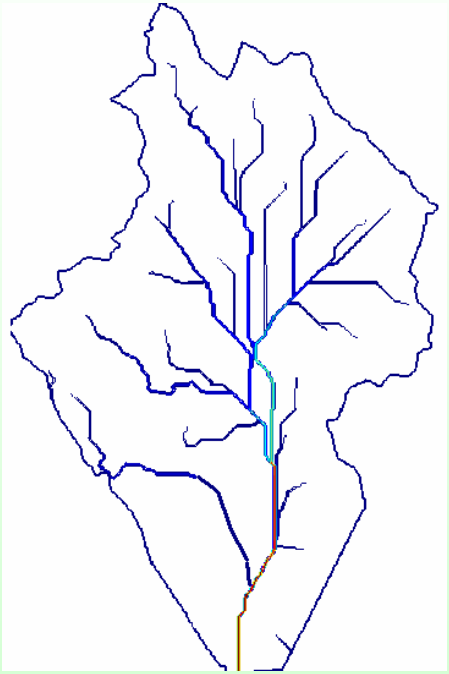
(under a uniform precipitation of 200 mm)

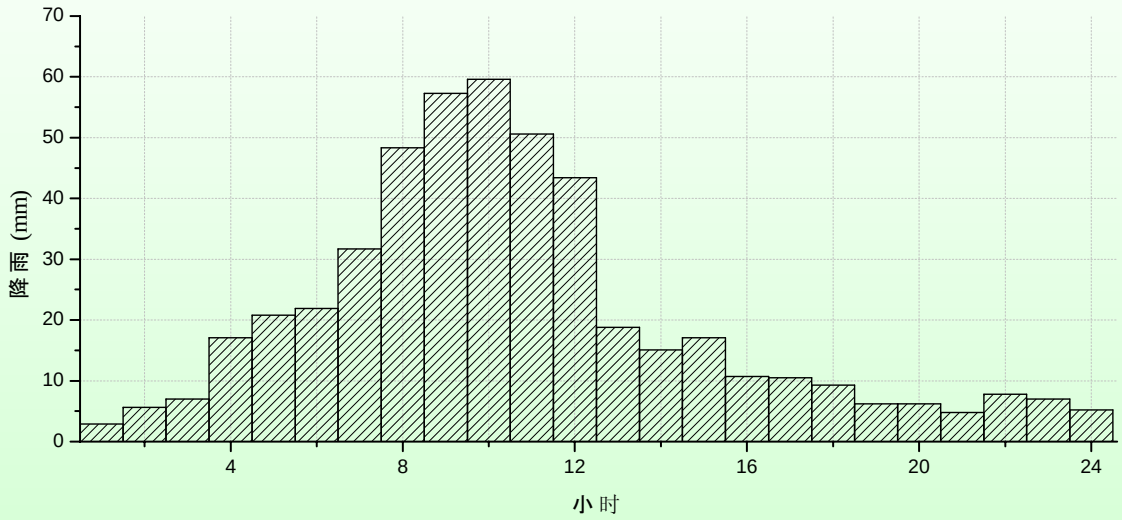
The Buji river basin, locating at the center of Shenzhen, is one of the most intensively urbanized areas in Shenzhen.



Land Use Maps of Buji Basin



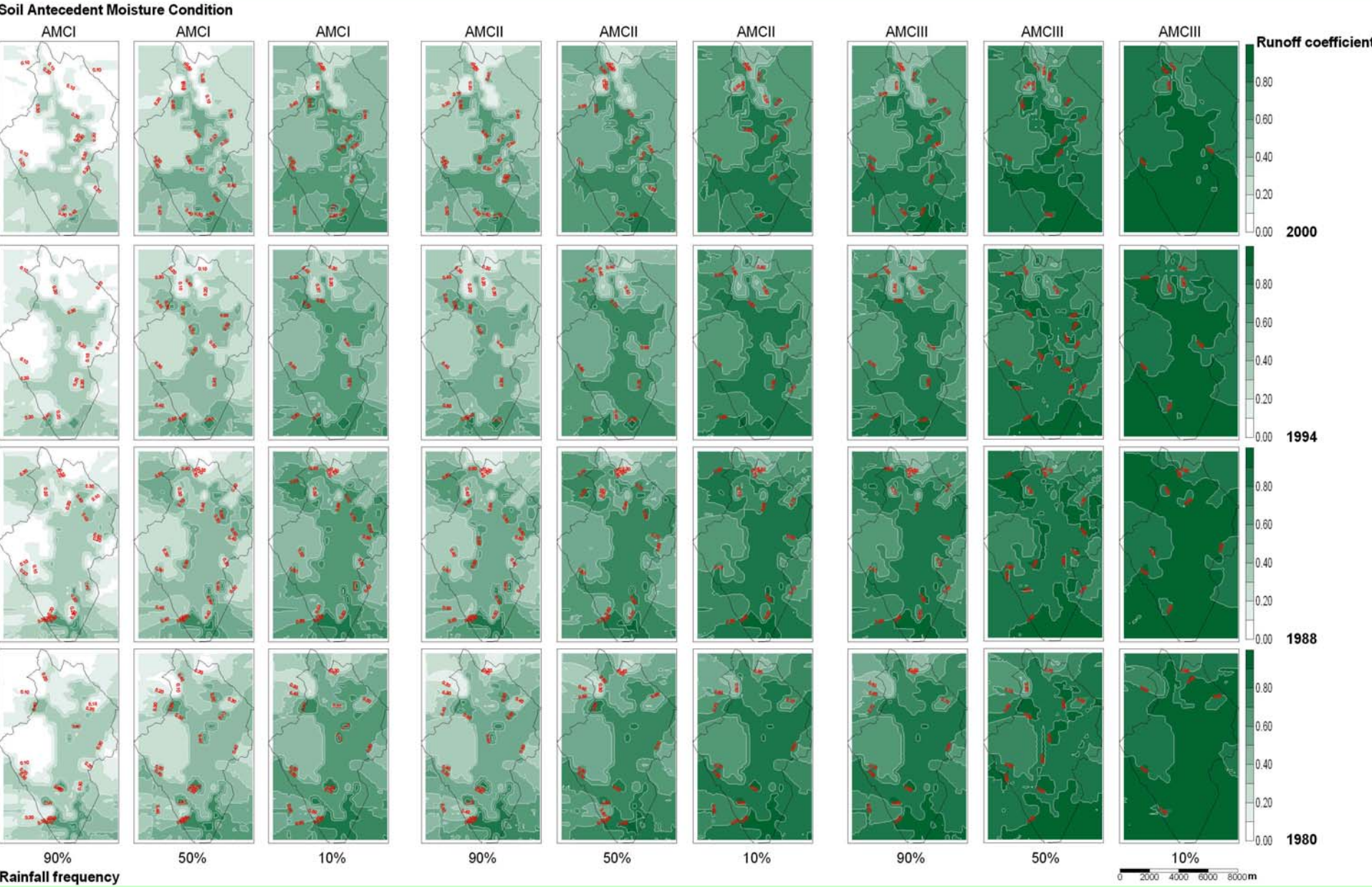




Buji River Network

Designed 100 year Storm

Runoff Coefficient Maps of Buji River under Designed Storms

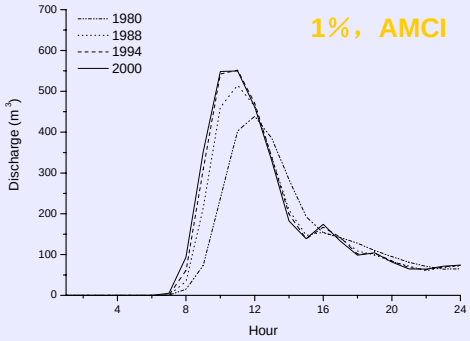


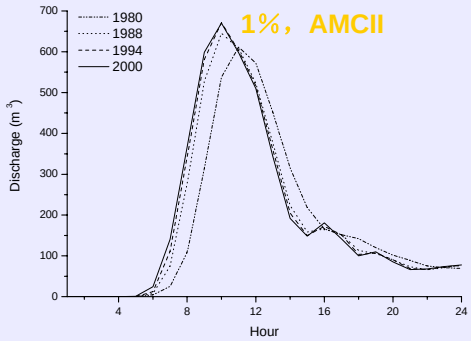
Integrated Runoff Coefficient of Buji River Basin Under Designed Storm (1980，1988，1994，2000)

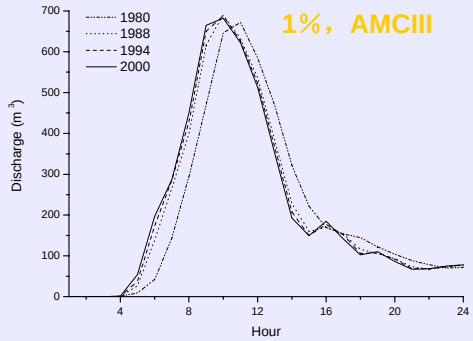
Storm Frequency	Year	Soil Antecedent Moisture Conditions			
		AMCI	AMCII	AMCIII	AMCI→AMCIII
90%	1980	0.215	0.457	0.742	71.02%
	1988	0.227	0.477	0.76	70.13%
	1994	0.267	0.517	0.786	66.03%
	2000	0.287	0.533	0.793	63.81%
	1980→2000	**33.49%**	**16.63%**	**6.87%**	——
50%	1980	0.368	0.609	0.832	55.77%
	1988	0.387	0.628	0.845	54.20%
	1994	0.427	0.66	0.863	50.52%
	2000	0.444	0.672	0.868	48.85%
	1980→2000	**20.65%**	**10.34%**	**4.33%**	——
10%	1980	0.541	0.743	0.899	39.82%
	1988	0.56	0.759	0.907	38.26%
	1994	0.596	0.782	0.918	35.08%
	2000	0.609	0.789	0.921	33.88%
	1980→2000	**12.57%**	**6.19%**	**2.45%**	——

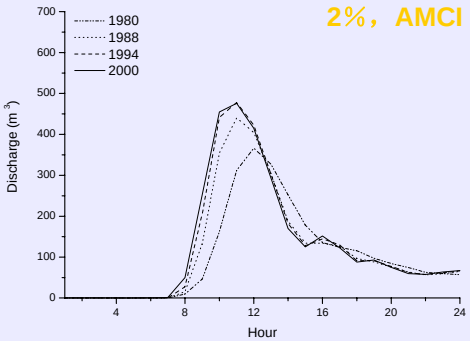
AMC：（I：Dry；II：Normal；III：Wet）；1%，2%，5%：Storm Frequency

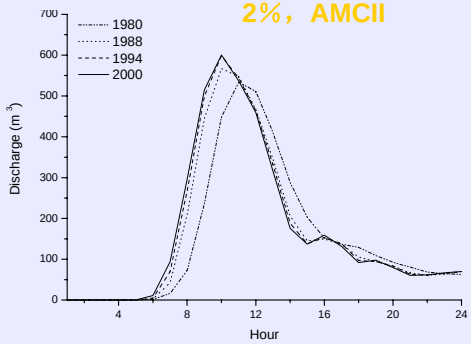
Hydrograph of the designed storm flood in 24 hours

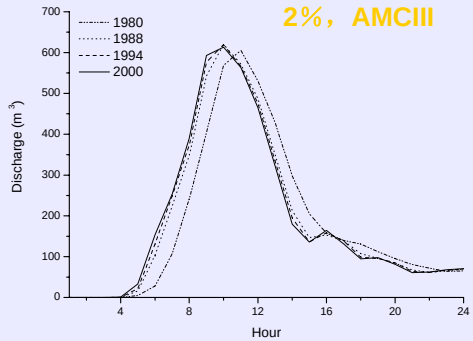


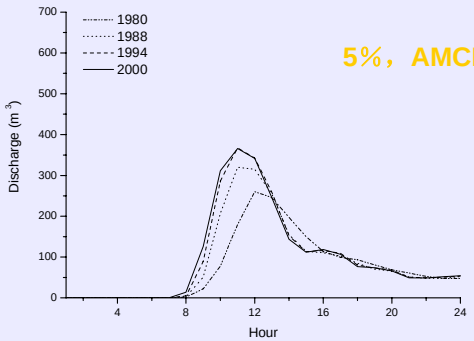


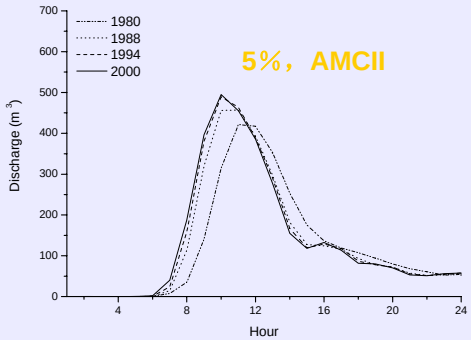


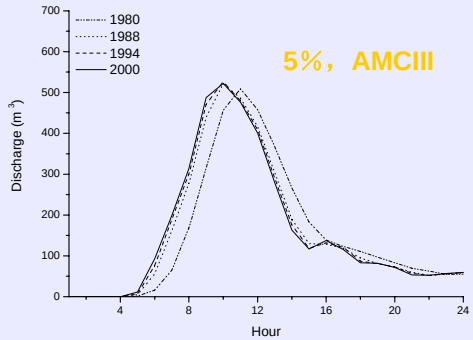












AMC：（I：Dry；II：Normal；III：Wet）；1%，2%，5%：Storm Frequency

Peak Flow of the Designed Storm Floods in 24 Hours ($10^4 m^3$)

Storm Frequency	Year	Soil Antecedent Moisture Condition (AMC)			
		AMCI	AMCII	AMCIII	AMCI→AMCIII
1%	1980	1058.8	1491.7	1756.3	39.7%
	1988	1167.6	1561.3	1802.0	35.2%
	1994	1254.5	1606.6	1821.8	31.1%
	2000	1270.2	1618.1	1828.4	30.5%
	1980→2000	**16.6%**	**7.8%**	**3.9%**	——
2%	1980	887.5	1302.9	1562.9	43.2%
	1988	986.7	1370.1	1607.7	38.6%
	1994	1069.5	1415.3	1626.5	34.2%
	2000	1085.5	1425.1	1633.0	33.5%
	1980→2000	**18.2%**	**8.6%**	**4.3%**	——
5%	1980	648.0	1041.3	1296.4	50.0%
	1988	739.0	1103.1	1335.3	44.7%
	1994	816.1	1147.0	1354.6	39.8%
	2000	830.3	1155.6	1358.9	38.9%
	1980→2000	**22.0%**	**9.9%**	**4.6%**	——

Next steps:

- Effect of climate change;
- Hazard mapping;
- Land use policy suggestion;
- Possibility of local flood insurance program;
- Development of real-time hydrometeoro-logicial model;
- Real-time flood risk mapping;
- Suggestions on integrated flash flood risk management in Shenzhen;
- Comparative studies in other case stations in China

Conclusion

- Flash flood risk management is an interdisciplinary issue of critical importance;
- Combination of geophysical and social sciences is needed to provide applied research and education to reduce flash flood risk;
- China needs to do a lot of works on flash flood risk management, especially in areas of hazard mapping, land use policy, flood insurance, disaster education and hydrometeorological prediction;
- America is a good example to learn from;
- Case stations will be an effective way to carry out integrated flash flood risk management practices.

Thank you for your attention!