



Vulnerability of Chinese Road System to Climate Changes

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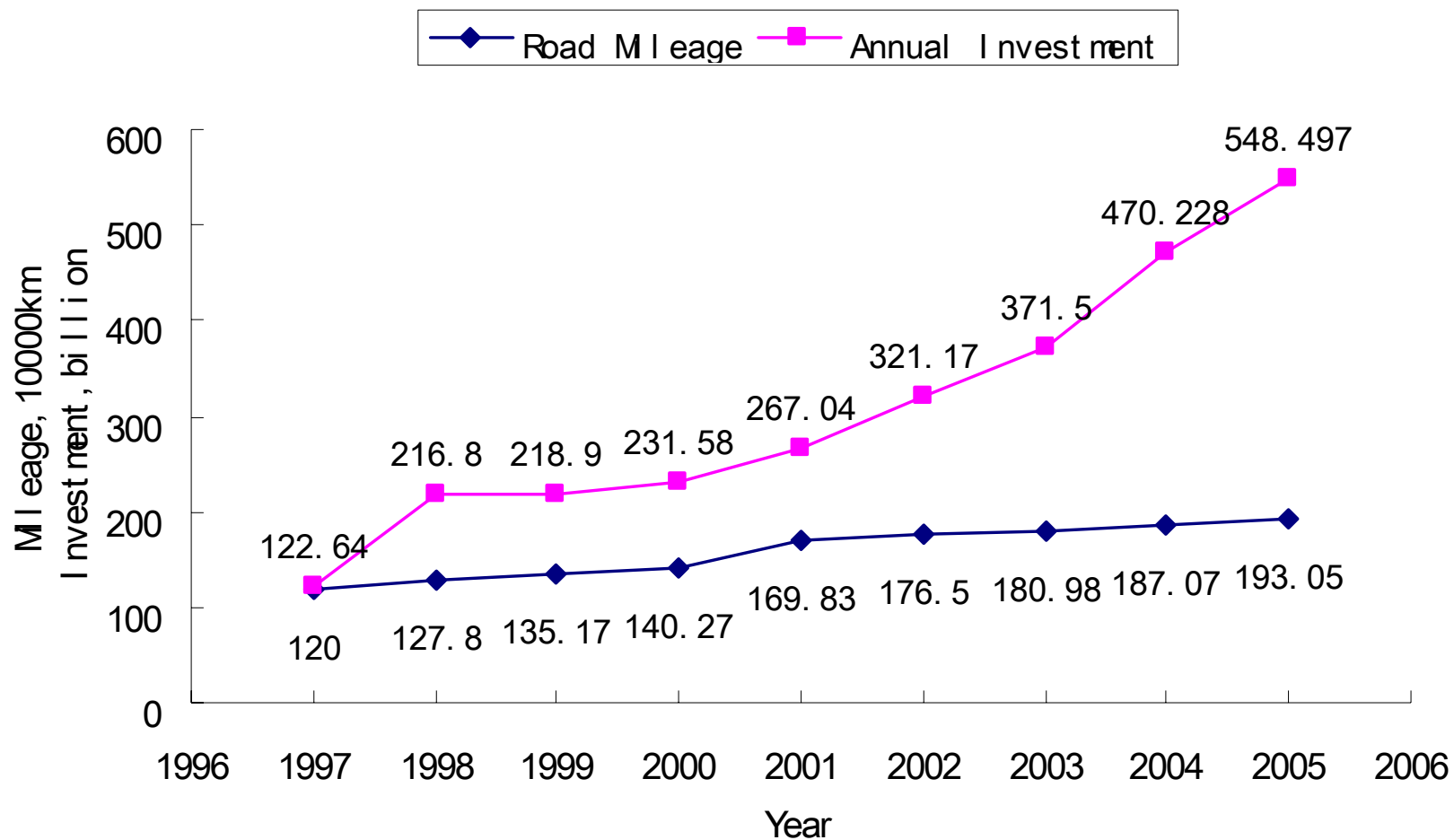
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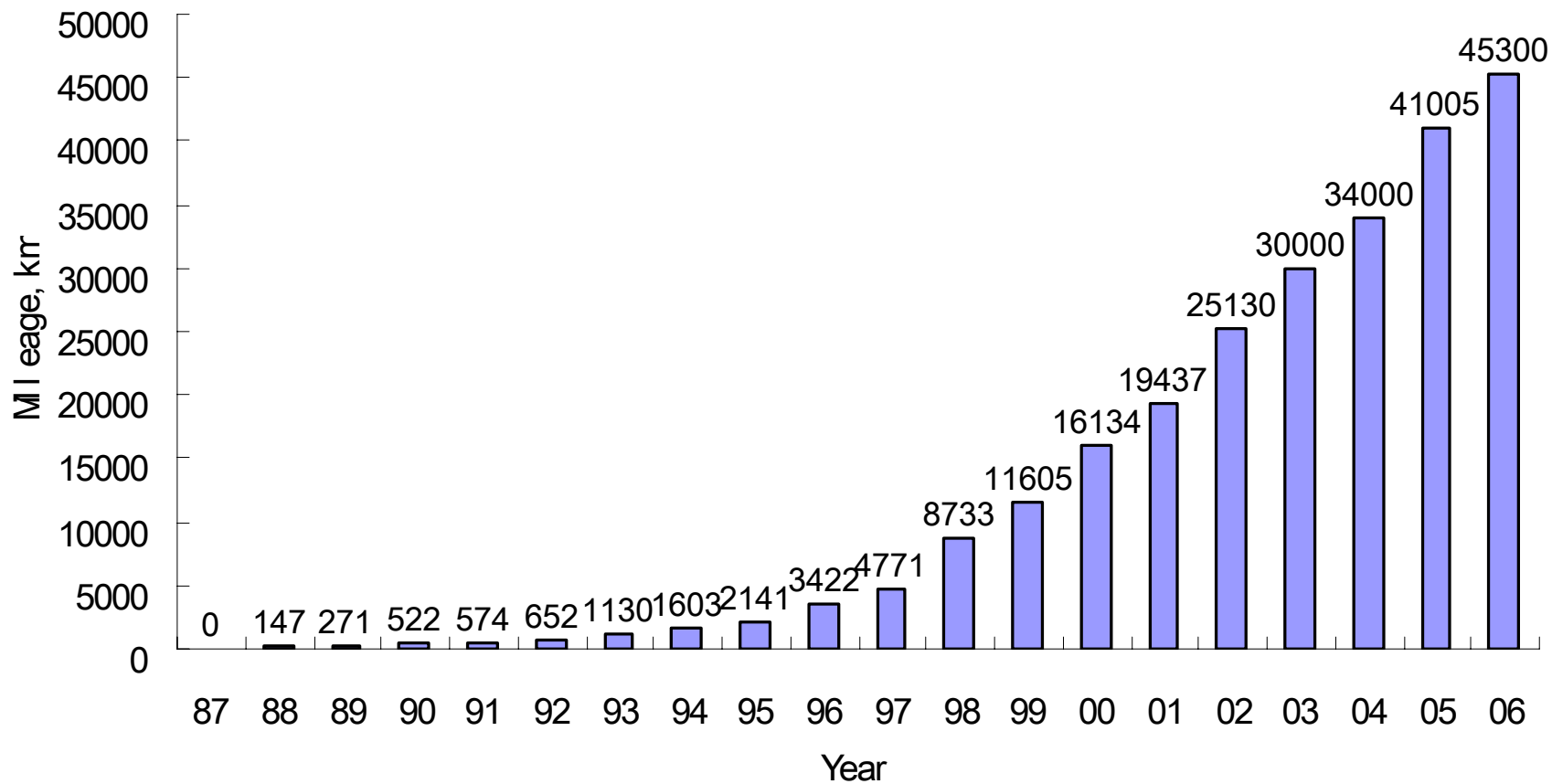


OVERVIEW OF CHINA'S ROAD SYSTEM

- **Rapid Development**
- **Huge Network**
- **Relatively Low Grade**



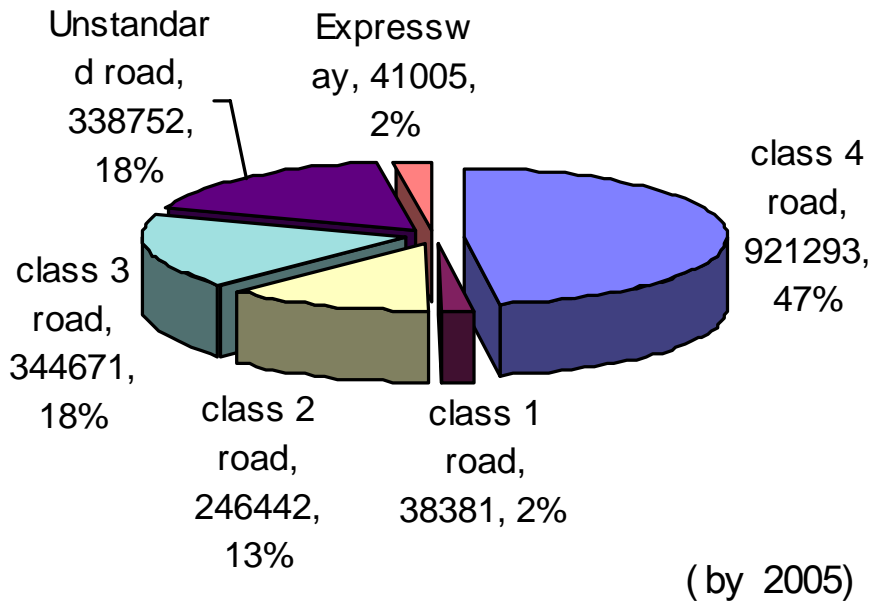
Growth of Road Mileage and Annual Investment in China



Growth of Expressway Mileage in China

Huge Road Network

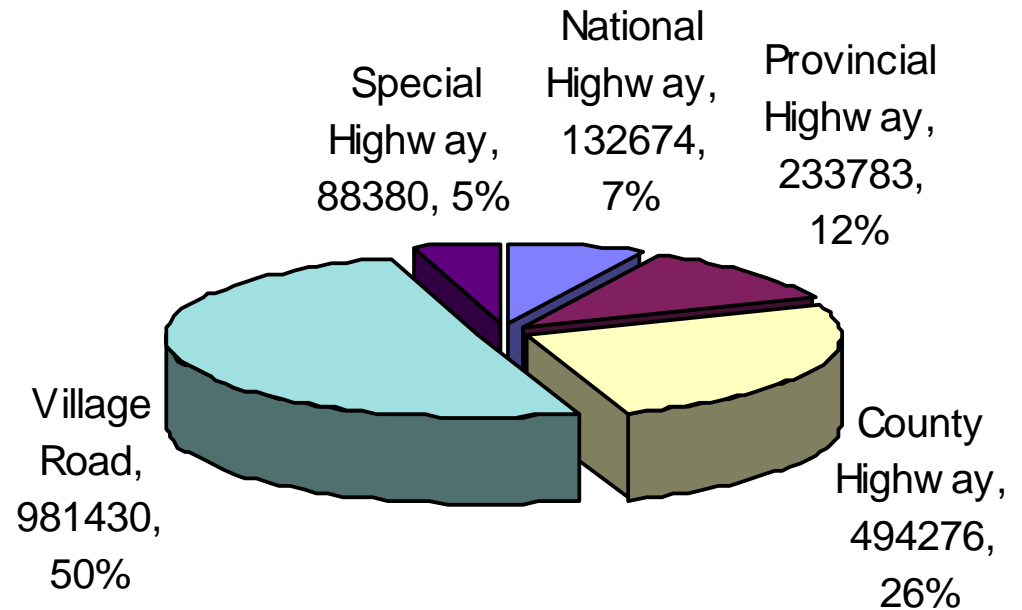
- **Total Road network:**
3.48 million km
- **Village Road:**
1.55 million km
- **Motorway:**
45.4 thousand km



Technical Classification(km)

(by 2005)

Administrative Classification(km)



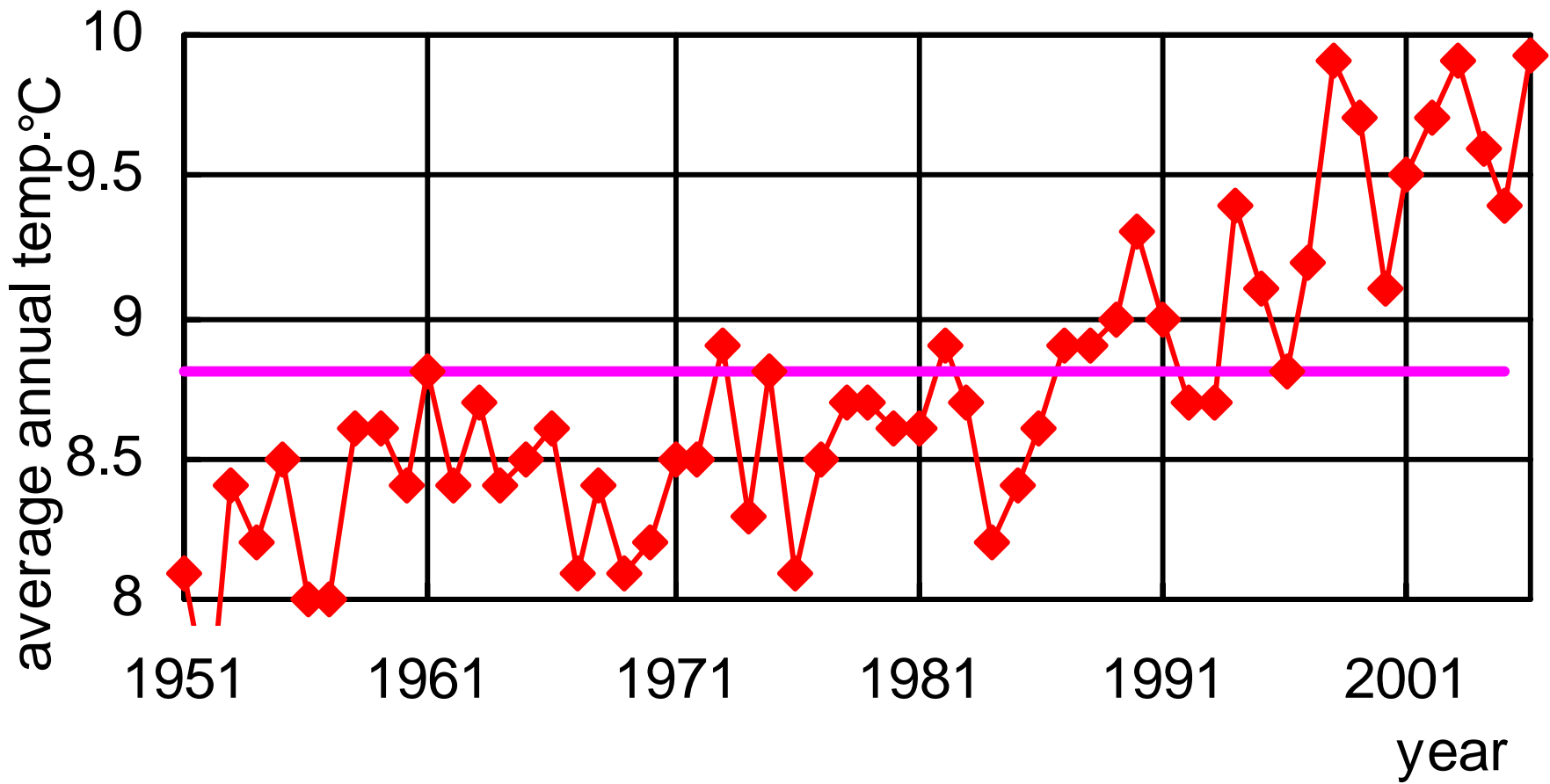


METEOROLOGICAL CHANGE IS SIGNIFICANT

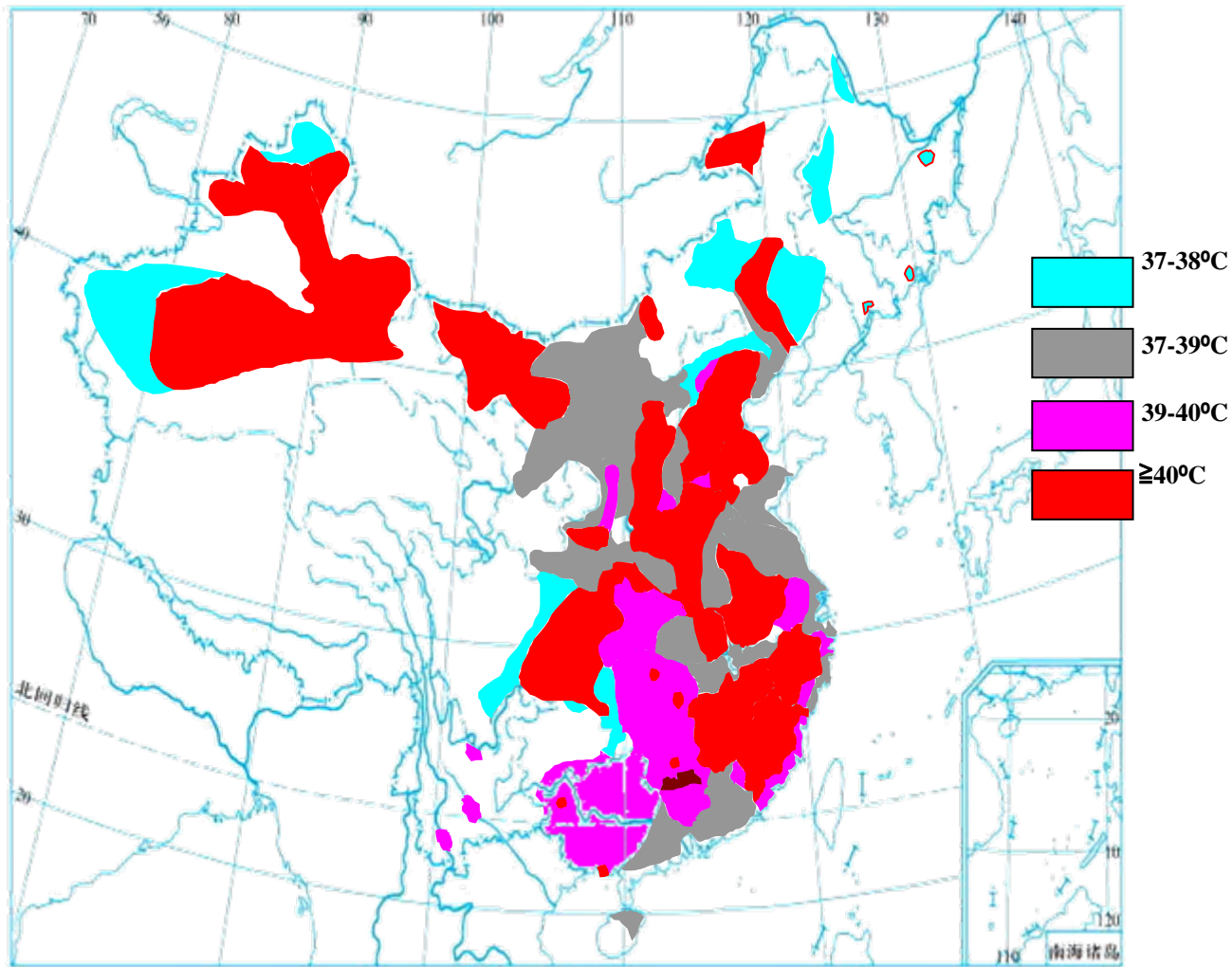
- **Trend of Warming**
- **Frequent Occurrence of
Extreme Weather Incidents**

TRENDS OF WARMING

- Warming is the global trends
- China's annual average temperature increased by $0.65 \pm 0.15^{\circ}\text{C}$ in last century

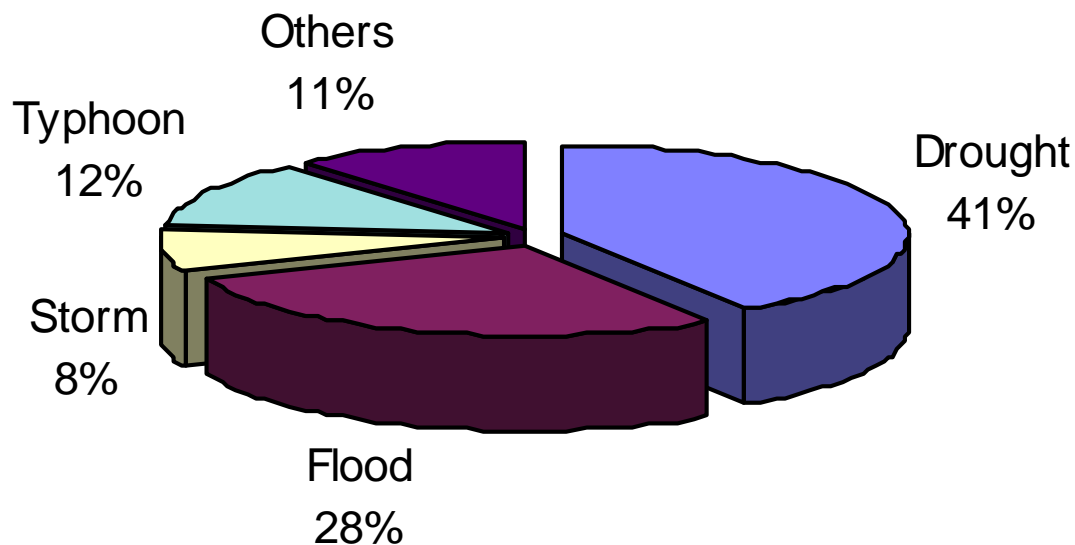


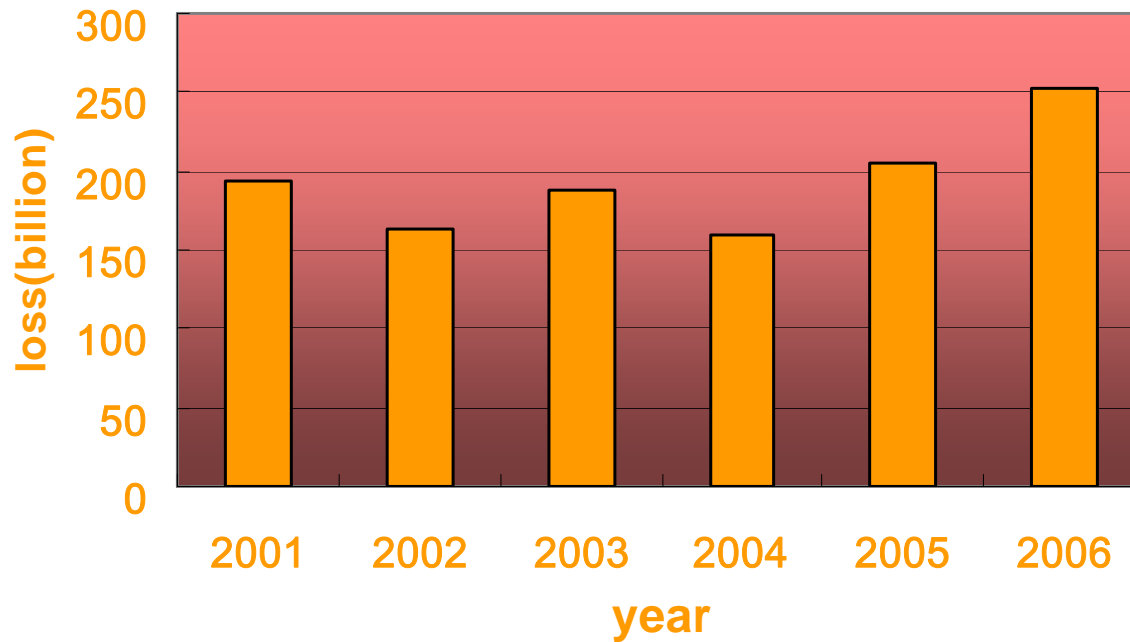
Changes of Annual Average Temperature in China



Distribution of Extreme High Temperature in Mainland China ($\geq 37^{\circ}\text{C}$)

FREQUENT OCCURRENCE OF EXTREME WEATHER INCIDENTS

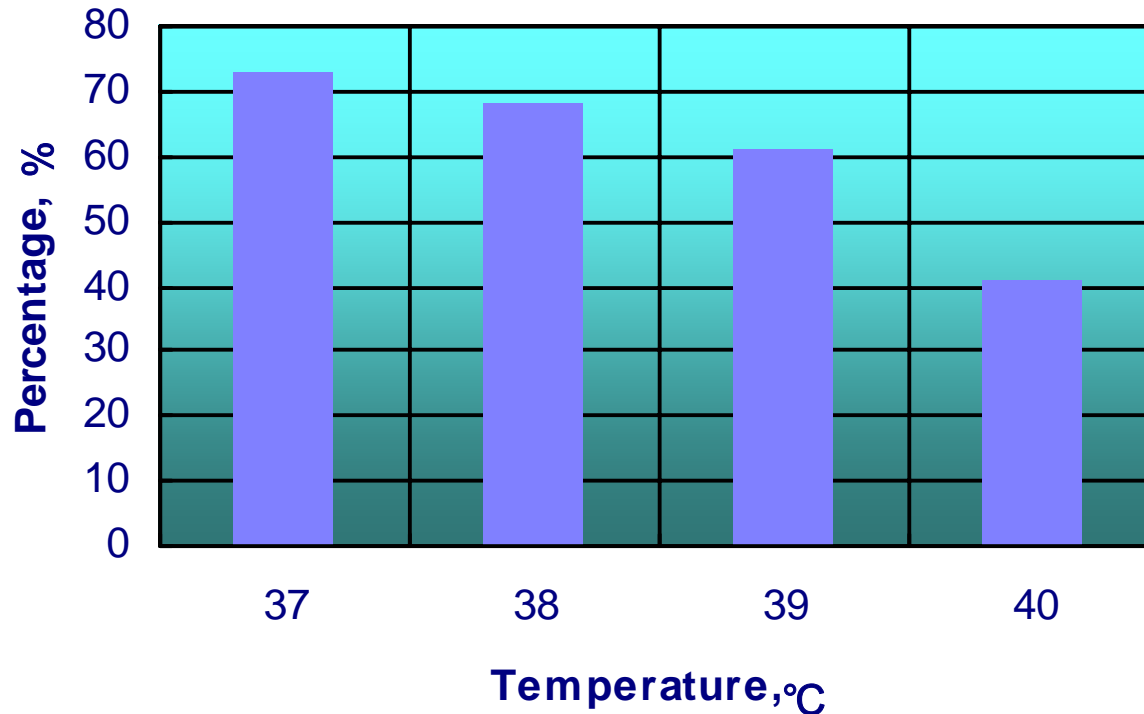




Economic Loss Caused by Natural Disasters

INFLUENCES OF CLIMATE CHANGES ON ROAD SYSTEM

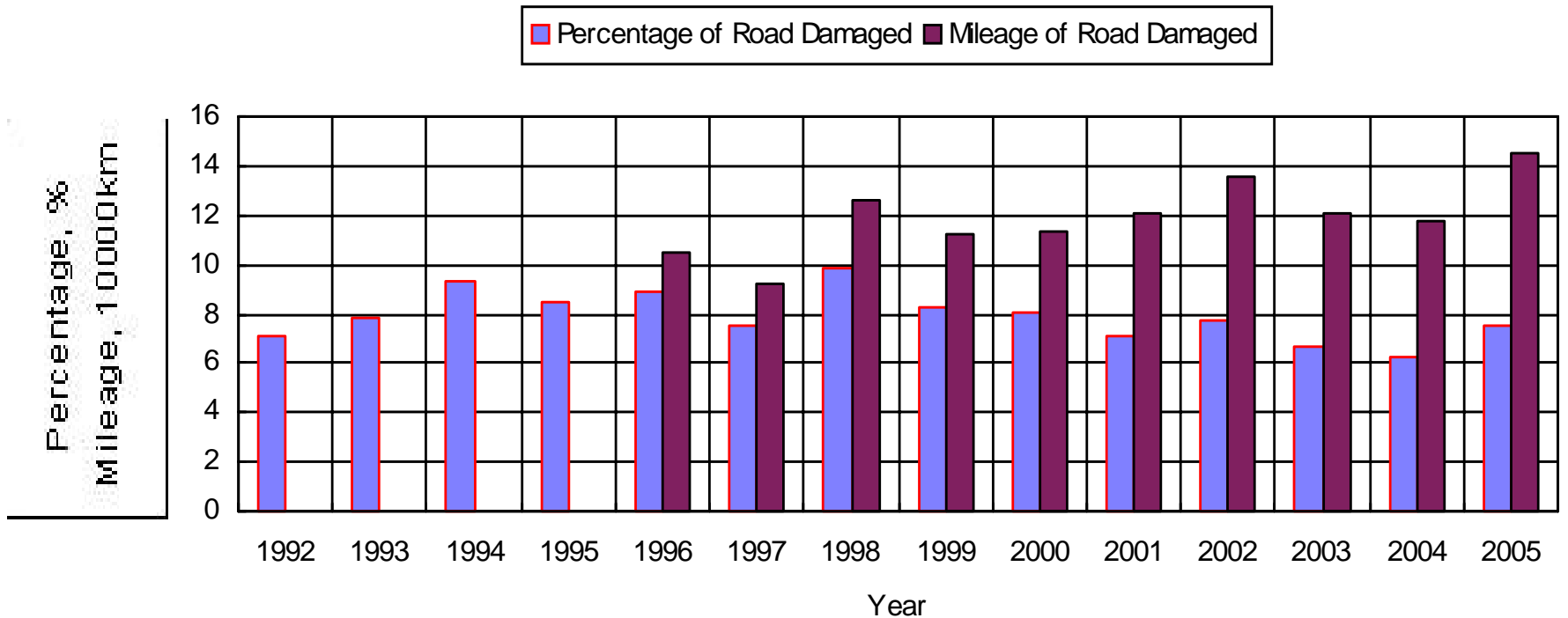
- **heat wave on asphalt roads**
- **gradual temperature rise on roads in frozen earth area**
- **Damages of heavy storm and typhoon**



Percentage of Expressway Influenced by Extreme Temperature

Gradual Temperature Rise on Roads in Frozen Earth Area

- ❑ The permafrost mileage of State Highway No.109 was shortened by 16.5Km in 15 years.
- ❑ The mileage of permafrost earth of State Highway No.214 was degraded from 92Km to 53.8Km.
- ❑ Qinghai-Tibet Highway (2412km) was reconstructed three times from 1973 to 2003.



Mileage of Flood Damage from 1992 to 2005



COUNTERMEASURES

- **To improve the stability of asphalt pavement at high temperature**
- **To protect permafrost earth**
- **To diminish the loss caused by flood and other disasters**



Forecast on extreme weather

We have established a Nationwide Weather Information Center for timely forecasting of weather along roads

Improve the stability of asphalt pavement at high temperature

- **Research and develop new materials, new structures and new technologies to against heat waves**
- **Improve the design standard and specifications**

Multi-measures to protect permafrost earth

- **Strengthening all-year-round observation on frozen earth**
- **Protecting frozen earth, controlling thawing speed in design stage**
- **strengthening the subgrade side protection in maintenance**

Countermeasures to flood disasters

- **Upgrade technical condition**
- **Strengthen road maintenance**
- **Make thorough alteration of flood damage section one by one**



CONCLUSIONS

- **METEOROLOGICAL CHANGE IS OBVIOUS**
- **ROAD SYSTEM IS HUGE BUT VULNERABLE TO CLIMATE CHANGE**
- **MULTI-MEASURES HAVE BEEN TAKEN**
- **FURTHER EFFORTS ARE NEEDED**



Thank you for your attention!