

# **Overview of Shanghai Multi-hazard Early Warning system and the role of Meteorological Services**

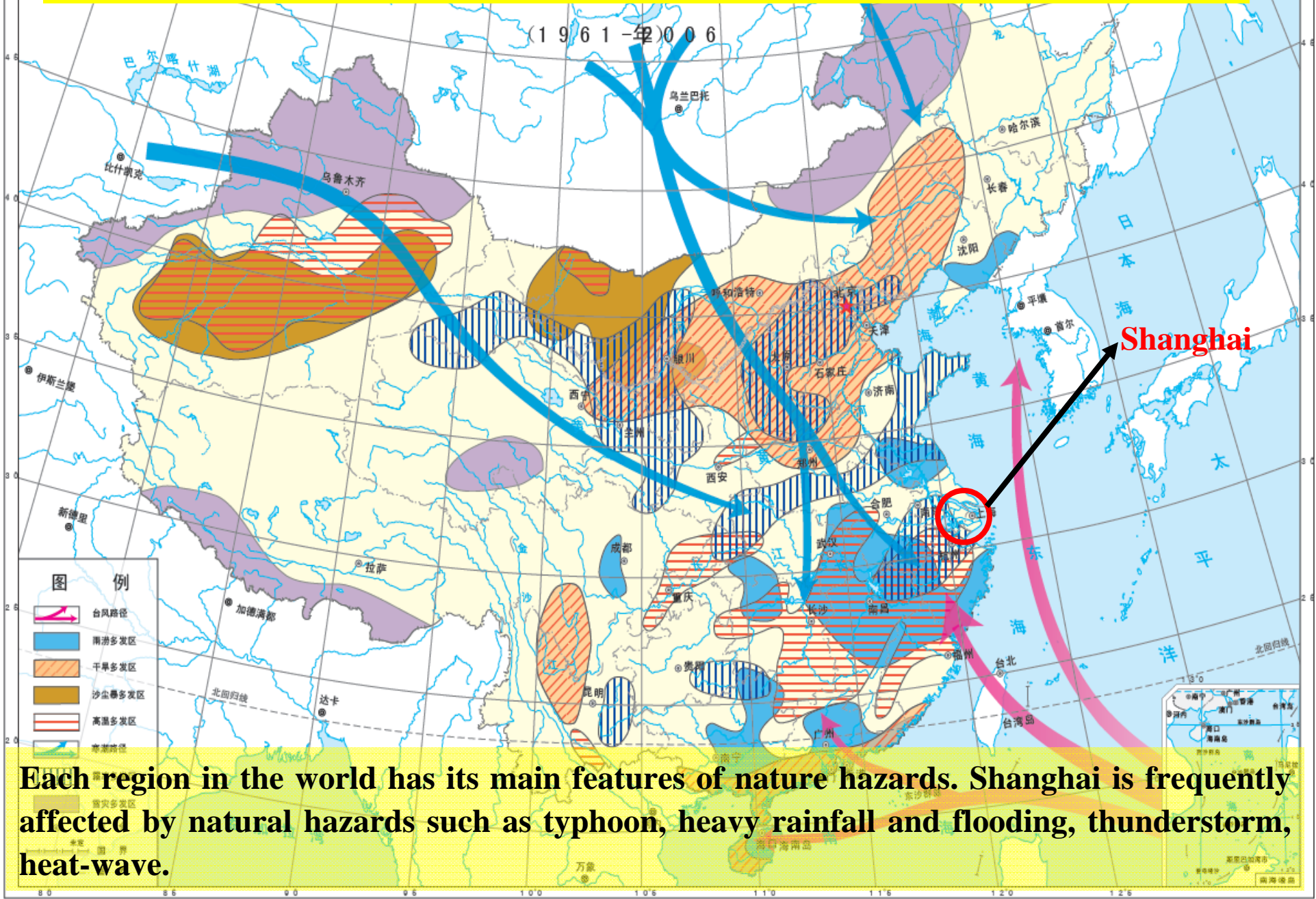
*Shanghai Meteorological Bureau, CMA*  
*Shanghai 200030, China*  
**(March 23, 2010)**

# Outline

1. **Background**
2. Governance and institutional arrangements
3. Utilization of risk information in emergency planning and warnings
4. Hazard monitoring, forecasting, and mandates for warning development
5. Warning dissemination mechanisms
6. Emergency preparedness and response activities
7. Improvement of overall operational framework of the early warning system

# Spatial distribution of major meteorological disasters in China

(1961-2006年)



Shanghai

Each region in the world has its main features of nature hazards. Shanghai is frequently affected by natural hazards such as typhoon, heavy rainfall and flooding, thunderstorm, heat-wave.

# Urbanization brings many challenges and opportunities to weather service

## a) Dense population:

population: 20million;

area: 6,340 square kilometers

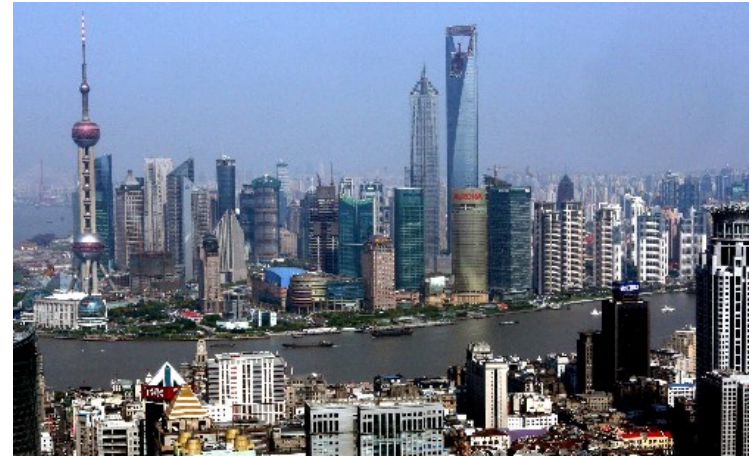
## b) Built-up structures:

20-plus-story buildings: >3600;

30-plus-story buildings: >840

## c) Rapid economic development:

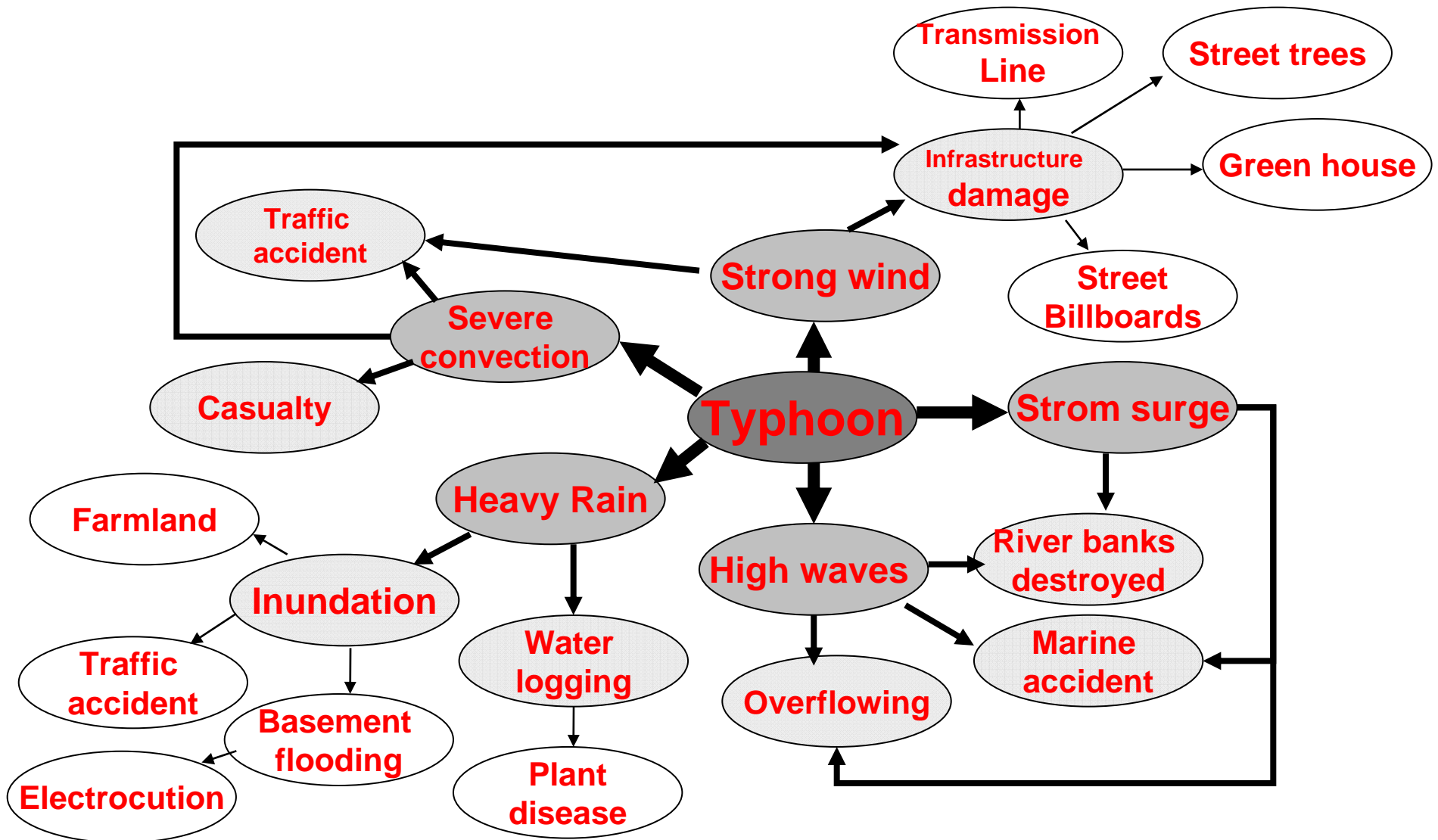
double-digit GDP growth for 14 consecutive years before 2007, 9.7% for 2008.



*Due to rapid urban economic and social development, higher concentration of industry, business, and denser population, severe weather induced hazards can trigger secondary (indirect) impacts (disasters) on the society and economy.*

# Example of Hazard Domino Effect

## Typhoon



## Background

Shanghai has integrated its emergency response and preparedness activities into the construction of the Multi-hazard Early Warning System (MHEWS) with a focus on strengthening multi-agency coordination and cooperation.

- ✓ In 2003, the Mayor of Shanghai signed the Shanghai Disastrous Weather Early Warning Signal Issuance Regulations.
- ✓ In April 2006, some necessary amendments were added to the above-mentioned regulations.
- ✓ On 26 October, 2006, the Standing Committee of Twelfth Shanghai People's Congress approved "Shanghai implementation measures for Meteorological Law of the People's Republic of China", which defined the obligations and responsibilities of the weather service in natural disaster emergency response and prevention.














# Severe weather warning in Shanghai

The CMA issues 14 categories of weather warning: Tropical Cyclones, heavy rain, heavy snow, cold surges, strong wind, dust, heat waves, droughts, thunder and lightening, hail, frost, heavy fog, haze, icy roads.



← (In Shanghai there is an additional Ozone warning bringing the total to 15)

Table 2 example of some severe weather warning signals issued in Shanghai

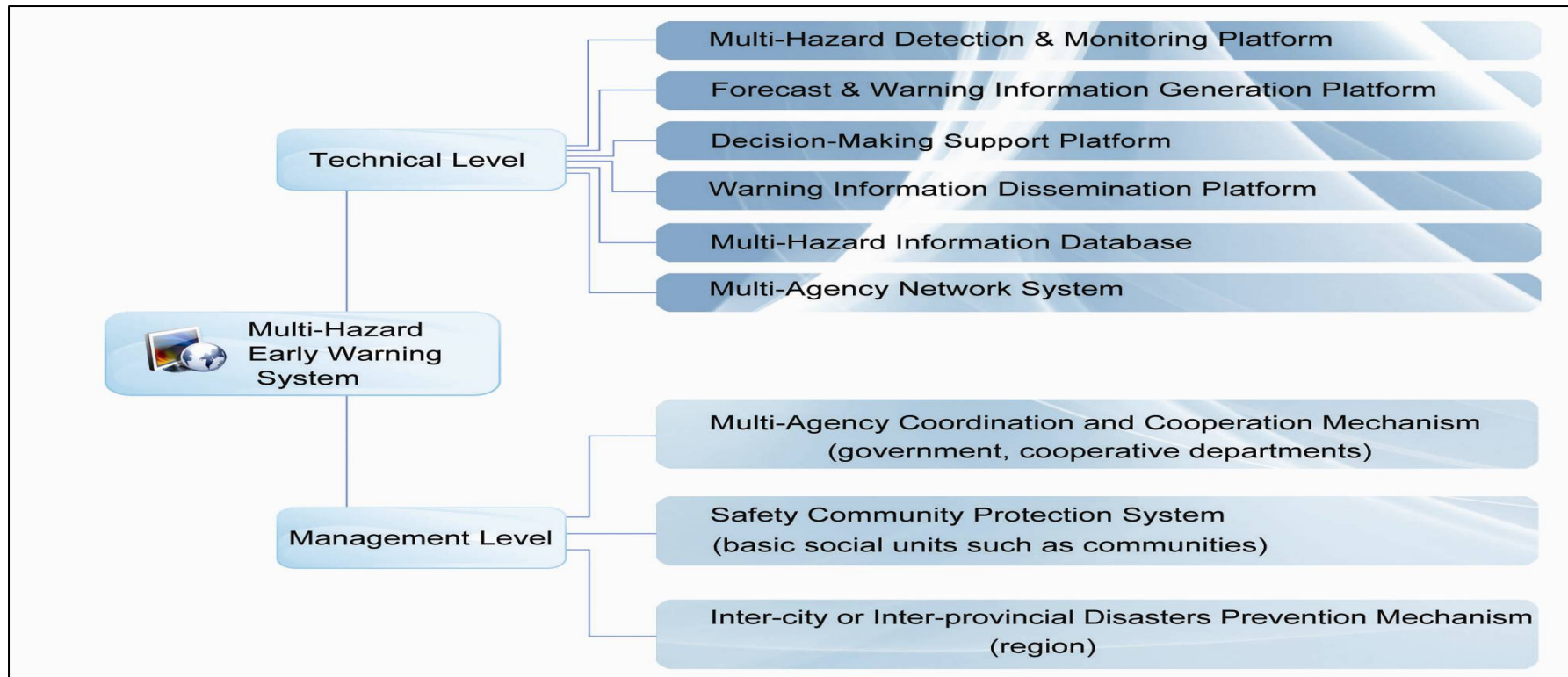
Severe weather	Level	Description	Signals
Typhoon	Blue	Tropical cyclone has been predicted to affect city within 24 hr with maximum wind force over 6(The Beaufort Scale)	
	Yellow	Tropical cyclone has been predicted to affect city within 24 hr with maximum wind force over 8(The Beaufort Scale)	
	Orange	Tropical cyclone has been predicted to affect city within 12hr with maximum wind force over 10(The Beaufort Scale) and possible with rainstorm.	
	Red	Tropical cyclone has been predicted to affect city with 6 hr with maximum wind force over 12 (The Beaufort Scale) and possible with rainstorm.	
Rainstorm	Yellow	6 hr rain above 50mm or 1 hr rain reach 20mm	
	Orange	3 hr rain above 50mm or 1 hr rain reach 30mm	
	Red	3 hr rain above 100mm or 1 hr rain reach 60mm	
Hot Weather	Yellow	Maximum temperature will climb up to 35°C within 24 hrs.	
	Orange	Maximum temperature will climb up to 37°C within 24 hrs.	
	Red	Maximum temperature will climb up to 40°C within 24 hrs.	
Fog	Yellow	Thick fog with visibility less than 500m has been predicted within 24 hrs.	
	Orange	Thick fog with visibility less than 300m has been predicted within 24 hrs.	
	Red	Thick fog with visibility less than 100m has been predicted within 24 hrs.	

**Severe weather warning**

➤ **color-coded warning signals**  
 ➤ **3-4 levels, ranked Red, Orange, Yellow, Blue,**



# Overview Shanghai MHEWS



➤ In addition to effort on severe weather technology warning development, Shanghai MHEWS focuses on the **domino effects** of high impact weather such as typhoon, severe convective weather, heat wave and so on.

➤ At technical level the forecast models of high impact weather's influence on city operation have been established. At management level the multi-agency joint response mechanisms have been established.

# Progress of Shanghai MHEWS

The early warning capacity of high impact weather's influence on traffic, agriculture, power, and public health has been enhanced through the development of early warning subsystems.

## ➤ High Impact Weather and their Early Warning (4)

- Severe convective weather (Early Warning Center)
- Typhoon (Early Warning Center)
- Heavy fog
- Snow and freezing rain

## ➤ Weather-related Hazards Early Warning (14)

- Heavy haze and static stability (Chemical Weather Prediction)
- Marine meteorological hazards
- Wind hazards
- Lightning hazards
- Agricultural meteorological hazards
- Urban traffic
- Aeronautical Risks
- Potential fire hazards
- Dangerous gas diffusion
- Bacterial food poisoning
- Heat wave and human health
- Urban inundation
- Energy security
- Infectious diseases

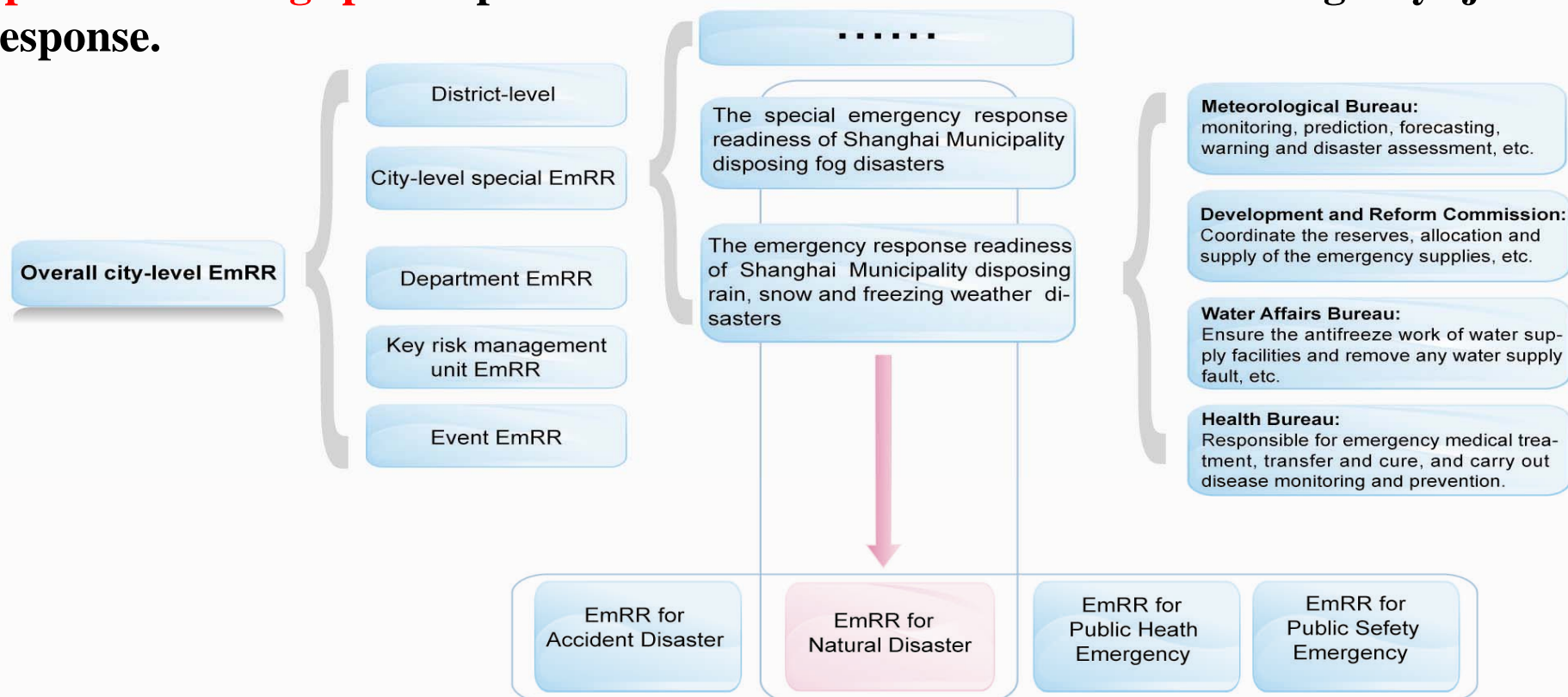
■ :Operational

■ :Under development

# Progress of Shanghai MHEWS

The preparedness system of Shanghai was perfected through the establishment of multi-agency joint response mechanisms. Special working plan for Emergency Preparedness and Response on meteorological hazards, such as **Heavy Fog, Snowstorm, Heat wave, Strong wind and Lightning** have been developed and issued by the General office of Shanghai Municipal Government.

**Special working plans** provide detailed instructions on multi-agency joint response.



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## **Policy on DPM (Central government)**

Chinese law has identified the responsibilities of weather service in response to disaster emergency and multi-agency coordination and cooperation activities. For instance,

- ***‘Public Emergency Response Law’*** regulates: Under the unified leadership of the country, the emergency response management system should be established through comprehensive coordination, classified management according to different levels and local management.
- ***‘Flood Control Law’*** regulates: Weather, hydrology, maritime and other related departments are responsible for providing the flood control command agency with real-time information of hydro-meteorology, storm surge forecasts should be delivered in a timely fashion. Furthermore, departments such as telecommunications, transportation, electric power and material supply should prioritize supporting flood control efforts.
- ***‘Meteorological Law’*** regulates: Weather departments at all levels should organize joint detection efforts in forecasting disastrous weather with other departments in different regions across the country. They must also provide disaster prevention measures, assessments and analysis on the impact of the weather disaster, in order to provide local governments with information which could be helpful in the decision-making process.

## Policy on DPM (Local government)

“Implementation Regulation of the Meteorological Law” makes clear the mandate of SMB in DPM.

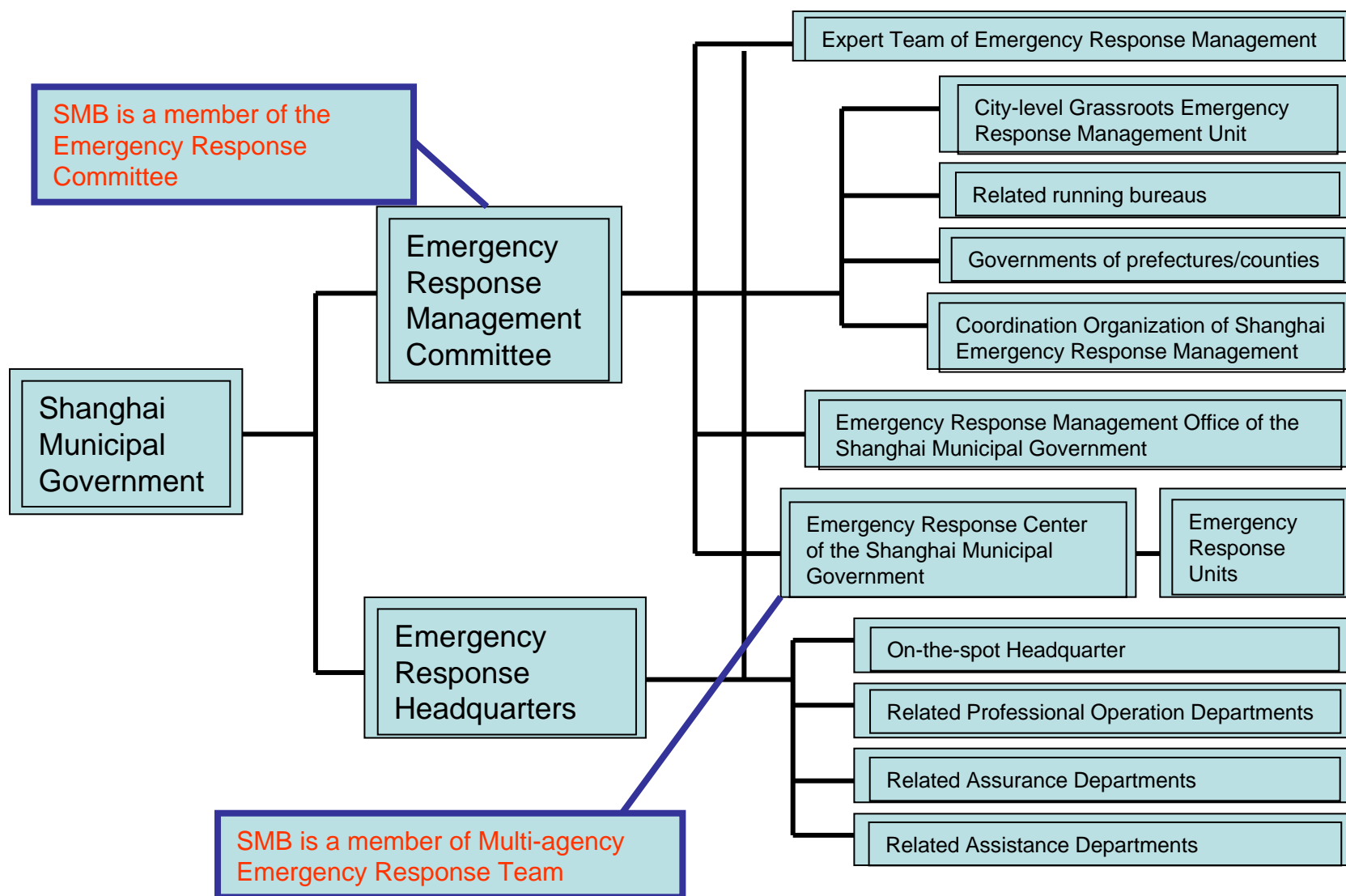
----- ***Weather departments*** should provide special services through multi-agency cooperation involving government departments such as:

- *Agriculture*
- *Flood Control*
- *Fire Control*
- *Environmental Protection*
- *Public Health*
- *Harbor and Maritime management*
- *Fisheries*
- *Traffic and Transportation*
- *Police*
- *Civil Administration*
- *Tourism*

---- ***Communications departments*** such as Radio, Television and the official government website for the city of Shanghai as well as ***Transportation operators*** such as airports, railways stations, harbors, tourist attractions and traffic control must follow the directives of the weather department and provide resources to facilitate the dissemination of **early warning information in a timely fashion.**

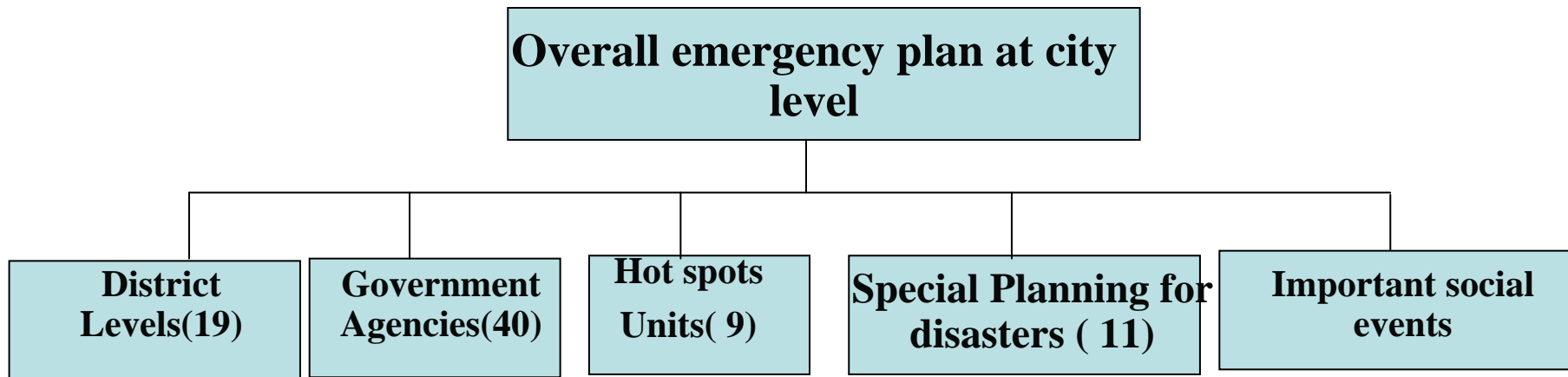
---- In terms of lightning disaster prevention ***all enterprises, social groups or organizations*** (such as schools and community centers), should also follow the advice of the weather department.

# Institutional frameworks to support emergency response



**As a member of the Standing Headquarters, the weather service participates in the Emergency planning as well as provides support to the expert teams as needed. Furthermore, SMB is a member of the related departments.**

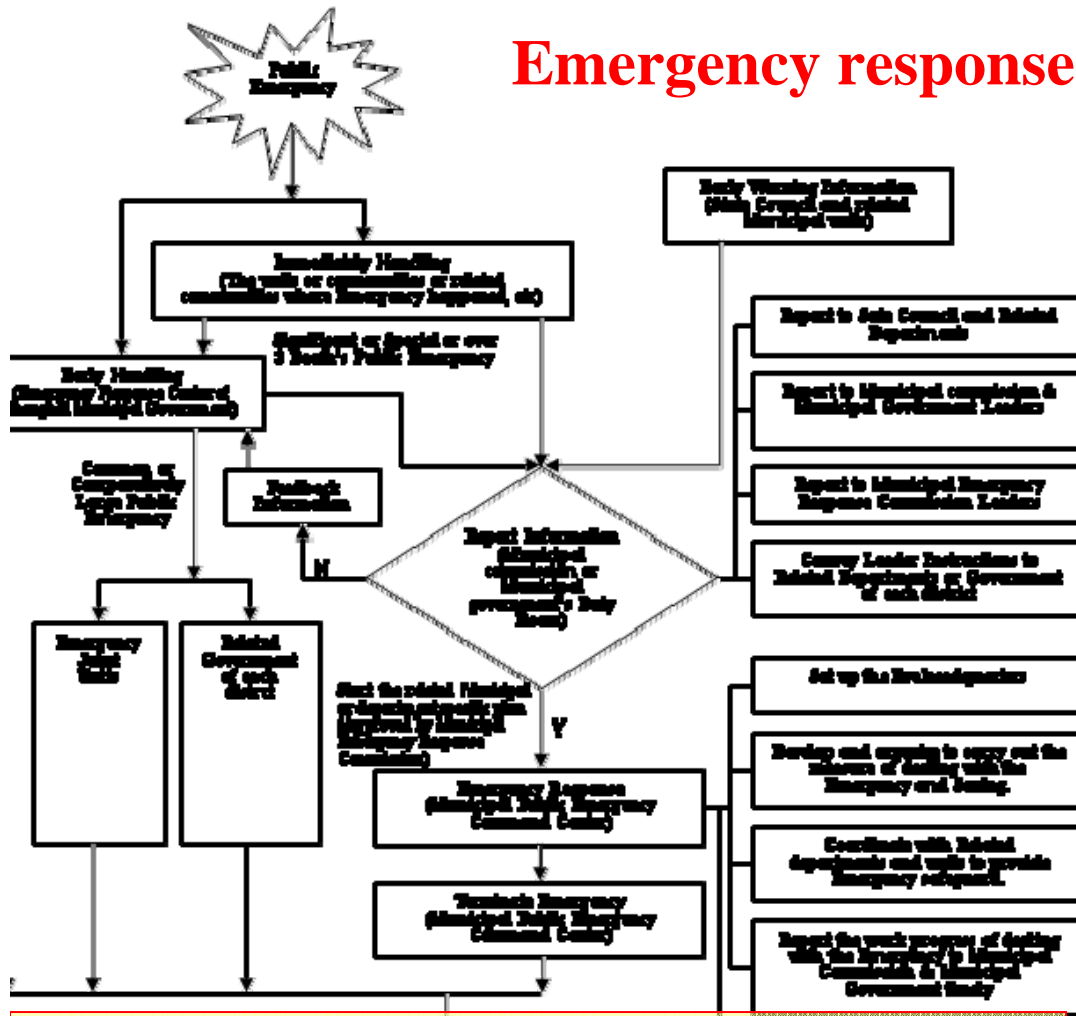
# Overview of Shanghai emergency response plans



- **The Shanghai Municipal Emergency Management Response Committee** invites experts, relevant departments and representatives from vulnerable areas to participate in the development of emergency response plans, and issues the plan in the form of government regulations.
- **Overall emergency response plan** provide **management support** to multi-agency cooperation and coordination, special working plans provide **detailed instructions** on multi-agency joint response.
- The **Shanghai Emergency Response Management office** is responsible for the coordination .
- The most important role for **meteorological service** in those emergency response plans are **monitoring and warning**.



# Emergency response procedures



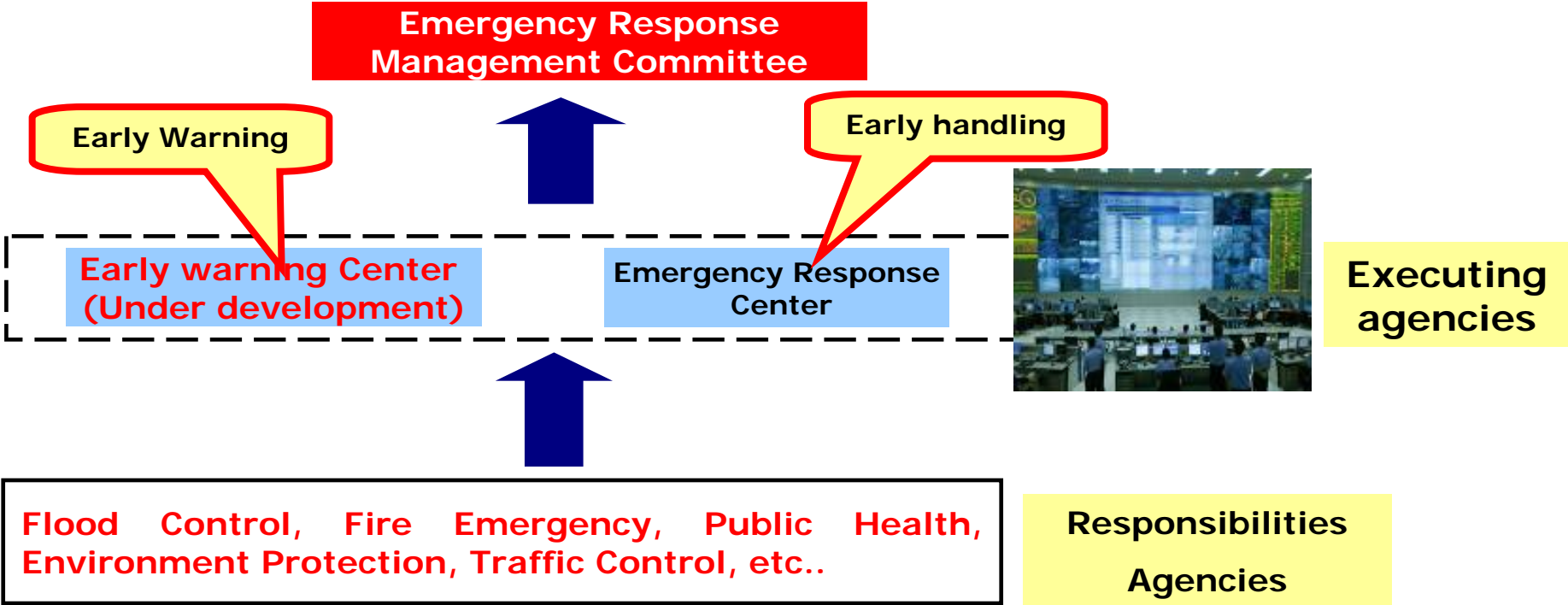
1. The Shanghai Municipal Government forecasts the potential or predictable emergency event in levels ( **very serious, serious, relatively serious, or moderate, corresponding with red, orange, yellow or blue warning signals respectively**).

2. The Emergency Response Center is responsible for the disposal of public emergency events of moderate or relatively serious level, as well as for early handling of serious or every serious large emergencies.

3. If the emergency is still beyond control after early handling, the Municipal Emergency Response Committee will determine the response level and scope, launch the corresponding preparedness, and if necessary set up headquarters to deal with emergencies.

In addition, the units and communities where the emergencies occur have full responsibility for early handling, and should direct the people for self and mutual-rescue. Furthermore the relevant departments should carry out immediate handling as soon as possible.

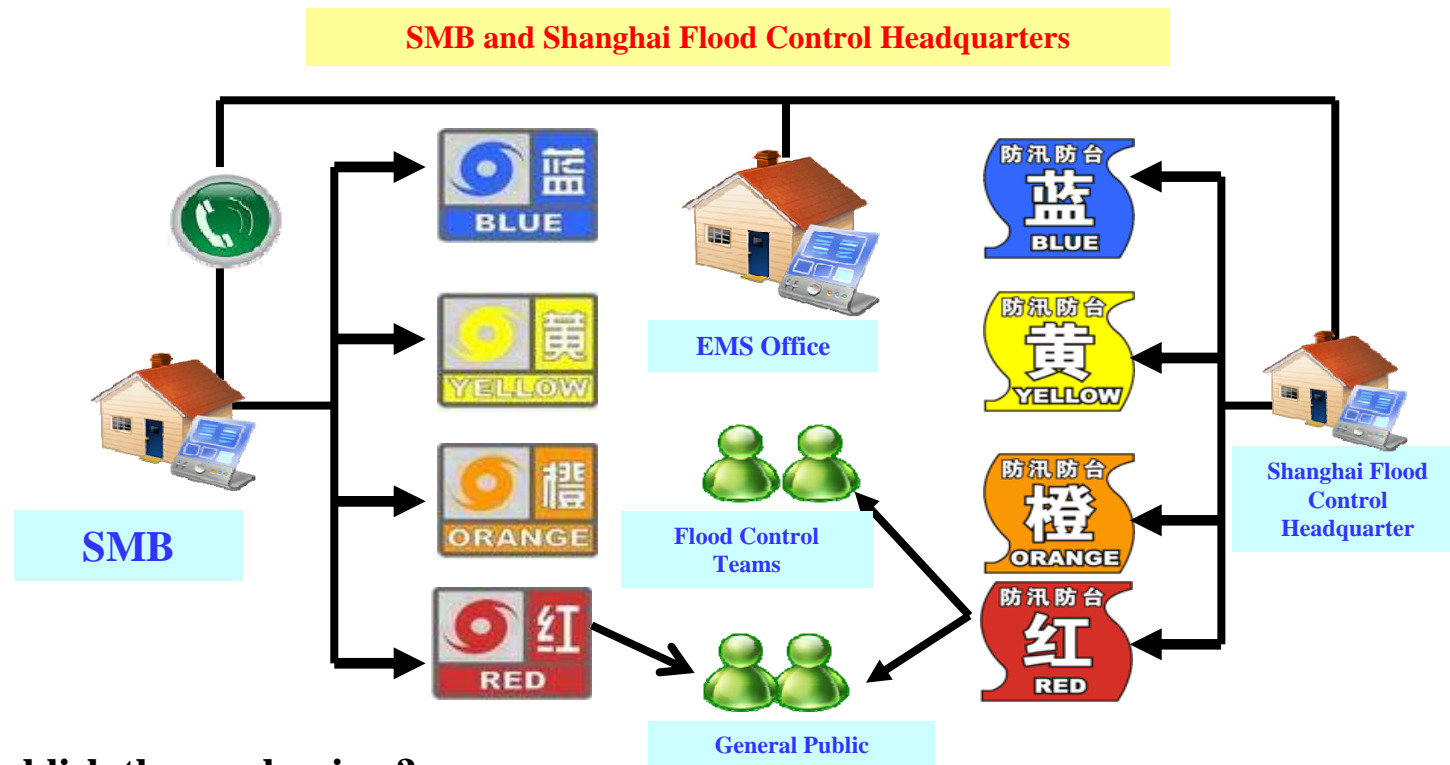
# Organizational structure for implementing Shanghai MHEW



**The capacity of disaster prevention and mitigation will be enhanced through establishment of Early Warning Center.**

# Operating procedures among agencies

## Coordination Mechanism (1): Joint Response Warnings and Standard Respond Actions











### How to establish the mechanism?



### Event driven opportunity

**August 5th, 2001:** a rainstorm affected Shanghai and led to serious economic losses. Response from the public was passive because there was no warning and the media had weak awareness of weather disaster warnings. This event identified the need for greater awareness and for the necessity for improved weather warning information and the need for **efficient coordination between agencies** involved in disaster response. This event pushed forward the establishment **severe weather warning system** and **multi-agency coordination mechanism** between weather and flood control departments.

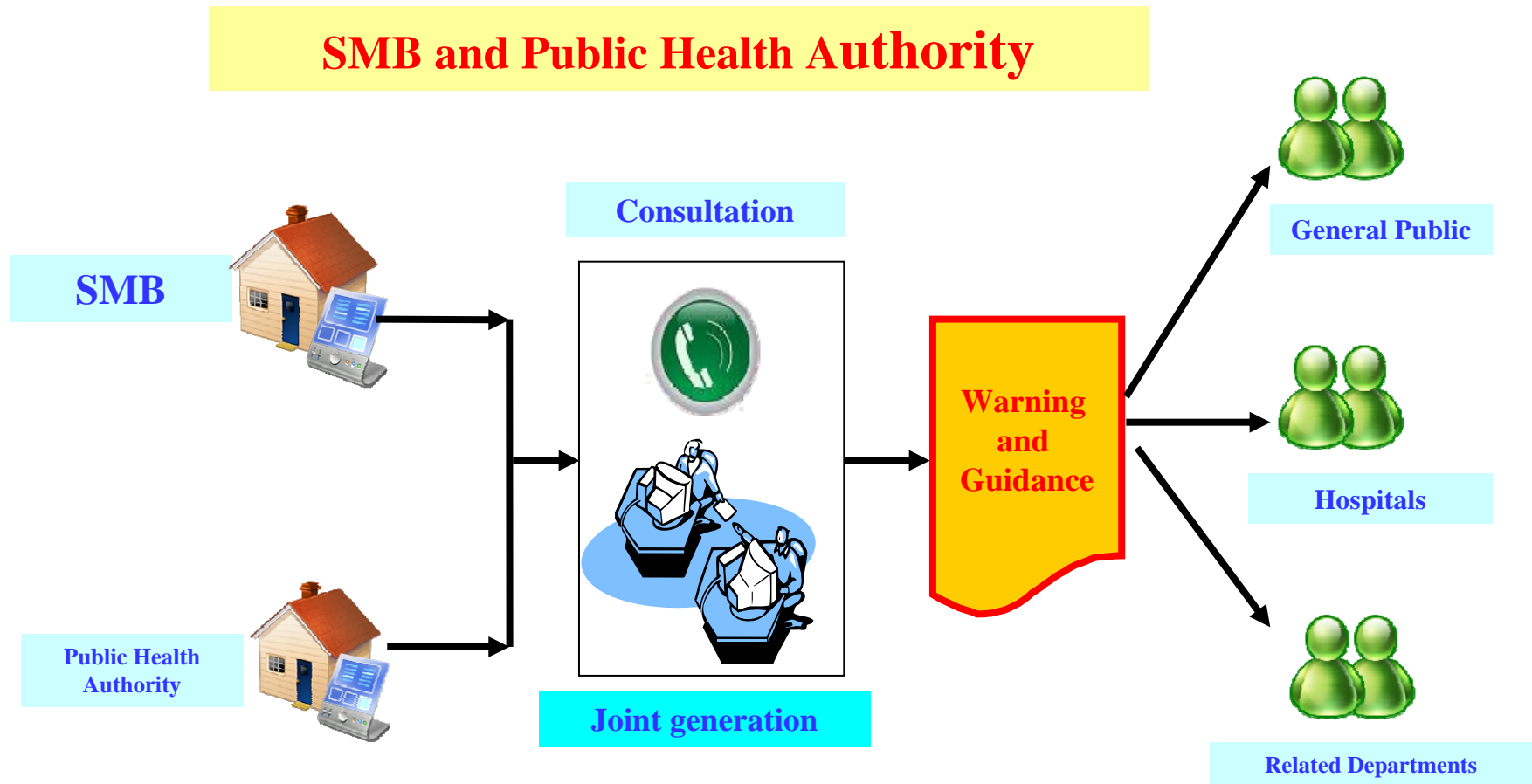
# Warning level and corresponding action

Shanghai Meteorological Bureau	Shanghai Water Affairs Bureau	<b>Response Action Levels (Implemented by Shanghai Flood Control Headquarters)</b>
		<ul style="list-style-type: none"> <li>•Organize a consultation meeting to strengthen flood monitoring and flood control supervision.</li> <li>•Report the situation to Municipal Flood Control Headquarters and</li> <li>•notify the Emergency Response Center of the Shanghai Municipal Government.</li> </ul>
		<ul style="list-style-type: none"> <li>•Organize a consultation meeting to strengthen flood monitoring and flood control supervision, propose specific preparation requirements,</li> <li>• report the situation to the Shanghai Municipal Government and</li> <li>• notify the Emergency Response Center.</li> </ul>
		<ul style="list-style-type: none"> <li>•Deputy commander-in-chief for Municipal Flood Control Headquarters will chair the consultation meeting to strengthen flood monitoring and flood control supervision, to direct counter-measures, and</li> <li>• report the situation to the leaders of the Shanghai Municipal Government. If necessary,</li> <li>•an emergency response meeting will be held to plan flood and typhoon control more efficiently.</li> </ul>
		<ul style="list-style-type: none"> <li>•Commander-in-chief of the Municipal Flood Control Headquarters will chair the consultation meeting, participating in planning flood and typhoon control guidelines. If necessary,</li> <li>•the leaders of the Shanghai Municipal Government will deliver a speech on television or radio to encourage the military and civilians to devote themselves to disaster resistance and rescue.</li> <li>•Report the situation to the State Council and related state-level departments according to National General Emergency Response Readiness and other related regulations.</li> </ul>

# Operating procedures among agencies

## Coordination Mechanism (2): Joint Production and Joint Dissemination

### SMB and Public Health Authority



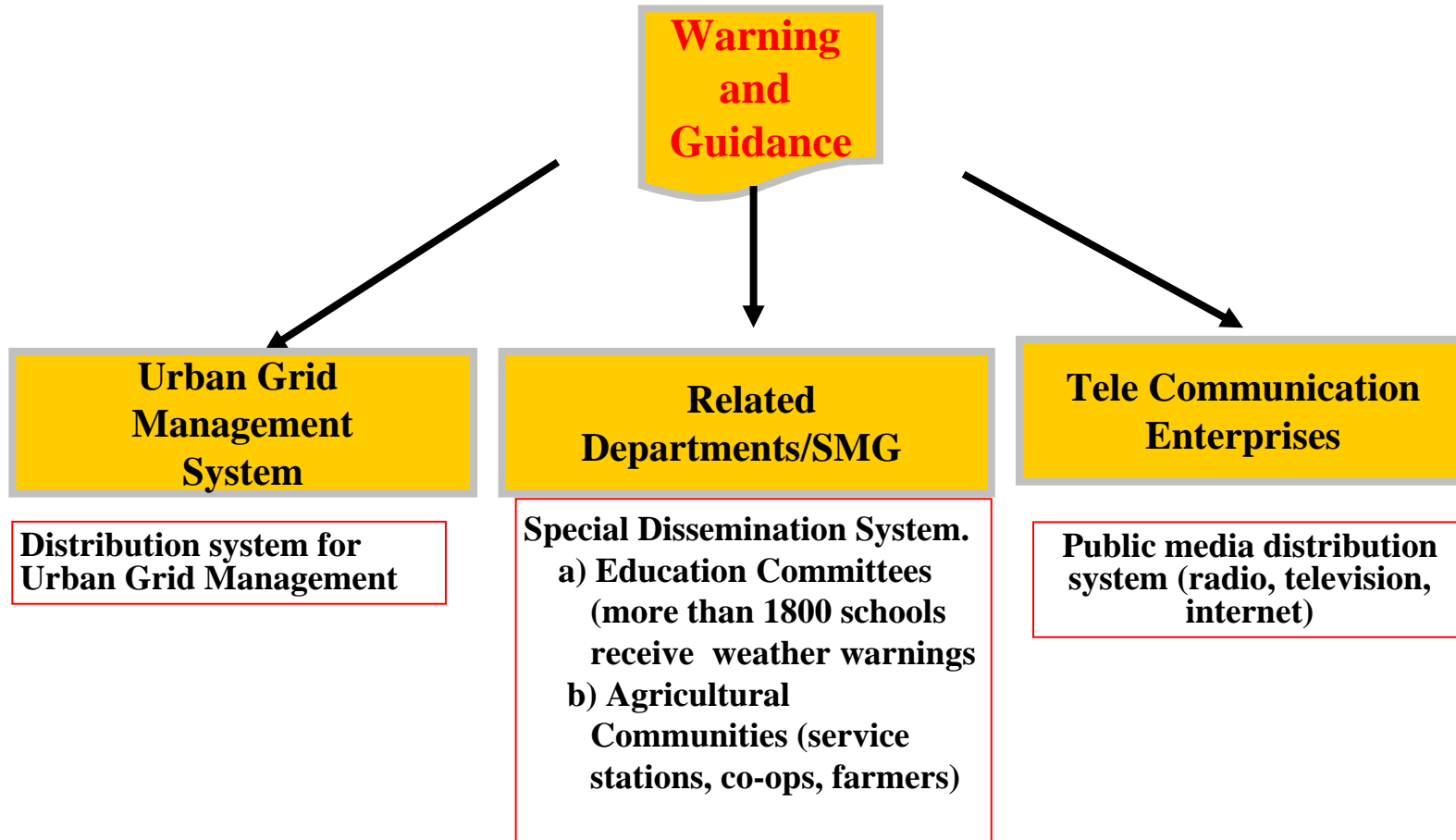
# How to establish the mechanism?

**Taking heat wave (weather event) and human health (Sensitive User) as example:**

1. First an investigation into the requirements of high sensitive departments was conducted.
2. Joint research program on the relationship between human health and heat waves was launched by experts from weather and human health departments. Databases were combined.
3. The outcomes were proven to be useful for DPM resulting in agreement on the multi-agency coordination mechanism. (Data sharing, joint production and dissemination of warning information )
4. According to the agreement, operational workflow was jointly setup.

# Operating procedures among agencies

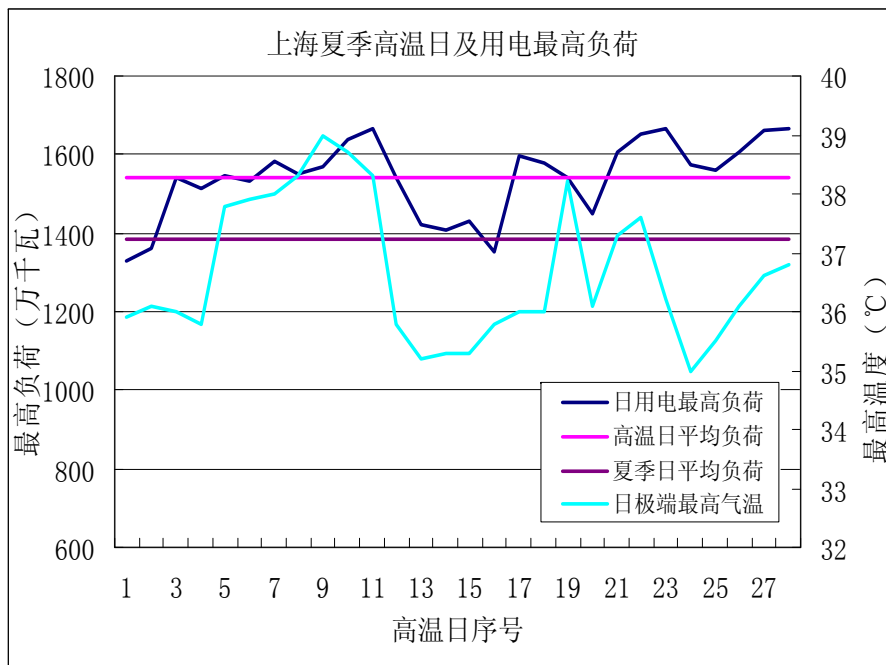
## Coordination Mechanism (3): Joint Dissemination



# Operating procedures among agencies

## Coordination Mechanism (4): Targeted Service for special user

The “**Special Weather Office**” is a joint production between **SMB** and the **Power Company** in the region to develop a **potential electricity load and consumption forecasting system** for the enterprise to adjust the load distribution in the region.



One process of torrential rain in summer can result in 3 million KW variation of the consumption.

10 degree temperature change can induce 550,000~600,000KW variation of consumption.

**Electricity consumption is sensitive to weather in Shanghai**

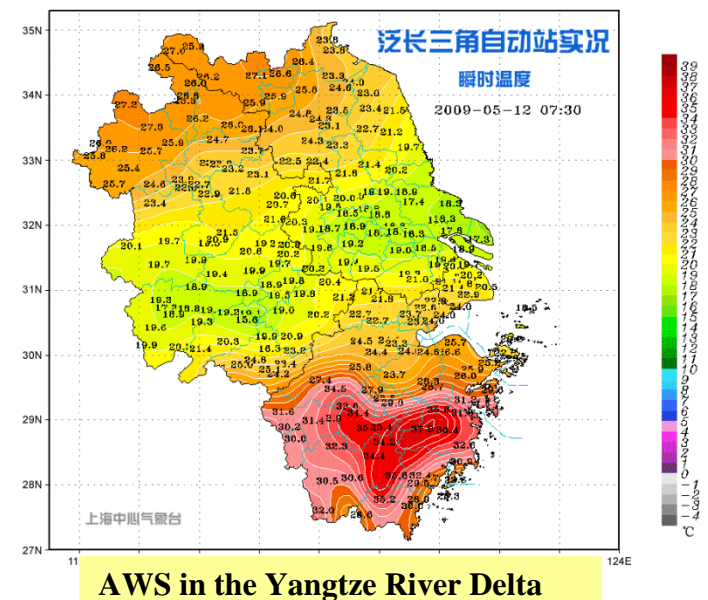
**(Potential for cost recovery!)**



# Operating procedures among agencies

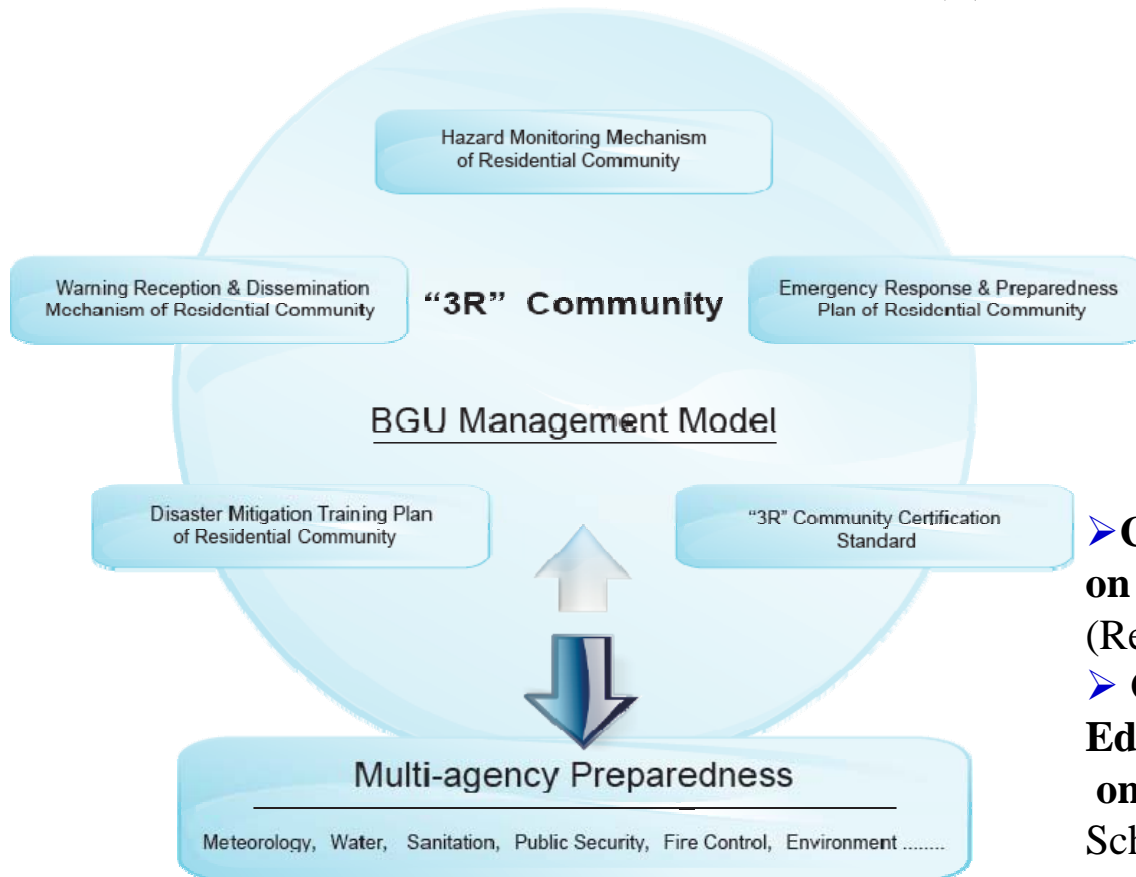
## Coordination Mechanism (5): Regional Joint Disaster Prevention

- Establishment of Regional Weather Information Sharing Platform
- Regional Intensified Emergency Observation
- Forecast consultation and on-the spot support
- Regional warning information sharing



# Operating procedures among agencies

## Coordination Mechanism (6):Community Safety Program



- Collaborations with Real-estate Bureau on weather warning dissemination (Reach 8000 Residential Communities) .
- Collaboration with Shanghai Education Commission on warning dissemination (Reach 1800 Schools) .

Based on the grid management strategy, Shanghai learn from the advanced experience of the world, so as to launch a safe strategy of residential community–**Risk Response Readiness** (“3R”). The Community Safety Program **aims to** provide “**End-to-End-to-End**” multi-hazards early warning services for policymakers, the public and special users.

## Financial and budget of Shanghai MHEWS

- It is no doubtful that the development, maintenance, sustainability and improvement of early warning systems is resource intensive.
  1. The daily operation of MHEW (Observation network, Communication, 24/7 operational forecasting, etc) is funded through both the **CMA and SMG**.
  2. Both of the above organizations applied for **MHEWS-related key project development funding**.
  3. Furthermore, **the cooperating stakeholders** will provide necessary financial resources to ensure the smooth operation of joint projects.



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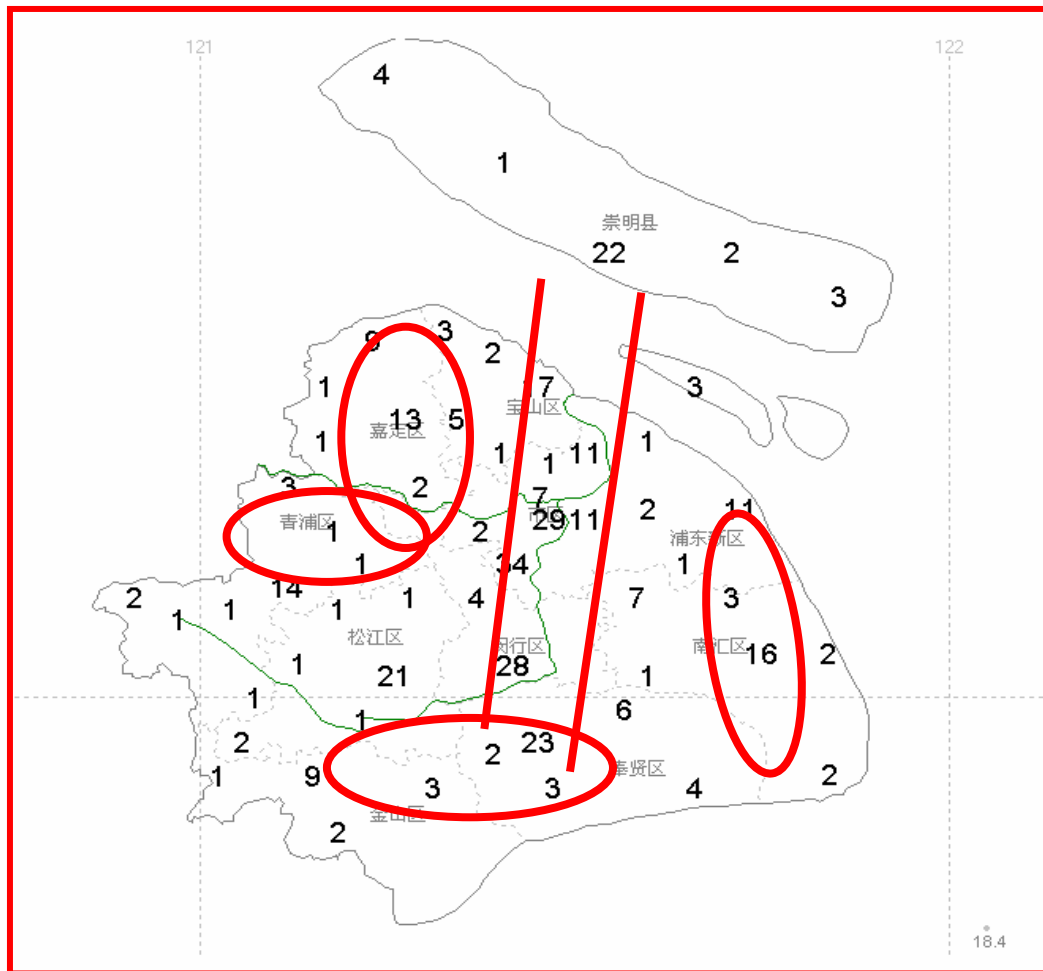
# Responsibilities and arrangements for the development of risk information

- **Civil Administration:** collection and statistical analysis of disaster risk information.
- **Statistic Bureau:** collection of statistics information for population, economic and social development.
- **Land Planning Administration:** land use planning.
- **Municipal Public Health Bureau:** collection of people's health information.
- **Municipal Power Company:** collection of electricity consumption and load factors.
- **Municipal Food and Drug Supervision Administration:** information collection of food poisoning.
- **Meteorological Bureau:** weather disaster risk assessment.

# Disastrous weather risk assessment of Shanghai

<b>Hazards</b>	<b>Introduction</b>	<b>Climate Average (Yearly)</b>
<b>Typhoon</b>	Almost every year Shanghai suffered the Pacific tropical cyclone attacks, during 1949-2002 186 tropical cyclones affected Shanghai with strong winds, heavy rains, storm surges and other disasters.	2 to 3 times; The tracks have shown northward tendency and will exert higher impact to Shanghai.
<b>Severe Convective Weather</b>	Severe Convective Weather mainly occurred along the Huangpu River and the western part of the city which is close to the Taihu Lake with torrential rain, squall line, thunderstorm, lightening	18 times; More extreme records have been broken in recent years
<b>Heavy Fog</b>	Mainly occurs in spring and winter, have great impact on the air quality and traffic.	39 days
<b>Heat wave</b>	The high temperature days (higher than 35 degree) is about 20-30 days in recent years, may affect the city water and electricity supply, agricultural production and livelihood of the people.	9 days

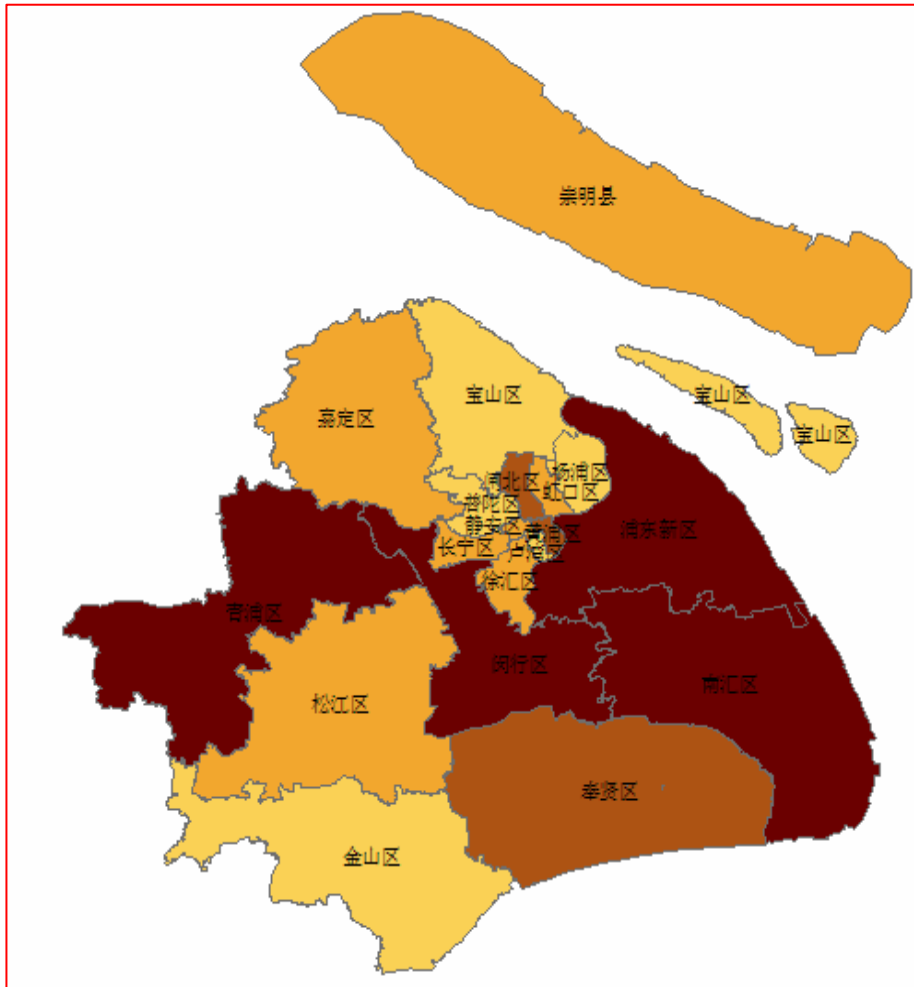
# Risk Information Utilization: Severe Convective Weather (1)



According to the distribution of severe convective weather in Shanghai, SMB has formulated prevention measures for high impact weather, and established a central warning central, as well as several district-level severe convective weather warning centres. These units are responsible for forecasting severe convective weather and providing information for the emergency joint response plan.

**Location of severe convective weather in Shanghai (1994-2004)**

# Risk Information Utilization: Lightning threats (2)



## Factors:

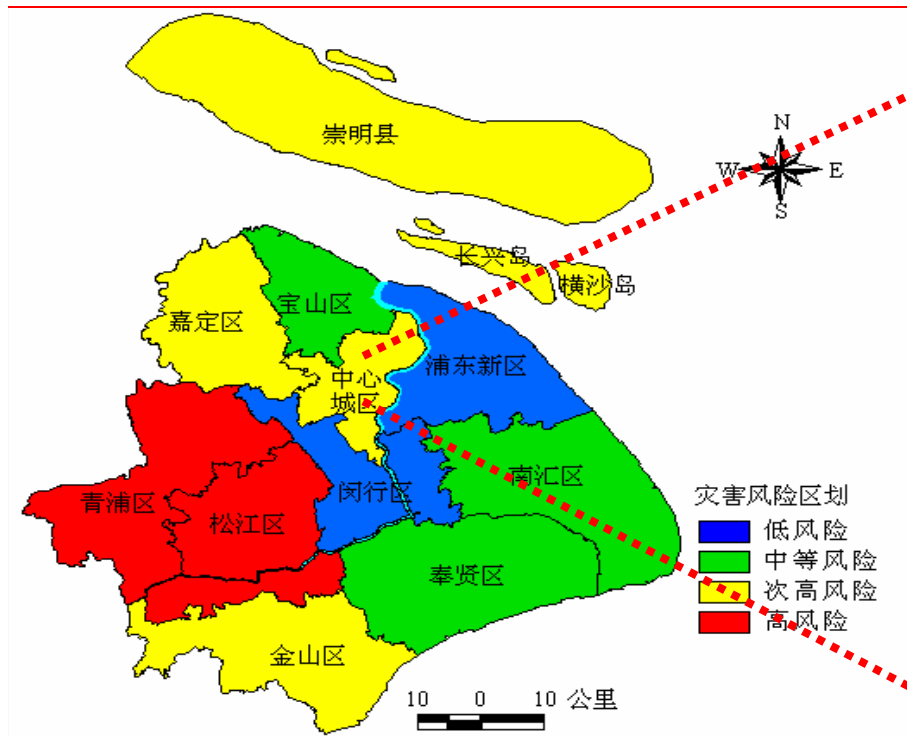
- Historical lightning disasters with damage reports (10 years);
- Historical lightning and thunderstorm data
- Exposure Information (i.e. numbers of high buildings)

Lightning Risk Map

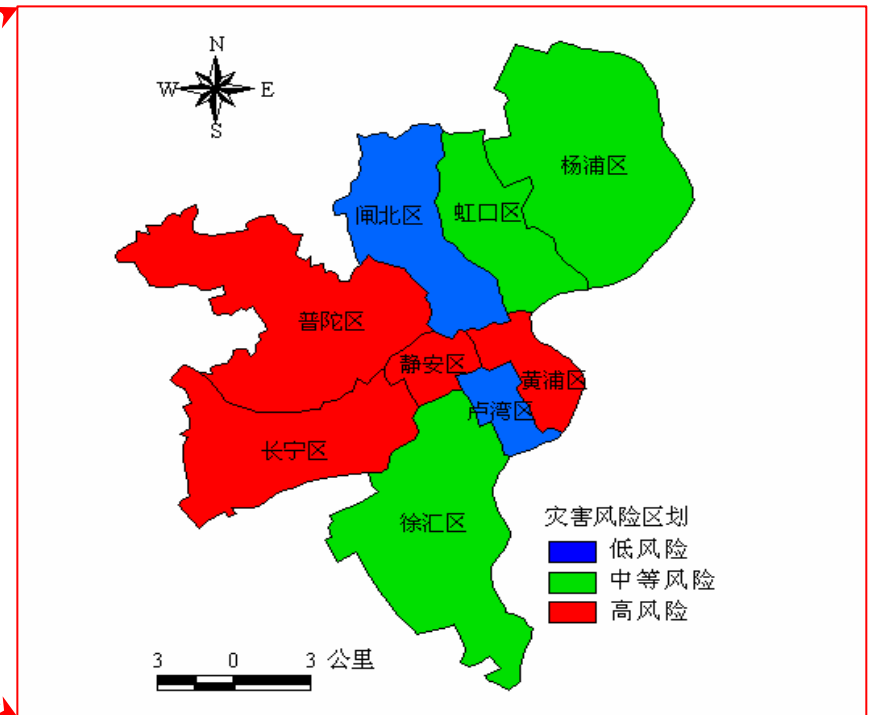


# Risk Information Utilization: Torrential Rain and Flood (3)

Factors such as regional total rainfall, drainage capacity, vulnerabilities were integrated to get the comprehensive risk map.



Flood risk map (Shanghai)



Flood risk map (City Centre)

The flood risk map contributes to:

- Guidelines for land use planning and strengthening the infrastructure for special regions.
- Directions for multi-agency cooperation and coordination in DPM for special regions.

## **Risk Information contributions to EWS**








- Basic information for weather impact forecast model development;
- Warning standard development and warning improvement;
- Information for emergency response planning;
- Directions on multi-agency cooperation and coordination in special zones;
- Basic information for land use planning.









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# Organizational Responsibilities

SMB has sole responsibility

Hazards	Signal
Typhoon	
Rainstorm	
Snowstorm	
Heat wave	
Drought	
Cold wave	
Gale	

Hazards	Signal
Lightning	
Hail	
Frost	
Heavy fog	
Haze	
Road icing	
Sand storm	
Ozone	

# Organizational Responsibilities

## Joint Mandate

<b>Hazards</b>	<b>Agency</b>
<b>Safety of Electricity and Power Supply</b>	<b>SMB and Power Company</b>
<b>Human Health</b>	<b>SMB and Public Health Bureau</b>
<b>Air Pollution</b>	<b>SMB and Environmental Protection Bureau</b>
<b>Bacterial Food Poisoning</b>	<b>SMB and Shanghai Municipal Food and Drug Supervision Administration</b>

# Organizational Responsibilities

Other agencies has sole responsibility

<b>Hazards</b>	<b>Agency</b>
<b>Earth quake</b>	<b>Shanghai Earthquake Bureau</b>
<b>Tsunami</b>	<b>Shanghai Water Affairs Bureau</b>
<b>Geological Disaster</b>	<b>Shanghai Land and Resources Administration</b>

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# Three level dissemination platform

1. **City-level Dissemination Platform.** The Municipal Emergency Response Office issues emergency management information to **3000 staff in 76 different departments.**

2. **Department-level Dissemination Platform.** The cell phone message platform of SMB has already sent warnings concerning water affairs, flood prevention, sunstroke and community management. The Information dissemination system covers more than **8000 residential areas, 1780 junior and primary schools, and 300 agricultural units.**

3. **Public-level Dissemination Platform (effectively used).**

——Cell phone mass message dissemination mechanism for serious disasters has been implemented

——Public warning dissemination network includes **22 000 public electronic screens, 2000 billboard TV screens, and 1000 electronic road signs.**



# Warning dissemination mechanisms

- ① SMS (Short message service)
- ② TV, Radio (FM subsidiary radio).
- ③ Newspaper, Magazine.
- ④ Web (China: [www.weather.gov.cn](http://www.weather.gov.cn); Shanghai: [www.soweather.com](http://www.soweather.com))
- ⑤ Basic Grid Unit management system.
- ⑥ Electronical screen.
- ⑦ Telephone (Warning call), Fax.



**SMS:** There are two major classes of user:

Special users: education, agriculture, construction, etc.

General public: Information delivered to the public can be customized. Weather information can be disseminated to the whole net if necessary, for example, the emergency warning for typhoon.

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**TV, Radio:** Up to now, the TV program are broadcasted in Chinese and English, and are expected to include French and Japanese during Expo 2010.

The weather information can be added or inserted into the ongoing TV and Radio program. For example, the “nowcasting” forecast and real time weather information were inserted into the radio ongoing program on July 22, 2009 during the total eclipse of the sun.

**FM Subsidiary Communication Authorization (SCA)** is used to broadcast warning information, which is a very important backup mechanism in big disasters.

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**Web:** The official website for disseminating the weather forecast for China is <http://www.weather.gov.cn>, to Shanghai the official website is <http://www.soweather.com>.

In addition, the weather forecast for the Shanghai and the east China will be distributed to the partner sites by SMB.



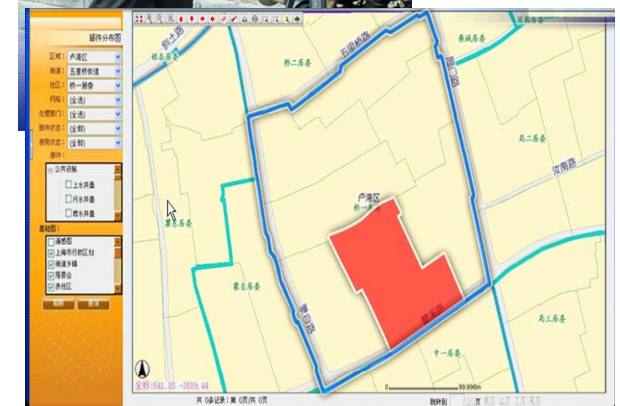
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- ⑤ **Basic Grid Unit management system**
- ⑥ Electronic screen
- ⑦ Telephone (Warning call), Fax.

**Basic Grid Unit management system:** Shanghai utilizes a Basic Grid Unit (BGU) management method for event monitoring and management in residential communities. The area of an average BGU is approximately 10,000 square meters. All BGUs are monitored and managed by supervisors, who are responsible for collecting information and forwarding it to the city and district response centre through the BGU network. SMB and other government agencies have provided many management and service products based on the BGU management framework.



**Grid supervisors**



# Warning dissemination mechanisms

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**Electronic screens:** weather information are issued via display screens in the streets and parks. At present there are 22,000 public electronic screens, 2,000 Digital TVs and 1,000 road sigals in the streets.



**Telephone:** The numbers are 12121, 969221, and 969222. There is also an active outgoing call service, named Warning Call (150 calls every minute).



## Warning disseminated through different methods

No.	Issuing methods	Users
1	Public Media (i.e. newspaper, TV)	the public
2	Outdoor Electronic Screen	the public
3	Radio Broadcasting	the public
4	Cell-Phone Dissemination System	municipal decision makers, government agencies, residential community managers, basic response units managers (i.e. school, hospital, construction sites), the public
5	Mobile Media TV	passengers in taxi, bus, and subway
6	FM Subsidiary Communication Authorization (SCA)	special users
7	Warning Call	basic response units office
8	Dedicated Line	municipal decision makers, city affairs management departments, and special users
9	BGU transmitting system	community supervisors

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## Emergency response activation (department)

- The Committee regularly organizes large-scale comprehensive training and exercises once or twice each year, and according to the actual situation, every department organizes the training and assessment as needed.
- The meteorological services actively participate in emergency response planning. The Municipal Emergency Response Management Committee and meteorological services jointly organize and conduct training sessions on an annual basis.



**Residential Community  
Response Rehearsal**





## Public awareness and education (Special day)

- May 12th is national **Disaster Prevention and Reduction Day**. The day aims to commemorate the May 12th, 2008, Wenchuan earthquake, and raise the public's awareness about preparing for and mitigating natural disasters.
- Furthermore, to maintain public awareness, we observe days such as **Meteorological Day** and **Fire Prevention Day**.



Movie show



Expert consultation



Disaster prevention post



Emergency evacuation rehearsal

# Public awareness and education (Daily)

- The local communities awareness was enhanced by means of internet, the media, distribution of multi-hazard brochures and posters.
- Representatives of meteorological services and other partners conducted training and exercises as part of their public outreach program.
- MHEW partners and the Shanghai Municipal Educational Committee will determine how the public awareness education programs are built into school curricula.



Contest on meteorological knowledge among local pupils



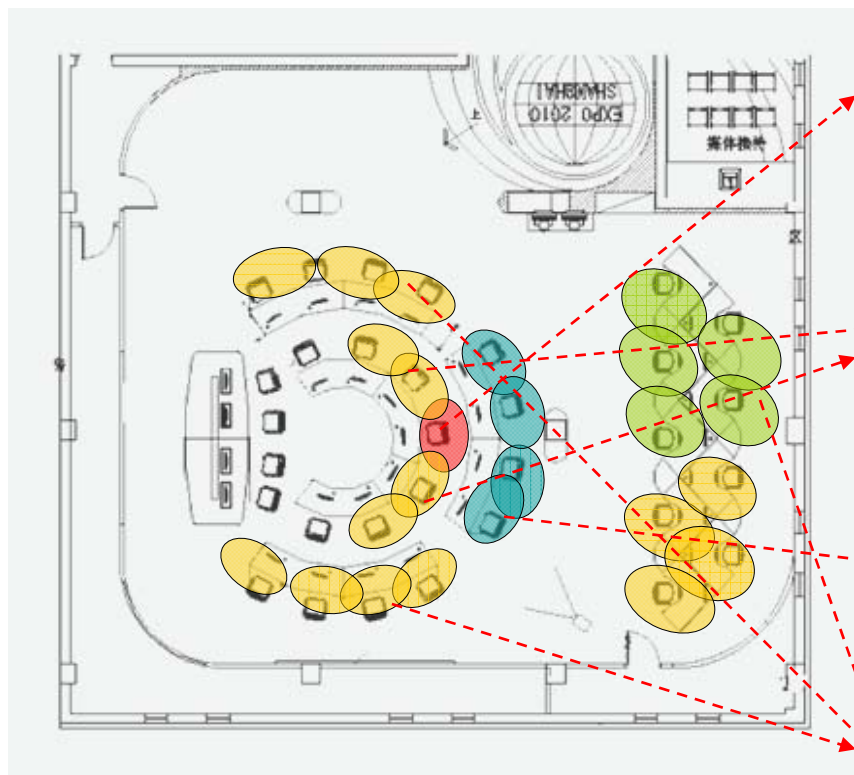
# Outline

1. Background
2. Governance and Institutional Arrangements
3. Utilization of risk information in emergency planning and warnings
4. Hazard monitoring, forecasting, and mandates for warning development
5. Warning dissemination mechanisms
6. Emergency preparedness and response activities
7. Improvement of overall operational framework of the early warning system

## Improvement of overall operational framework

- SMB has established a professional position to collect feedback from disaster risk management agencies, other stakeholders and the public for the purpose of improving MHEW products.
- The Municipal Emergency Response Management Committee holds quarterly working group meetings of MHEW partners to review feedback on system operations and to improve the work flow mechanism.

### PWS platform and Specialized “Service Delivery Professionals”



• **Chief Service Officer (CSO):** Coordinator in the PWS platform: emergency response; early warning issuance; consultation with other agencies; interviews.

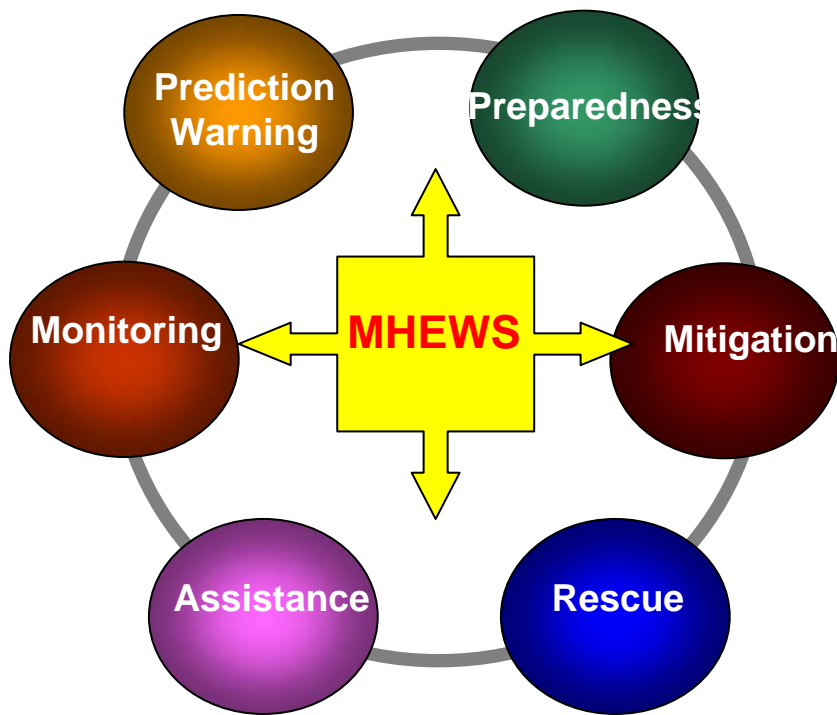
• **Assistant CSO:** service inspection; special service implement; assessment analysis; Liaison with high sensitive users and media.

• **Counselors for multi-agency coordination:** providing targeted services to the categorized users; concerning people's livelihood in the public health, air quality, heat stroke risk, bacterial food poisoning etc.

• **Advisor Expert to the public :** Through telephone, website and media (TV, Radio).

# Experience Summary

Multi hazard Early Warning is a **new service delivery methodology** that integrates inputs for a wide range of weather related threaten information.



Multi-phase Response Framework  
for emergency response

- The purpose of MHEW is to establish a **bridge** between all kinds of products and data with sensitive users.
- Early warning is the **first step** and **penetrates the whole procedure** of DPM process.
- In EWS, **Domino relations of the direct hazard to indirect impacts or secondary impacts should be paid more attention.**
- **Better pre-established channels were needed for disseminating guidance at government and grassroots levels as efficiently as possible based on different categories of risk and needs.**

# Experience Summary



## Disastrous weather warning :

- weather service (**end**)
- user (**end**)

## Multi-hazard early warning :

- weather service (**end** )
- partner (**end**)
- user (**end**)

*The **right** information should be delivered to the **right** person at the **right** place at **right** time.*

**Thank you**  
**Comments and Questions**