UN GEONOW 2024
首届联合国地信周

Technological Response to Emergencies and Disaster Reduction of China: Challenges and Achievements

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October 23, 2024

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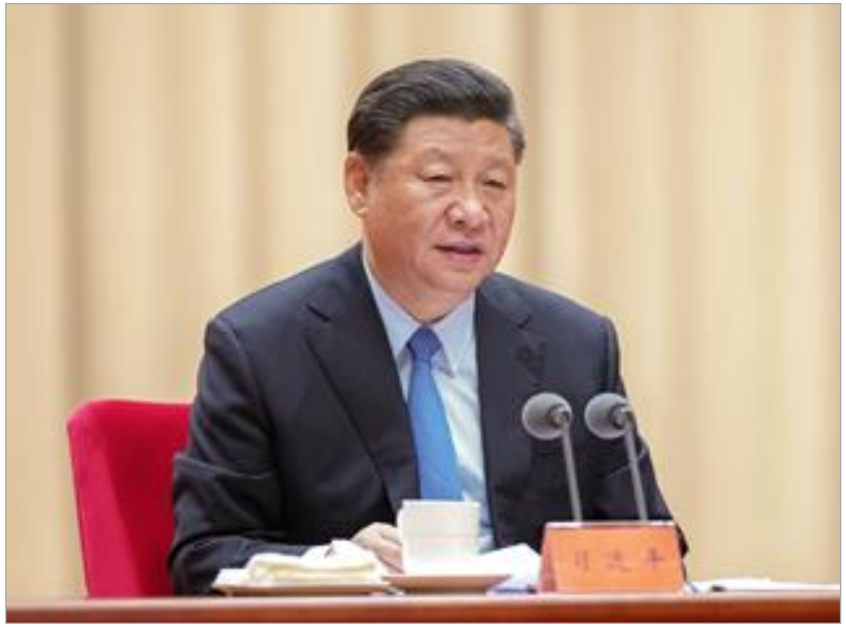

- China is one of the countries with the most serious natural disasters in the world.There are many types of disasters, widely distributed in different regions, with high frequency of occurrence and heavy losses, which is a basic national condition.We must adhere to prevention as the main approach, combining prevention, resistance and rescue, and the unity of normal disaster reduction and emergency disaster relief.We must strive to achieve a shift from focusing on post-disaster relief to focusing on pre-disaster prevention, from responding to a single type of disaster to comprehensive disaster reduction, and from reducing disaster losses to reducing disaster risks. (July 28, 2016)
- We need to establish an efficient and scientific natural disaster prevention and control system, improve the ability of the whole society to prevent and control natural disasters, and provide strong guarantees for protecting the safety of people's lives and property and national security. (October 10, 2018)
- We need to strengthen the technical support of emergency management equipment, optimize and integrate various technological resources, promote independent innovation in emergency management technology, and rely on technology to improve the scientific, professional, intelligent, and refined level of emergency management. (November 29, 2019)

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Ⅰ. Basic Characteristics of Disasters in China

1. Basic Characteristics

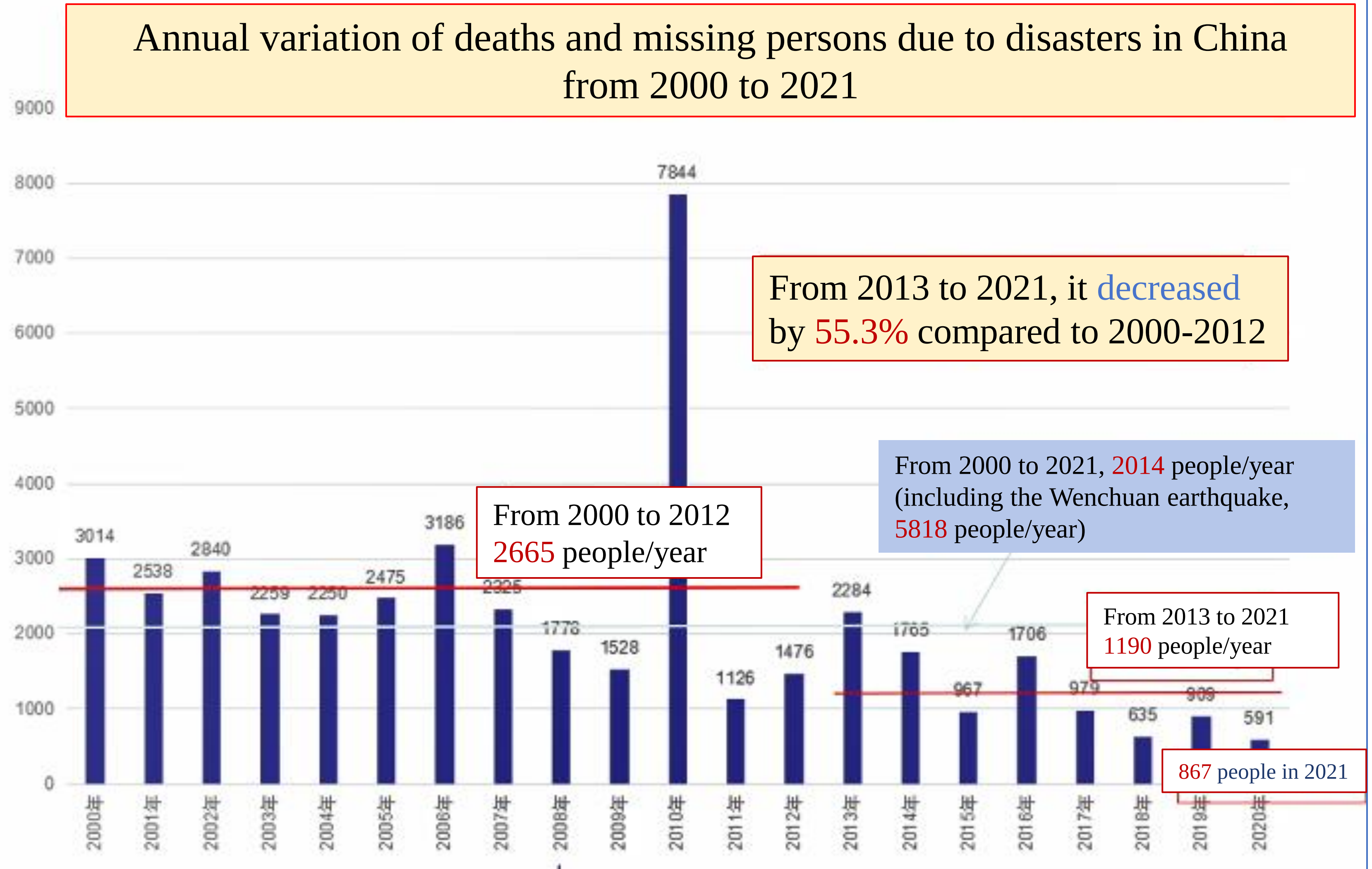
Multiple types: Except for disasters caused by modern volcanic activity, almost all natural disasters occur every year, such as floods, droughts, earthquakes, typhoons, hailstorms, snowstorms, landslides, mudslides, pests and diseases, forest fires, etc.

Wide distribution: Natural disasters have affected various parts of the country to varying degrees, especially densely populated areas in the southeast that are located in high-risk areas for meteorological and geological disasters.

High frequency: Regional floods, droughts, forest and grassland fires, earthquakes, geological disasters and other disasters occur every year. An average of about 7 typhoons land in the southeastern coastal areas each year.

Heavy losses: The average direct economic loss from various disasters is 300 billion yuan per year, and the average number of people affected by disasters per year is over 100 million. In 2022, disasters caused a total of 112 million people to be affected, with direct economic losses of 238.65 billion yuan.

Ⅰ. Basic Characteristics of Disasters in China



Excluding the number of deaths and missing persons in the 2008 Wenchuan earthquake

Number of deaths and missing persons in forest and grassland fires from 2018 to 2021

Ⅰ. Basic Characteristics of Disasters in China

3. Disaster situation in the first half of 2024

Economic Losses

Direct economic losses amounted to RMB 93.16 billion.

Agricultural Losses

The affected area of crops is 3172.1 thousand hectares.

Construction Losses

23,000 houses collapsed and 279,000 houses damaged.

Personnel affected

Various natural disasters throughout the year affected a total of 32.381 million people, with 322 people dead or missing and 856,000 people urgently evacuated and resettled.

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II. Current Development Situation of Disaster

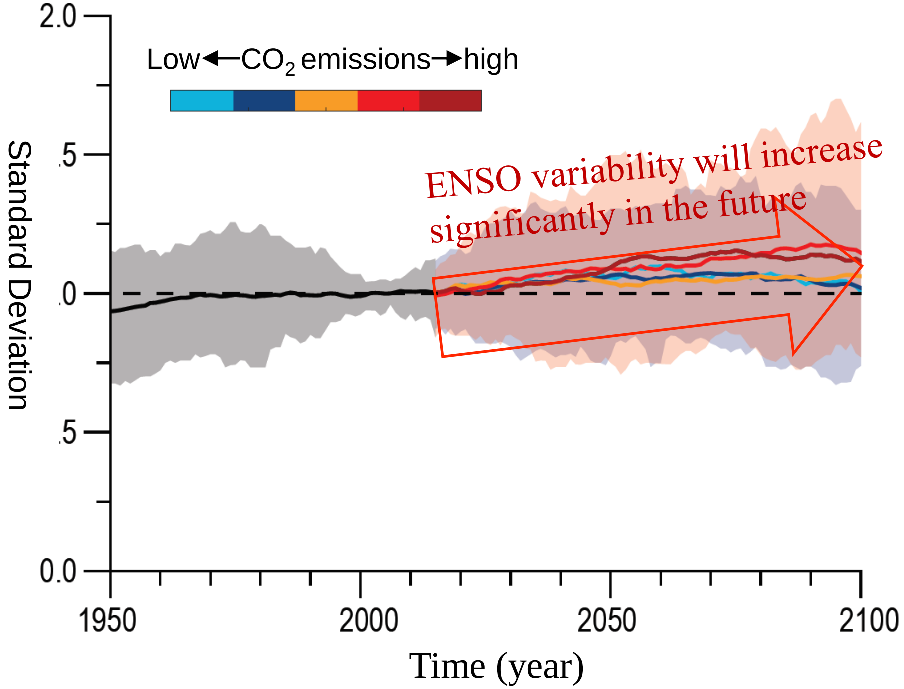
- Antarctic ice is melting six times faster than in the 1980s.
- Chance of a temporary increase in global average temperature of 1.5°C above pre-industrial levels: 10% for 2017-2021, 50% for 2022-2026.
- There is a 93% chance that at least one year between 2022 and 2026 will be the hottest on record.

- In 2022, natural disasters such as hurricanes and floods will cause global economic losses of up to $275 billion, or about RMB 1.88 trillion (Swiss Re Institute).
- The total losses from natural disasters were almost twice the average level of the previous 10 years: Hurricane Ian made landfall in Florida, USA, causing an estimated $50 billion to $65 billion; storms such as Eunice and Dudley in northwestern Europe caused a total of more than $4 billion.
- Insured losses from natural disaster have grown by an average of 5% to 7% per year over the past 30 years.

Ⅱ. Current Development Situation of Disaster

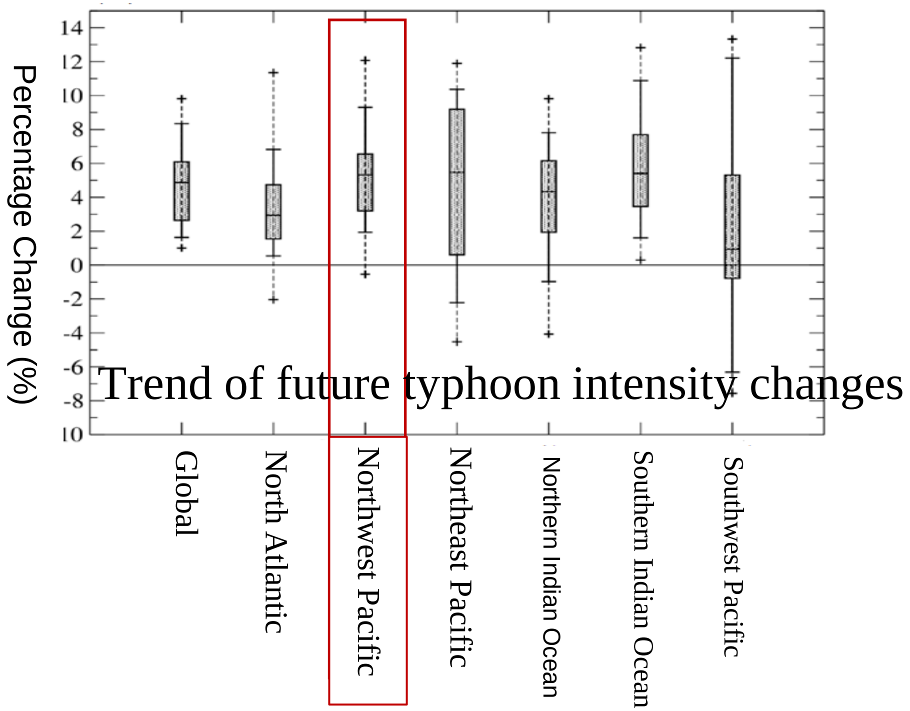
☐ The possibility of the superposition of extreme climate anomalies and extreme weather anomalies is increasing.

- **El Nino variability will increase significantly due to global warming.**
  - Leading to persistent climate anomalies, causing changes in the intensity and impact range of large-scale rain belts.
  - Triggering extreme weather and climate events such as rainstorm, high temperature and drought.



Historical and future changes in the El Nino-Southern Oscillation (ENSO)

- **Typhoons will become stronger and their impact will expand northwards in the future.**
  - The IPCC clearly pointed out that the frequency of typhoons may remain unchanged in the future, but the intensity will increase and the landing location will be more northerly, especially the northwest Pacific typhoons that affect China.



Trend of future typhoon intensity changes

Ⅱ. Characteristic 1: Increasing Extremeness of Disasters

		Rainstorm and floods in the summer of 1998	Summer rainstorm and flood in 2023
PRECIPITATION	Occurrence Time	Late June - late July	Late July - Early August
	General Characteristics	Large-scale continuous climate anomalies, several consecutive heavy rainfall processes	Regional weather anomalies, single heavy precipitation process
	Total Precipitation	680 mm	272 mm
	Peak Daily Precipitation	22 mm/day	52 mm/day
FLOOD	Affected Area	2.848 million square kilometers	435,000 square kilometers
	Impact Area	Yangtze River, the Pearl River, Minjiang River, Songhua River, Nenjiang River and other major rivers	Small watersheds such as Yongding River, Lalin River, Mudanjiang River, Yalu River, Ant River, Muling River, Woken River, Suifen River, etc
	Disaster Characteristics	Mountain disasters caused a large number of deaths and a large area of farmland was affected	Waterlogging, floods in small watersheds, mountain torrents, landslides and mudslides

Floods occurred in Jinma Town, Kaiyuan Town, Qili Township and other villages and towns in Shulan City, and some bridges collapsed

Ⅱ. Characteristic 1: Increasing Extremeness of Disasters

☐ The characteristics of rapid changes from drought to flood within the season are prominent.

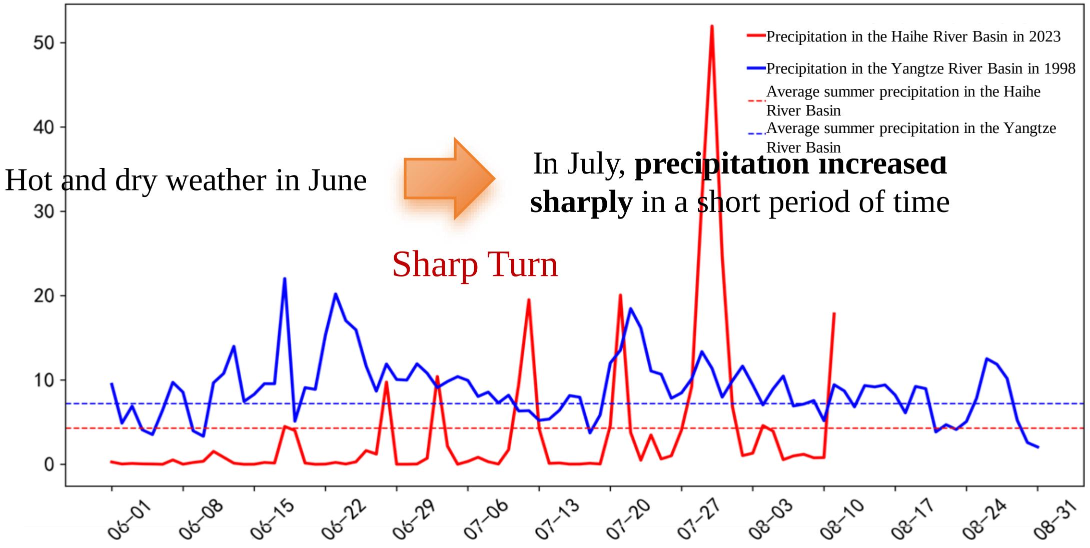
- The persistent heat wave in June turned into heavy rain and floods in July.
- The overall rain belt in the summer of 1998 was abnormal, with more heavy precipitation events.

☐ Short-term heavy rainfall features are obvious.

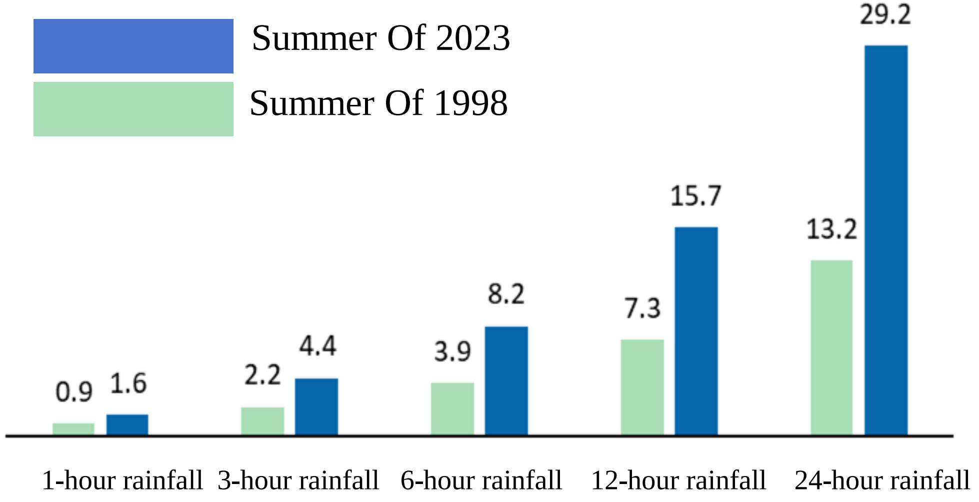
- The short-term rain is strong and the rainstorm process has pulse characteristics.
- The short-term rainfall intensity is relatively small, and the 3-24 hour precipitation intensity is less than half of the heavy rain in 2023.

☐ Urban waterlogging and small watershed flood disasters are serious.

- Severe urban waterlogging, mountain torrents in arid areas and floods in small watersheds.
- In 1998, floods occurred in many river basins and major rivers.

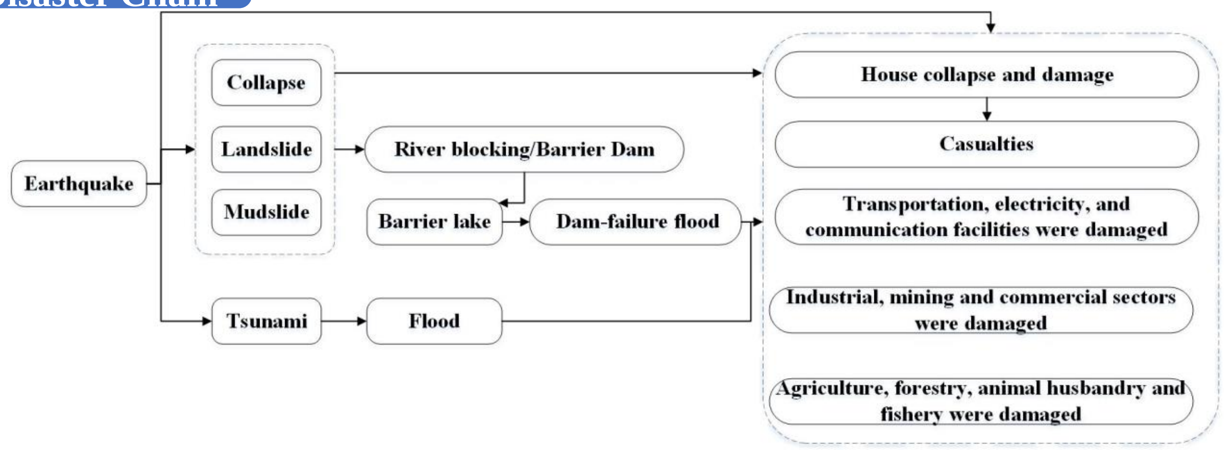


Average Rainfall During The Process (unit: mm)

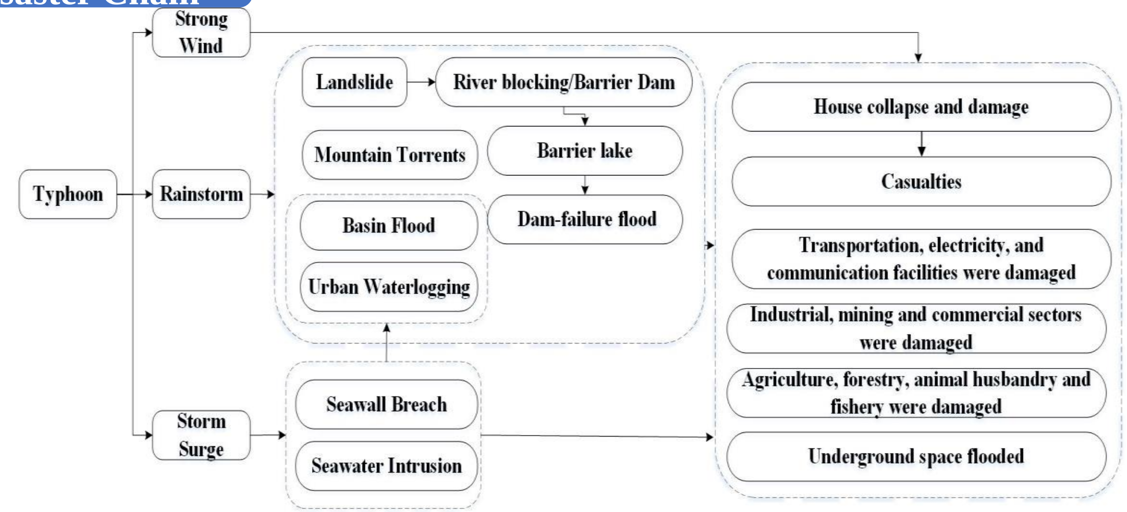


Ⅱ. Characteristic 2: Disasters Chains Are Becoming More and More Frequent

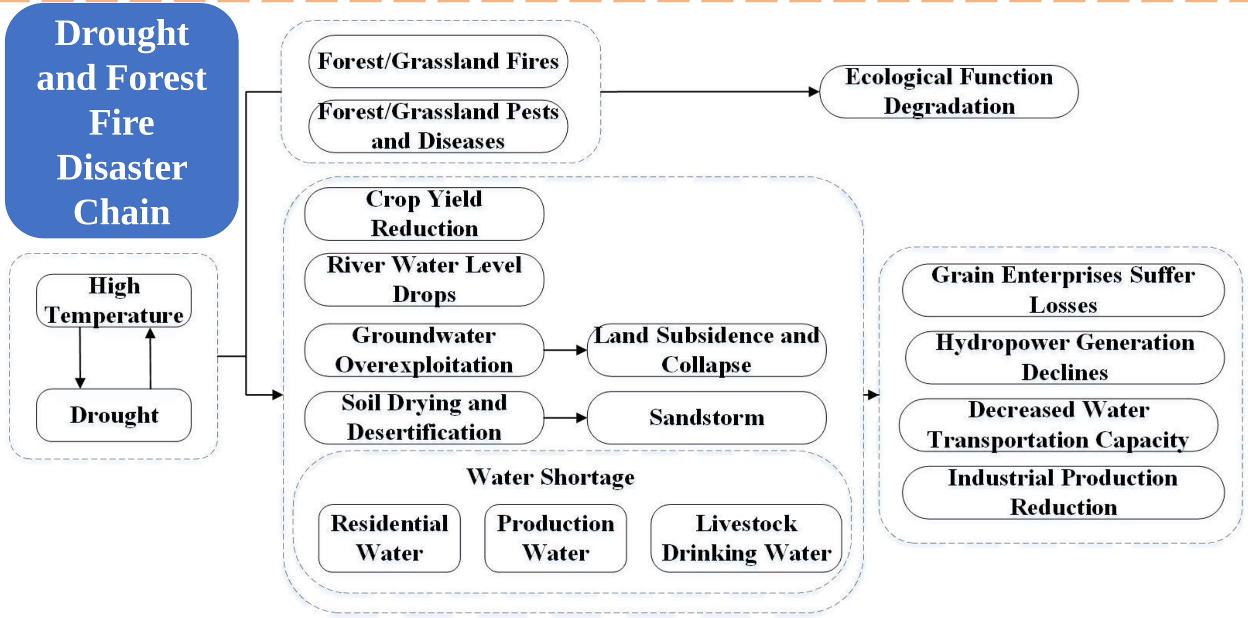
Earthquake Disaster Chain



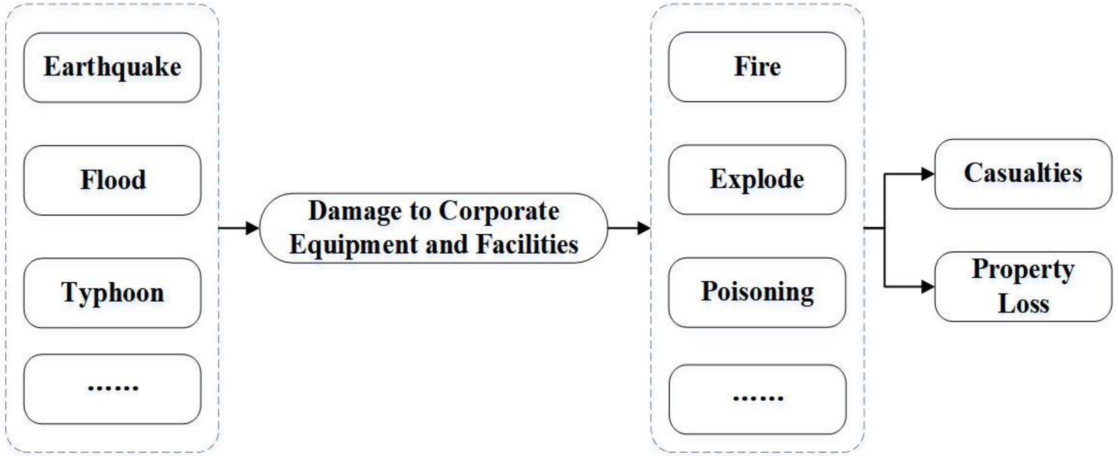
Typhoon Disaster Chain



Drought and Forest Fire Disaster Chain

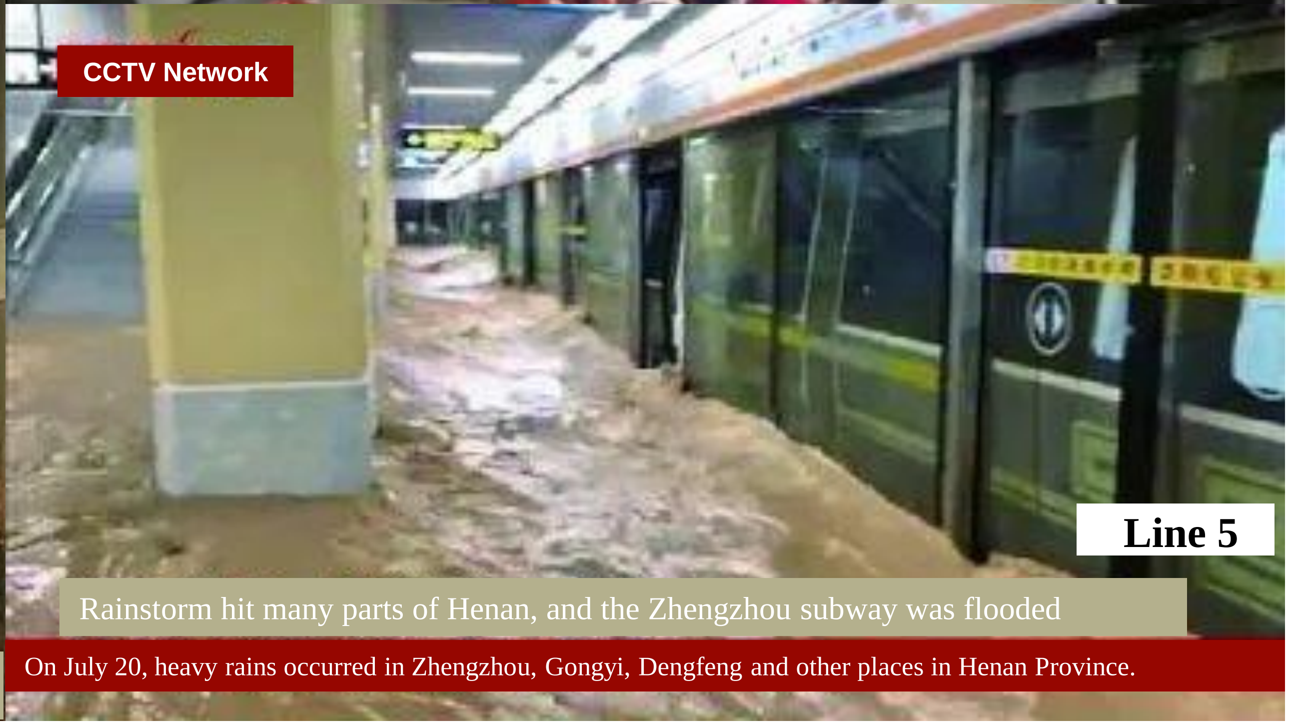


Cross-category Disaster Chain



Ⅱ. Characteristic 2: Disasters Chains Are Becoming More and More Frequent

- **The "July 20" heavy rain in Zhengzhou, Henan, killed 398 people, including 251 people in mountain torrents and geological disasters in Zhengzhou.**



Ⅱ. Characteristic 2: Disasters Chains Are Becoming More and More Frequent

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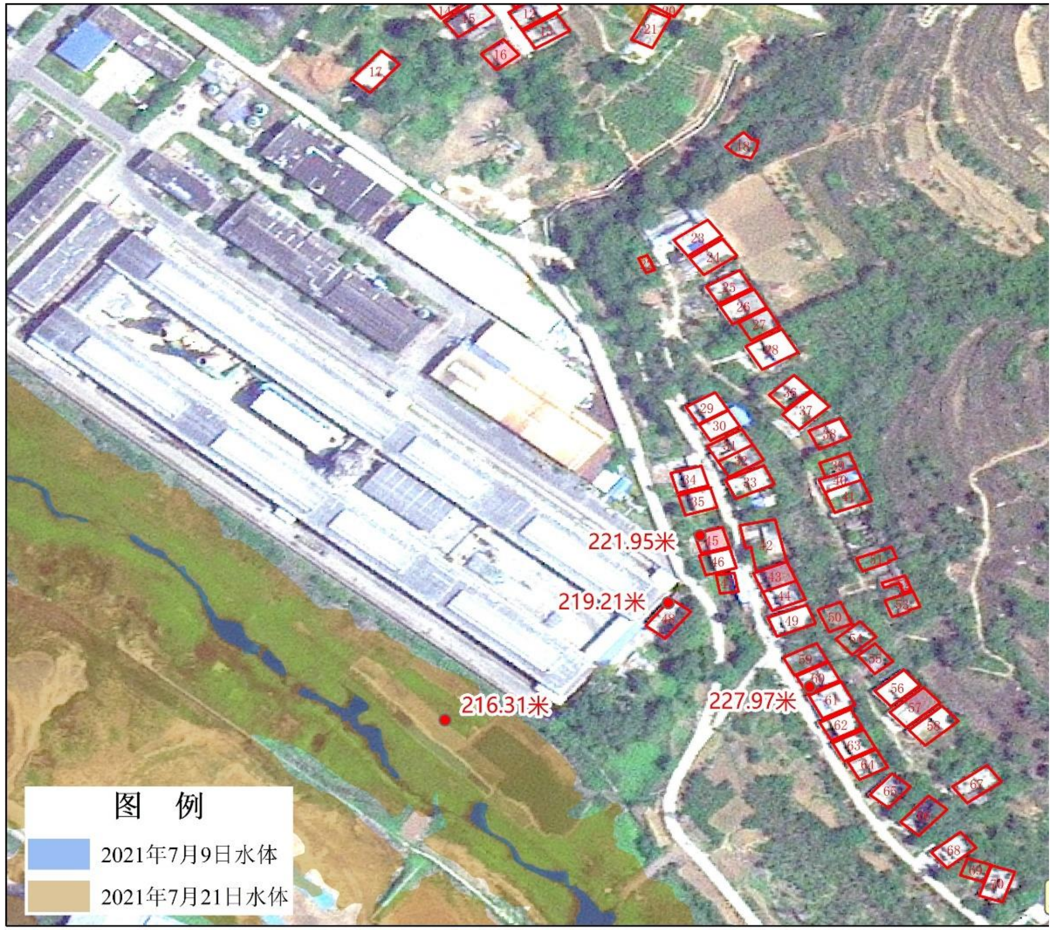
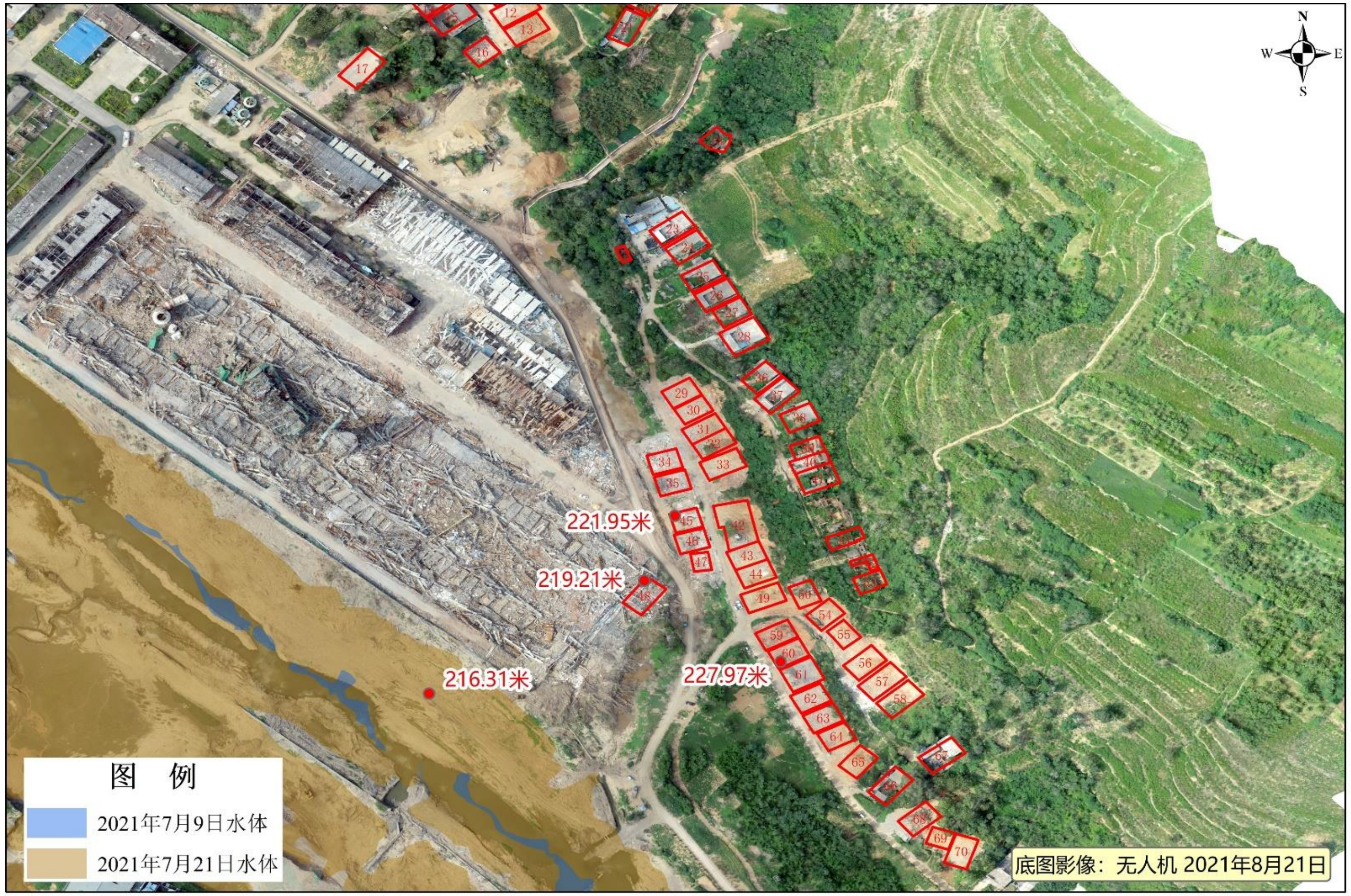
Remote Sensing Monitoring Map of The Surrounding Area of Dengfeng Power Plant Group Aluminum Alloy Co., Ltd.



应急管理部国家减灾中心（应急管理部卫星减灾应用中心）　0 50 100 200 米



应急管理部国家减灾中心（应急管理部卫星减灾应用中心）　0 50 100 200 米　制图时间：2021年9月1日

Ⅱ. Characteristic 2: Disasters Chains Are Becoming More and More Frequent

- **The Luding earthquake resulted in 118 deaths and missing persons, with 81.4% of deaths caused by geological disasters triggered by the earthquake.**

Ⅱ. Characteristics 3: Mountain Floods Trigger Light Rain, Leading to Major Disasters

Disaster Events	Time Of Occurrence	Location	Disaster Type	Total Rainfall/mm
Pingwu County "7.12"	7.11–12	Muzuo Tibetan Township, Pingwu County, Mianyang City, Sichuan Province	Mountain Torrents, Mudslides	203.5
Wudalianchi City "7.12"	7.12	Chaoyangshan Town, Wudalianchi City, Heihe City, Heilongjiang Province	Mountain Torrents	120–200
Beichuan County "7.16"	7.15–16	Baishi Township, Beichuan County, Mianyang City, Sichuan Province	Mountain Torrents, Mudslides	118.3
Zhongyang County "8.11"	8.10–11	Jinluo Town, Zhongyang County, Lvliang City, Shanxi Province	Mountain torrents, overflowing dams	219.7
Pengzhou City "8.13"	8.13	Longmenshan Town, Pengzhou City, Chengdu City, Sichuan Province	Mountain Torrents	27.4
Datong County "8.17"	8.17–18	Qinglin Township and Qingshan Township, Datong County, Xining City, Qinghai Province	Mountain Torrents	122.2

Ⅱ. Characteristics 4: Dam Pipe Surge Threats on Small and Medium-sized Rivers Are Great

- **River embankment defense chief**: 331000 kilometers of river embankments with a grade of 5 or above have been built nationwide, protecting a population of 650 million and 42000 hectares of arable land. More than 90% of river embankments are earth and stone dams built in the 1970s and 1980s. During the flood season, they are easily affected by high water levels and are prone to leakage, piping, and other dangerous situations.
- **The task of patrolling embankments and inspecting risks is heavy**: hundreds of thousands of people patrol embankments and inspect risks every year during the flood season. During peak periods, more than 700000 people are organized to patrol embankments and inspect risks 24 hours a day in the five provinces of the middle and lower reaches of the Yangtze River.
- **Manual dike patrol is difficult to sustain:** manual dike patrol is time-consuming, labor-intensive, inefficient and costly, and many dike patrol and hazard inspection personnel lack professional knowledge.

The breach of the embankment resulted in the flooding of the town

Traditional large-scale manual dike patrol scenario

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Ⅲ. Establishment of National Institute of Natural Hazards

Mainly responsible for researching major policies, basic theories, key technologies, and important equipment for natural disaster prevention and control, as well as demonstrating the transformation and application of scientific and technological achievements.

Benchmarking against domestic first-class and international advanced standards, it aims at the significant scientific and technological needs for comprehensive disaster prevention, mitigation, and emergency management. It carries out basic theoretical research, application technology development, and emergency rescue equipment development for disasters such as meteorological, water and drought, earthquakes, geological, and forest/grassland fires, providing important scientific and technological support for preventing and resolving major disaster risks and emergency management.

On December 30, 2019, State Councilor Wang Yong Attended the Unveiling Ceremony

Ⅲ. Talent Team

There are 563 Staff Members, Including 10 Research Centers and 6 Management Service Departments.

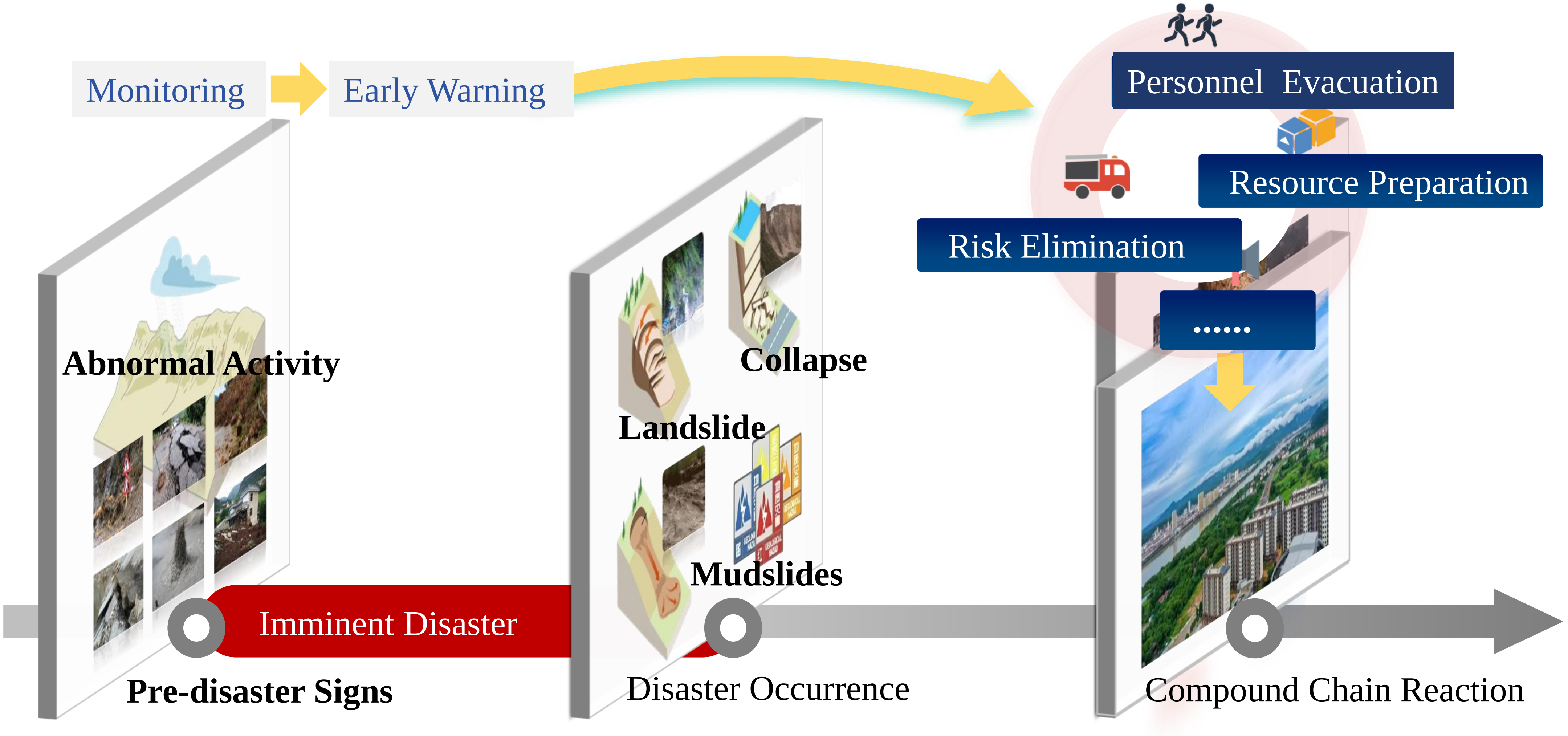
Leaders

- Academic Committee
- Science and Technology Committee
- Professional Title Evaluation Committee
- Degree Committee

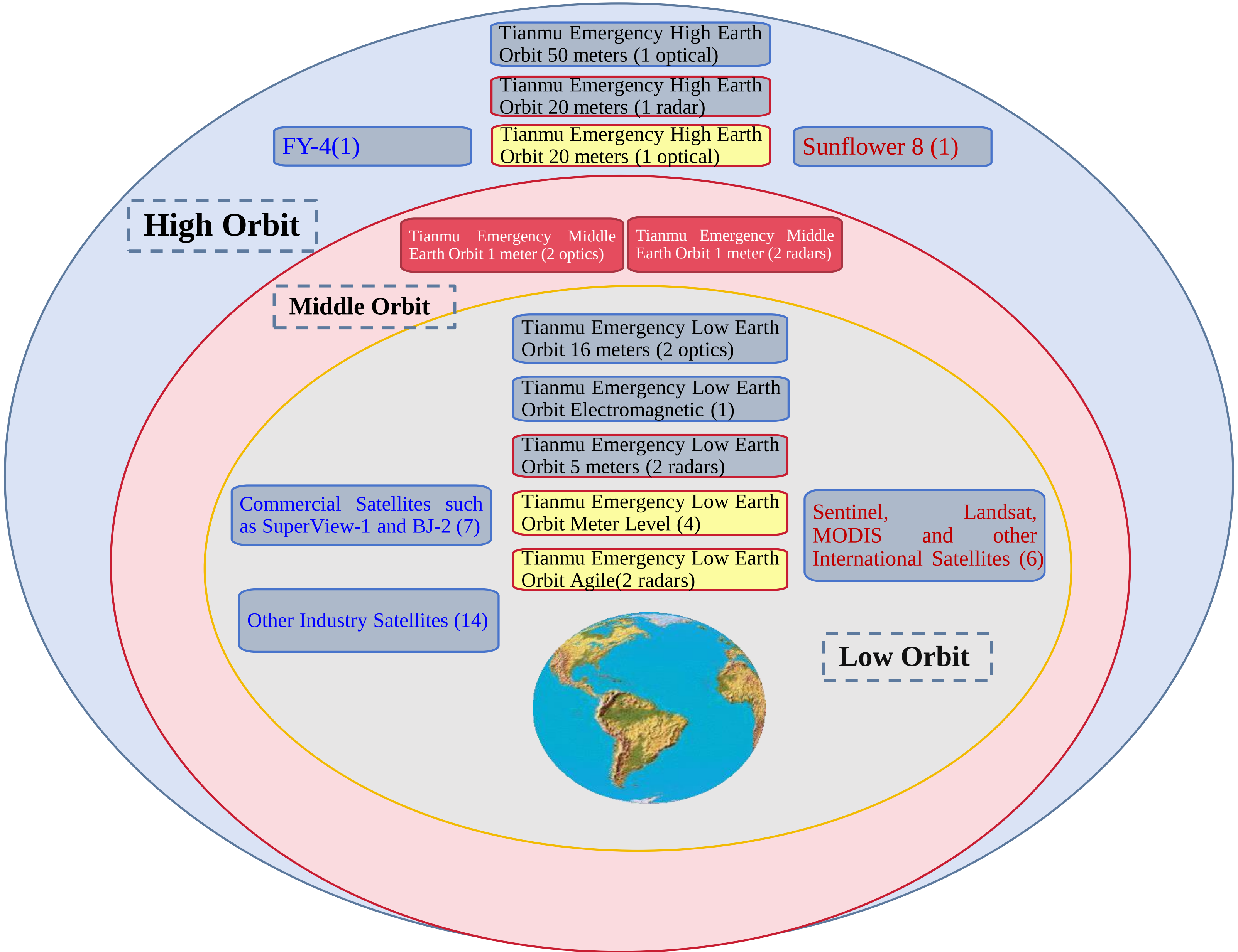
Office
Party and Mass Work Department
Personnel and Talent Department
Technology Cooperation Department
Planning and Finance Department
Comprehensive Service Center

Earthquake Disaster Research Center
Geological Hazard Research Center
Basic Science Research Center
Space Information Research Center
Strategic Planning Research Center
Rescue Equipment Research Center
Meteorological Disaster Research Center
Urban Disaster Research Center
Water and Drought Disaster Research Center
Forest Fire Research Center

Emergency Juncture Pre-position, Interrupt Disaster Chain Reaction, Reduce Disaster Losses

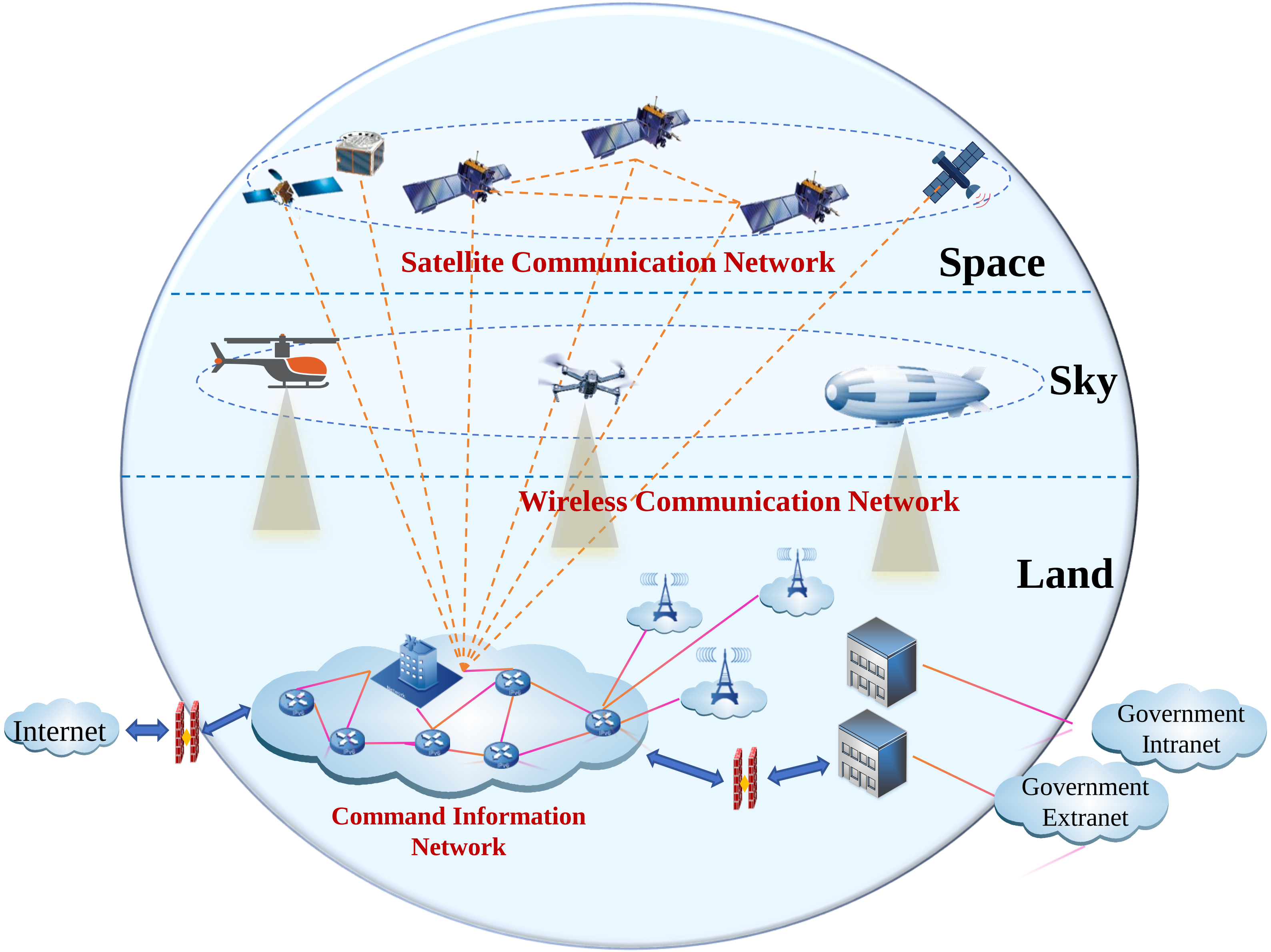


Ⅲ. Emergency Disaster Reduction Satellite Constellation



Ⅲ. Emergency Communication Network

Build an emergency communication network with "full coverage, comprehensive integration, and full connectivity", achieve "full coverage, regional enhancement, ubiquitous access, and on-demand service", and provide unified and efficient communication support for emergency rescue.



Ⅲ. Emergency Management Business

Object

- Natural Disasters
- Production Safety Accidents
- Comprehen-sive Prevention

Emergency Management Business

pre event → Incident occurred → During event → Post event

whole process management

- command
- monitor
- On duty

Normal situation

- monitoring and early warning
- risk assessment
- disaster prevention and control
- supervision and administration

Abnormal situation

- Disaster Report
- Disaster information release
- Emergency response
- Coordination and linkage
- Emergency dispatch
- Command rescue operations
- Resource Allocation
- Post disaster assessment
- Post disaster relief
- accident investigation
- Investigation and rectification supervision

Compre-hensive guarante

- laws and regulations
- Preparation, management, and drills of contingency plans
- Equipment and material management
- team management
- Infrastructure
- Statistical analysis of emergency management
- Government activities
- international exchanges and cooperation
- publicity and education
- Construction of Science and Technology Informatization

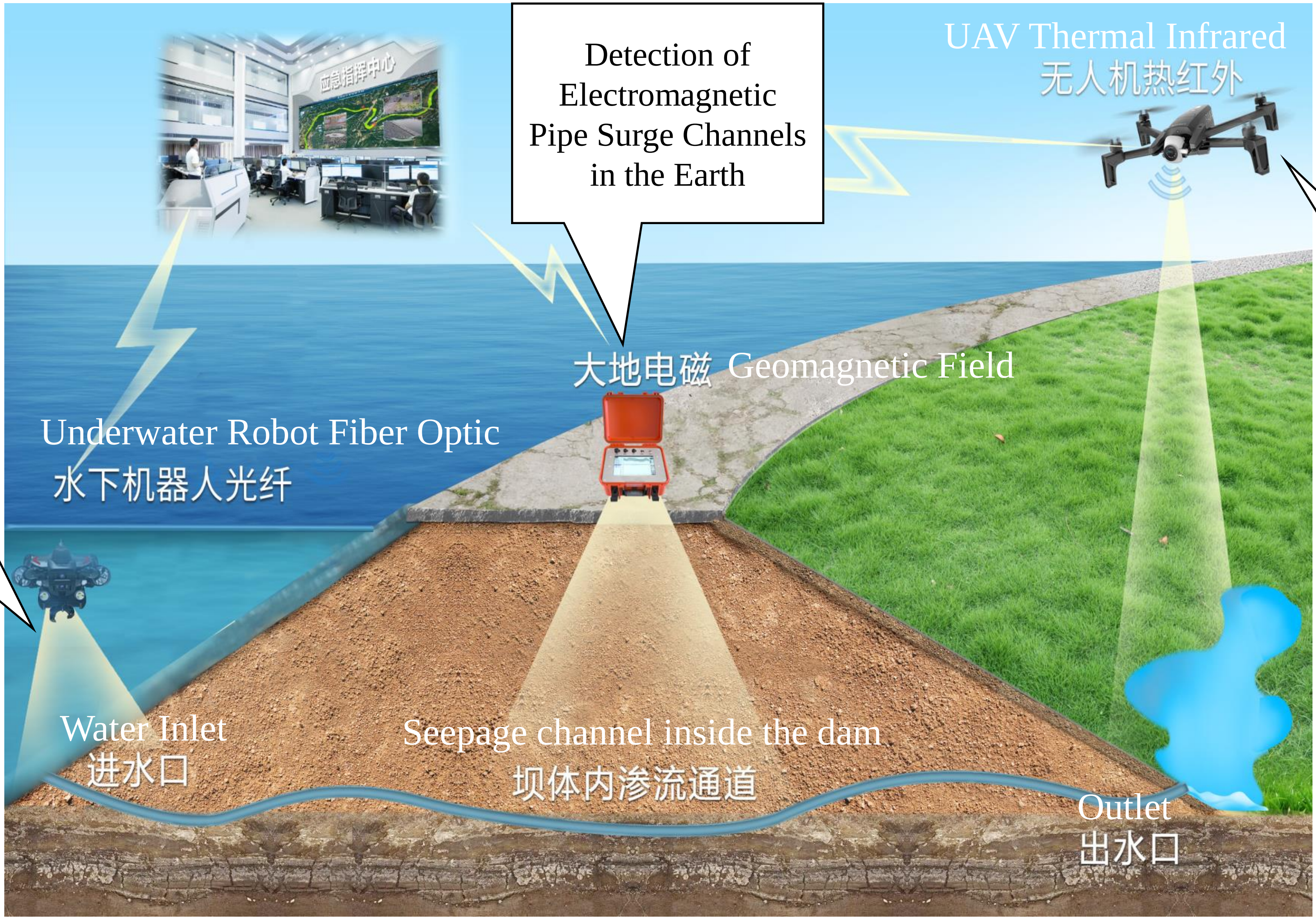
External Collaboration

- The People's Liberation Army and the Armed Police Force
- National Development and Reform Commission
- Ministry of Public Security
- Ministry of Natural Resources
- Ministry of Ecology and Environment
- Ministry of Housing and Urban-Rural Development
- Ministry of Transport
- Ministry of Water Resources
- Ministry of agriculture and rural affairs
- Health Commission
- State Administration for Market Regulation
- China Meteorological Administration
- ......

Around pre event, incident occurred, during event, and post event, there are a total of 4 categories, 28 subcategories, and 90 business items.

Ⅲ. Monitoring of Dam Pipe Surge - Basic Principles

Fiber optic acoustic waves and underwater robot sonar detection of pipe inlet



Detection of Electromagnetic Pipe Surge Channels in the Earth

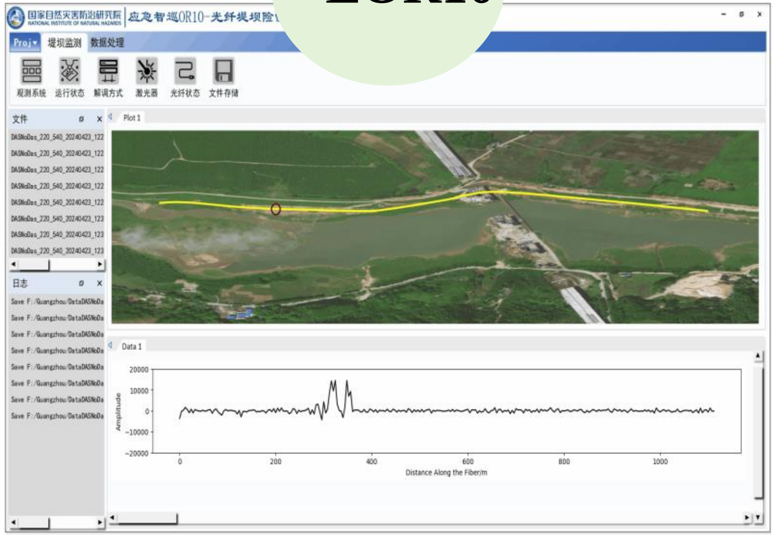
UAV inspection of pipe leakage points

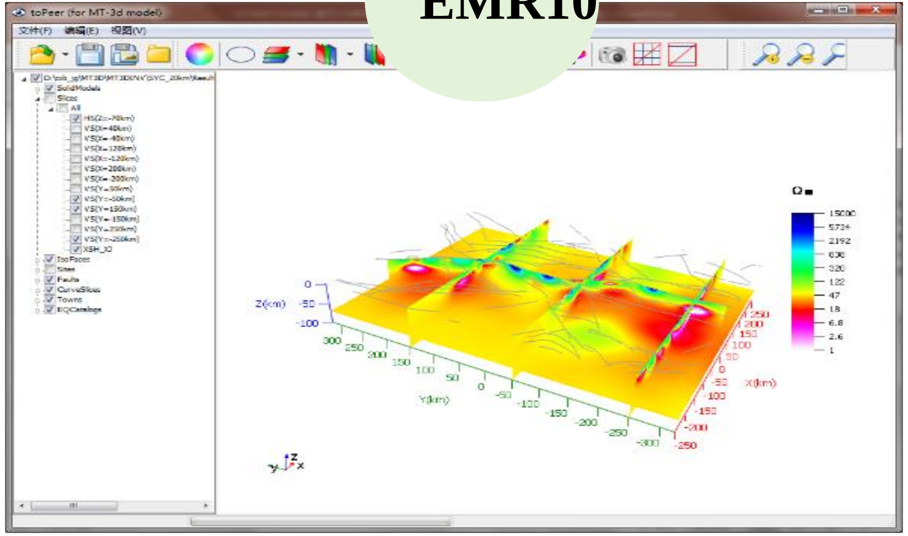
Ⅲ. Monitoring of Dam Pipe Surge - Technical Equipment

EAR10

EOR10

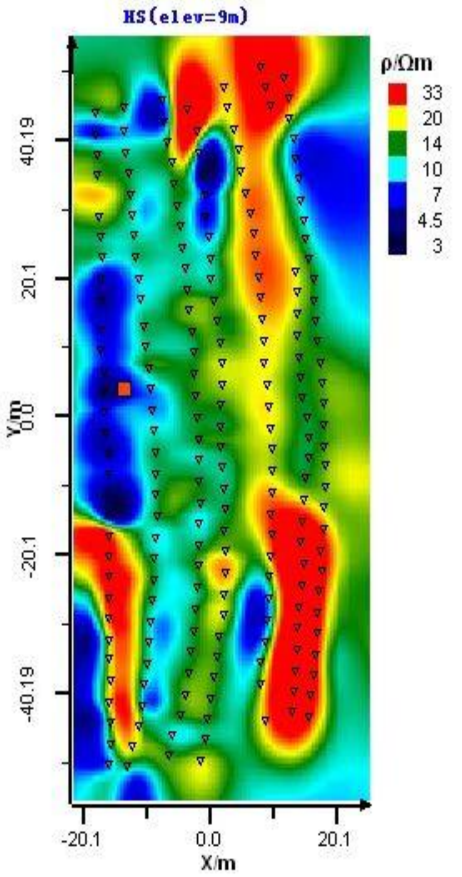
EMR10





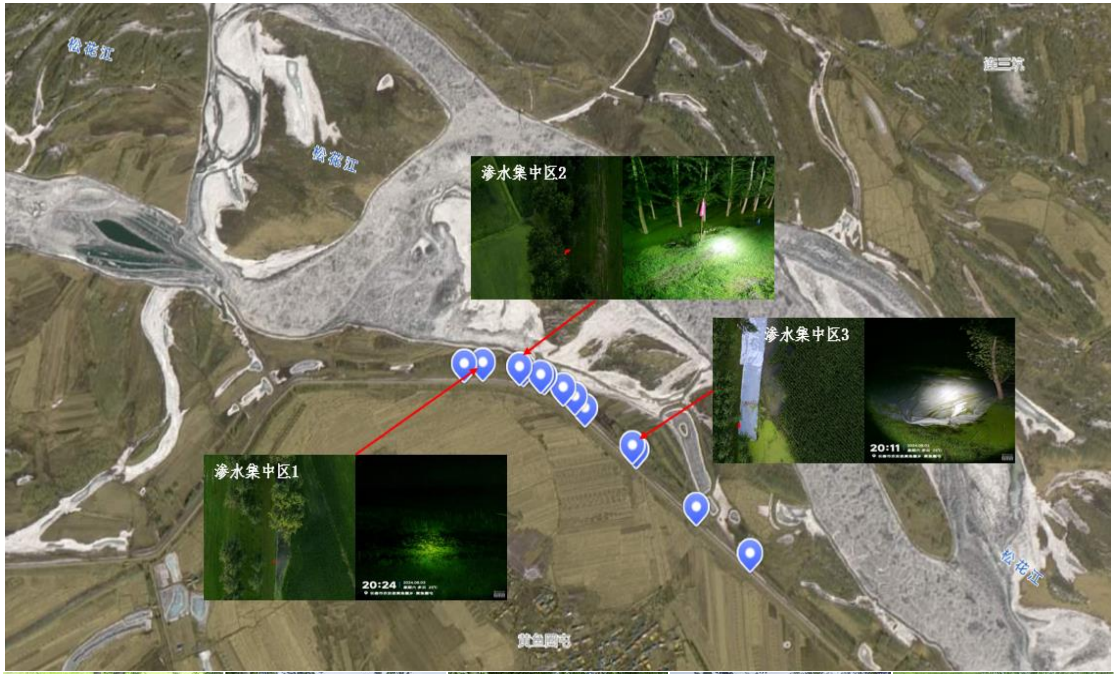
Ⅲ. Monitoring of Dam Pipe Surge - Practical Case 1

On July 5, 2024, a major breach occurred in the Dongting Lake embankment of Tuanzhouyuan in Huarong County, Yueyang City. A patrol was conducted on the 15 kilometer embankment of Qiantuanjian, 19 hazards were confirmed, with 26 monitoring points, 4 potential inlets, and 2 suspected leakage channels identified.



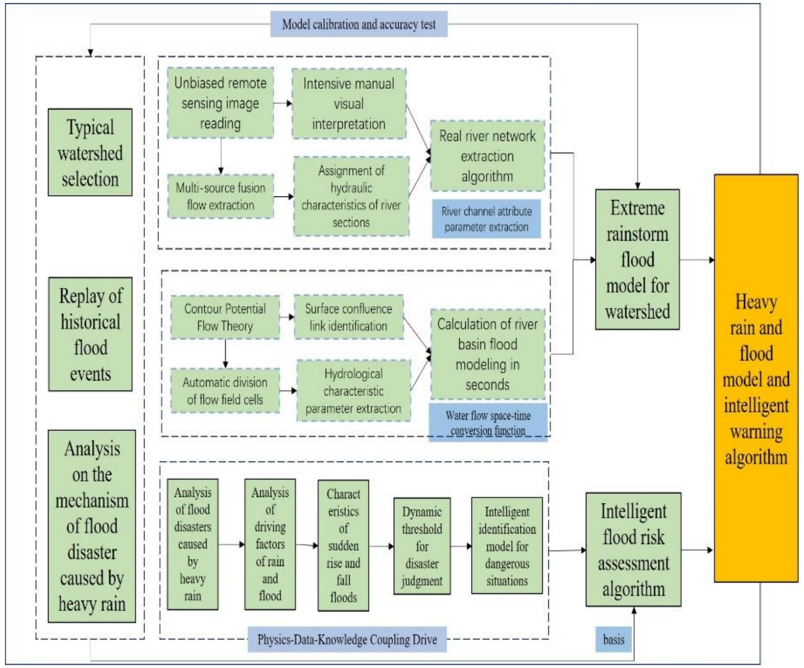
Ⅲ. Monitoring of Dam Pipe Surge - Practical Case 2

On August 3, 2024, Jilin encountered a flood hazard, and focused on inspecting the main stream of the Songhua River in Dehui and Nong'an in Changchun City and Ningjiang and Qianguo sections in Songyuan City. After five consecutive days of inspection, a total of 19 pipe bursts, 33 seepage points, and 1 collapse were found and confirmed, and 8 suspected water inlets were discovered.

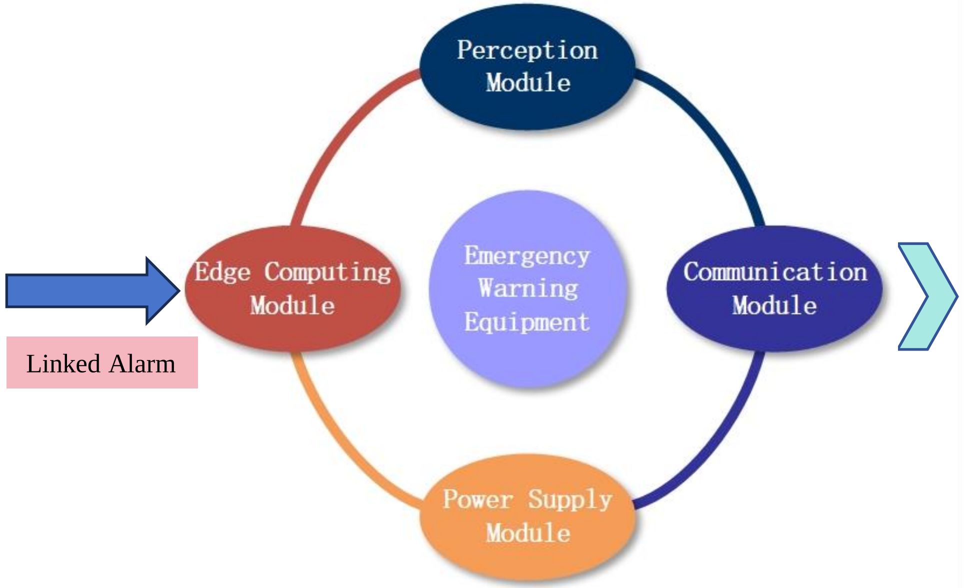


Ⅲ. Mountain Torrents Telemetry Alarm - Basic Principles

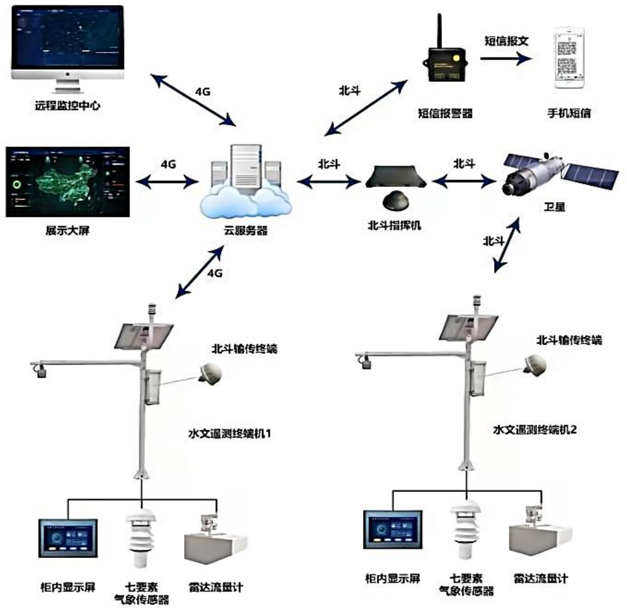
Technical Principle: **Non-contact integrated telemetry, Beidou/4G multi-mode communication, single station intelligent alarm based on edge computing, and multi station joint prevention and control of the self-organized network to achieve accurate intelligent alarm in the "Three off" environment.**



Intelligent alarm model algorithm



Emergency telemetry alarm integrated equipment



"Three off" emergency telemetry alarm system

Ⅲ. Mountain Torrents Telemetry Alarm - Technical Equipment

Sensor Hardware

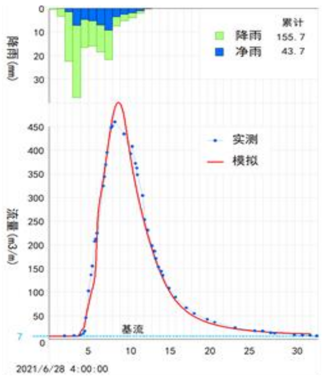
- Radar rain sensor
- Ambient temperature and humidity sensor
- Air pressure sensor
- Total radiation sensor
- Ultrasonic wind speed and direction sensor

Radar water level and flow rate sensor (built-in cross-sectional flow algorithm)

- **Radar rain measurement and non-contact flow measurement solve the problem of easy destruction and failure of traditional monitoring equipment**
- **Combines meteorological, hydrological and video and other multi-factors to synchronize telemetry and support real-time risk assessment at the front end**

Data Transmission Terminal

Model Algorithm Software

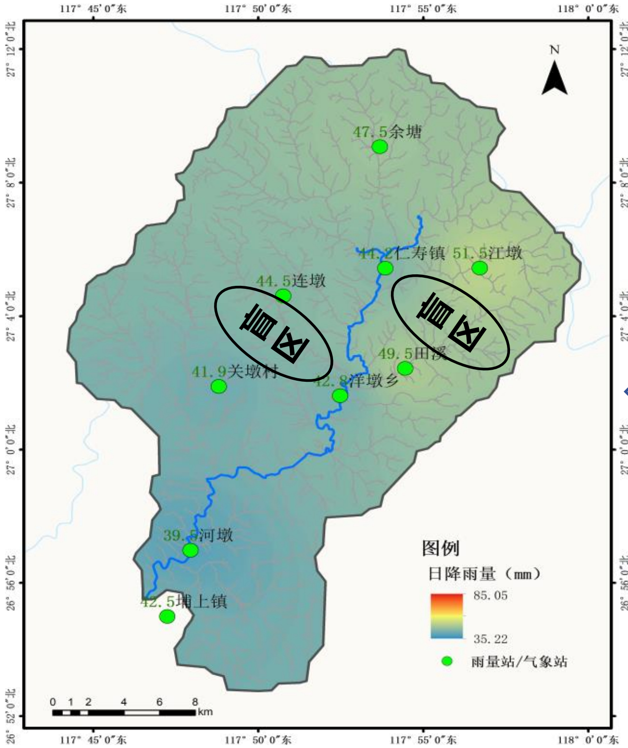


Single-station flood rise and fall simulation

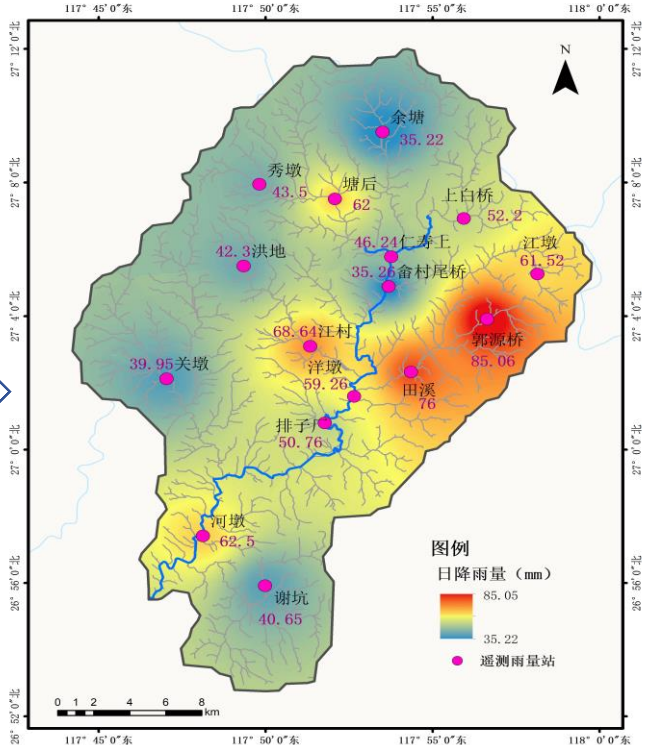
Multi site distributed simulation algorithm

Ⅲ. Mountain Torrents Telemetry Alarm - Practical Case

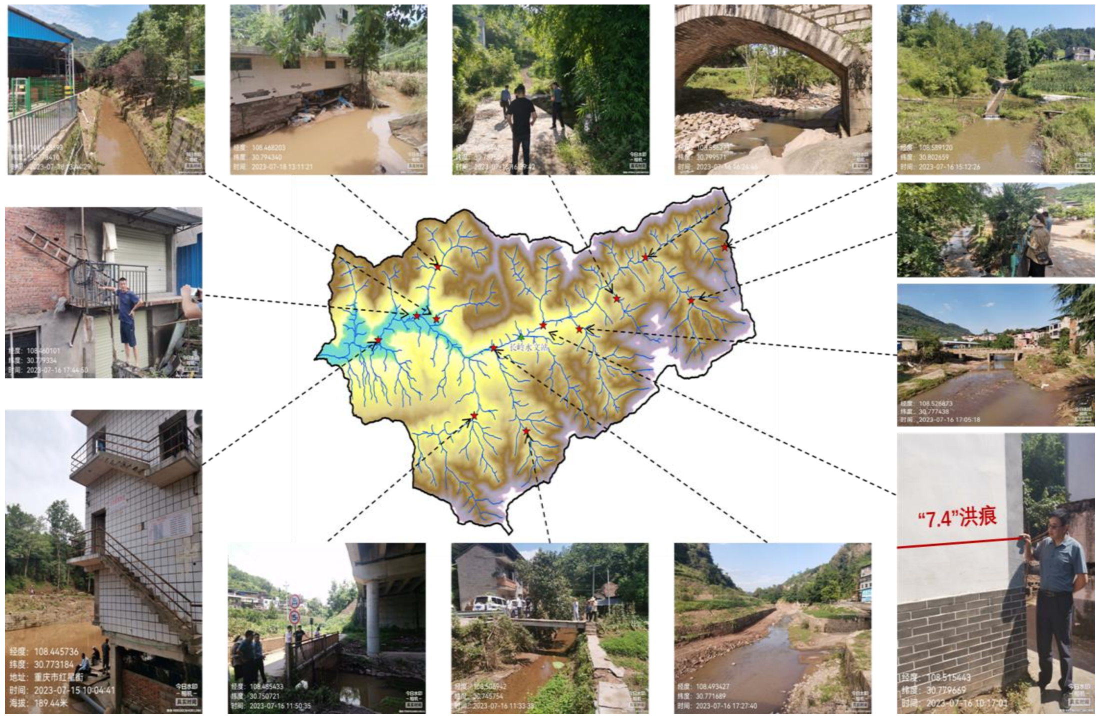
Pilot Construction: Currently, 65 telemetry alarm stations have been deployed in Fujian, Guizhou and Chongqing, including 10 stations integrated with towers. Single station alarms are 30 minutes in advance, and upstream and downstream linkages are 40 minutes in advance.



Traditional weather station rainfall monitoring

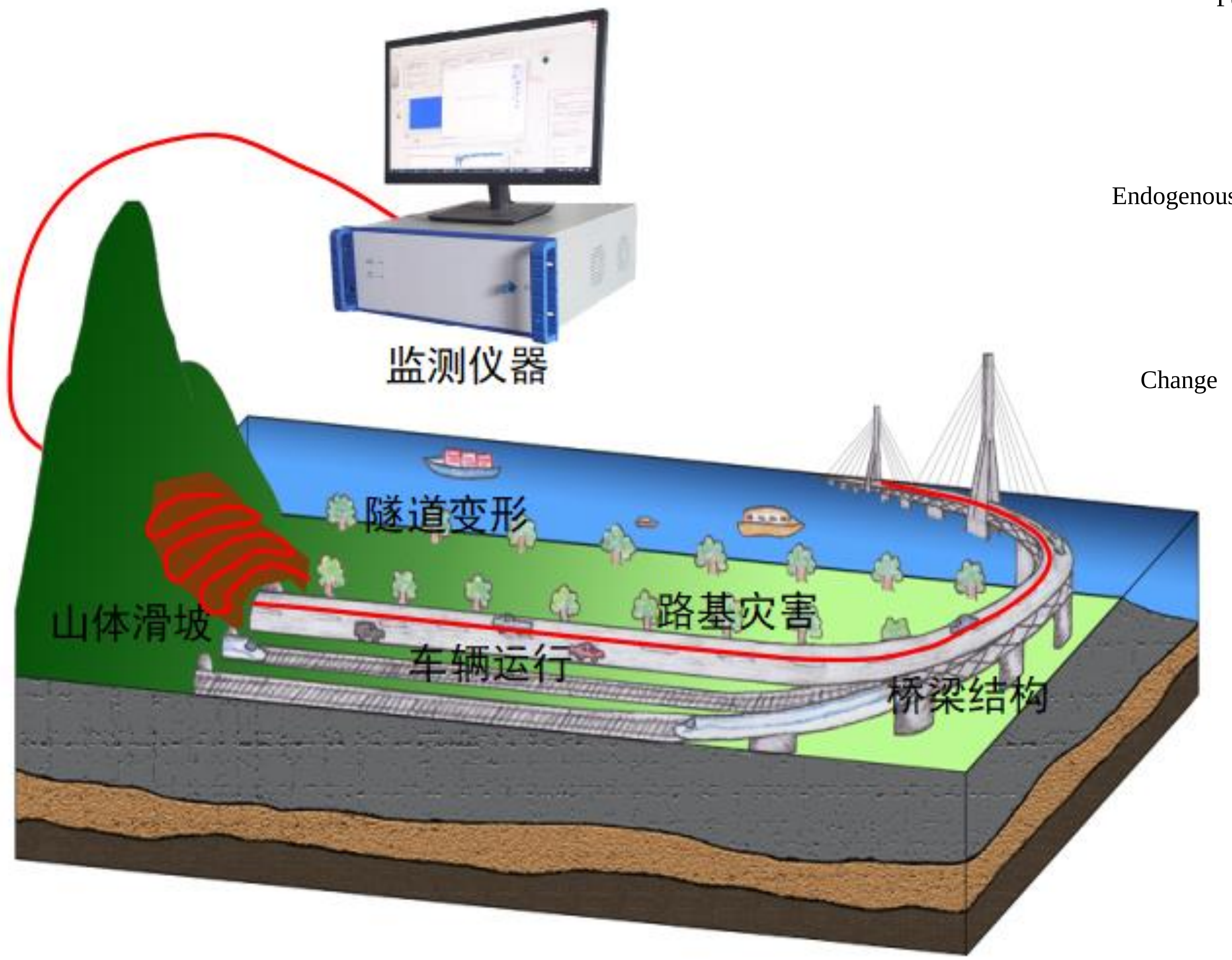


Remote sensing warning station rainfall monitoring (Shunchang pilot)

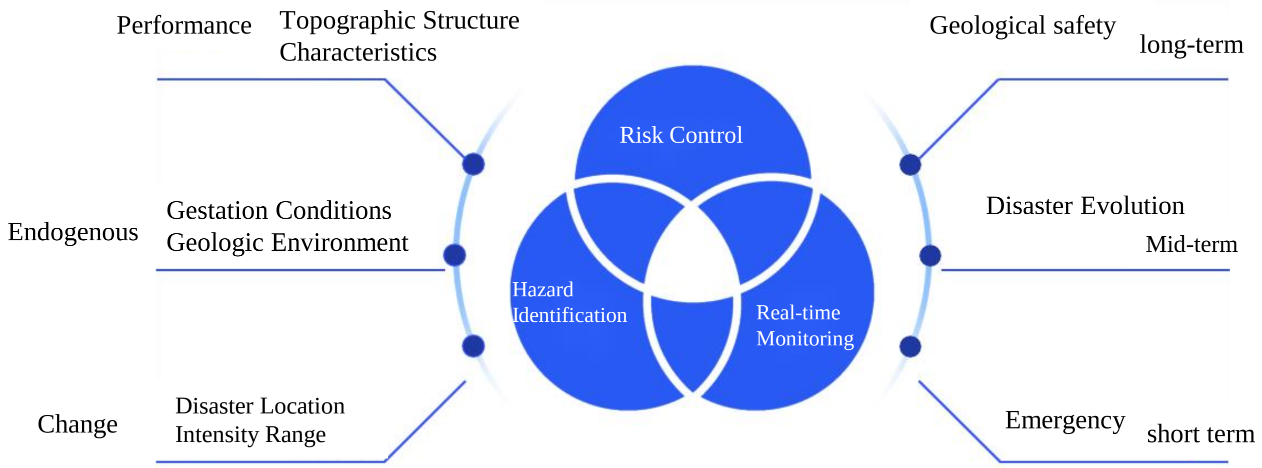


Flood survey and site layout in Wuqiao small watershed (Wanzhou pilot)

Ⅲ. Traffic Facility Monitoring - Basic Principles



Intelligent fiber optic monitoring system for smart highways throughout the entire life cycle



Theory of "Intelligent Traffic Monitoring"

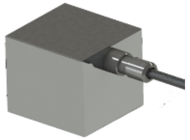
Ⅲ. Traffic Facility Monitoring - Technical Equipment

Chip-level sensing, full-spectrum demodulation, integrated storage and computing, and intelligent interpretation meet the needs of long-distance, large-span, and complex environmental disaster monitoring.

Fiber Bragg Grating demodulator

Temperature

Flexibility



Vibration

Pressure

Tilt

Stress

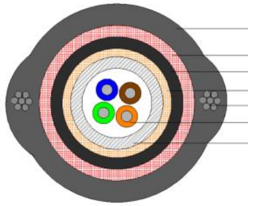
Earthquake

Distributed Acoustic Sensing(DAS)

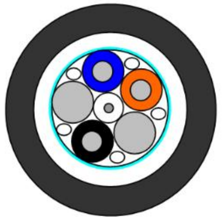
Brillouin Optical Time Domain Analysis(BOTDA)

Distributed Temperature Sensing System (DTS)

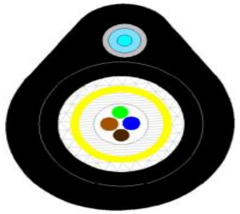
Portable Fiber Optic Sensing Demodulator(FBG)



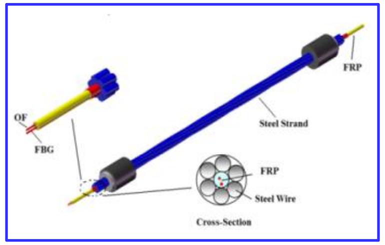
High sensitivity sensor



Multi-parameter sensing



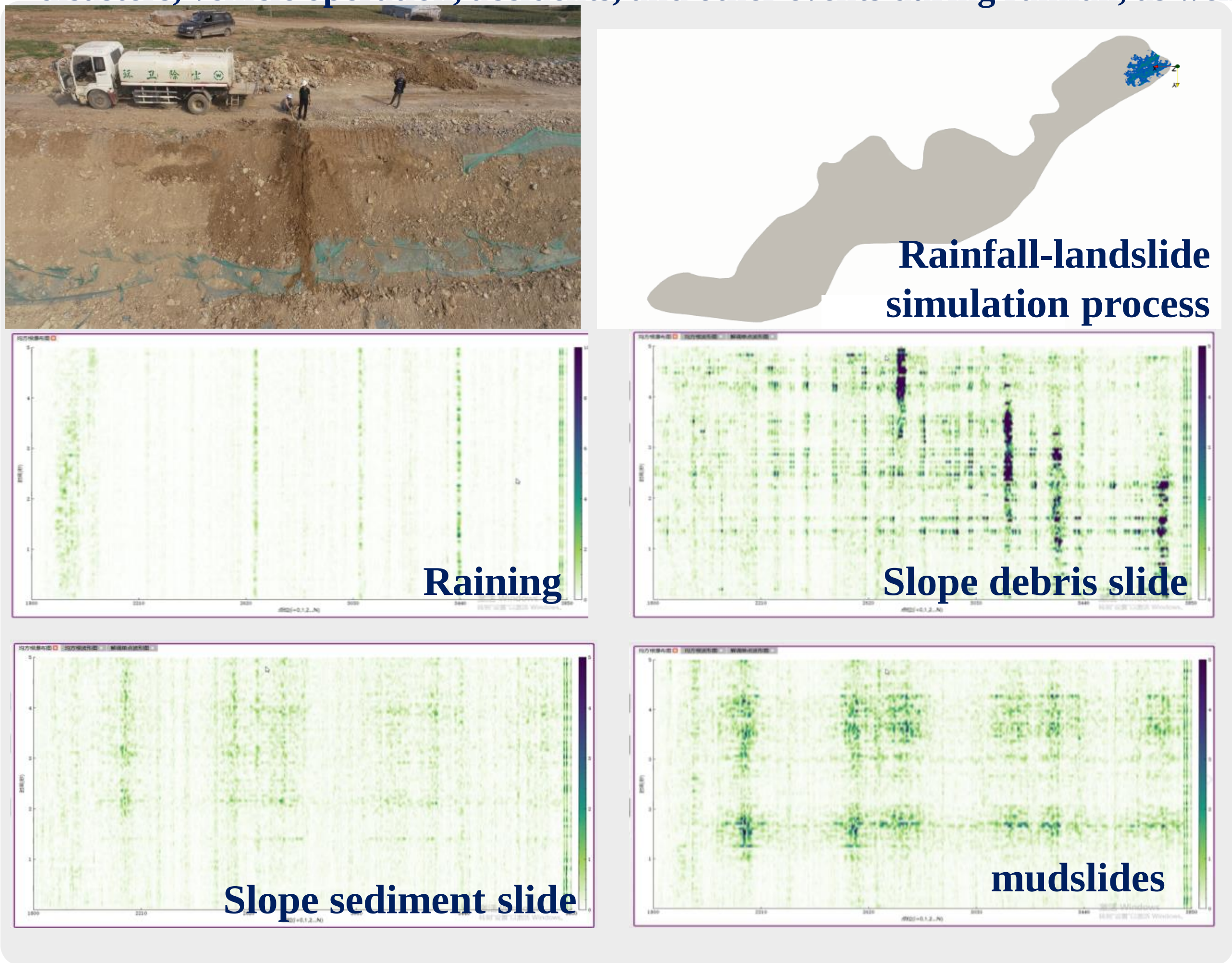
Structural Optimization Sensing



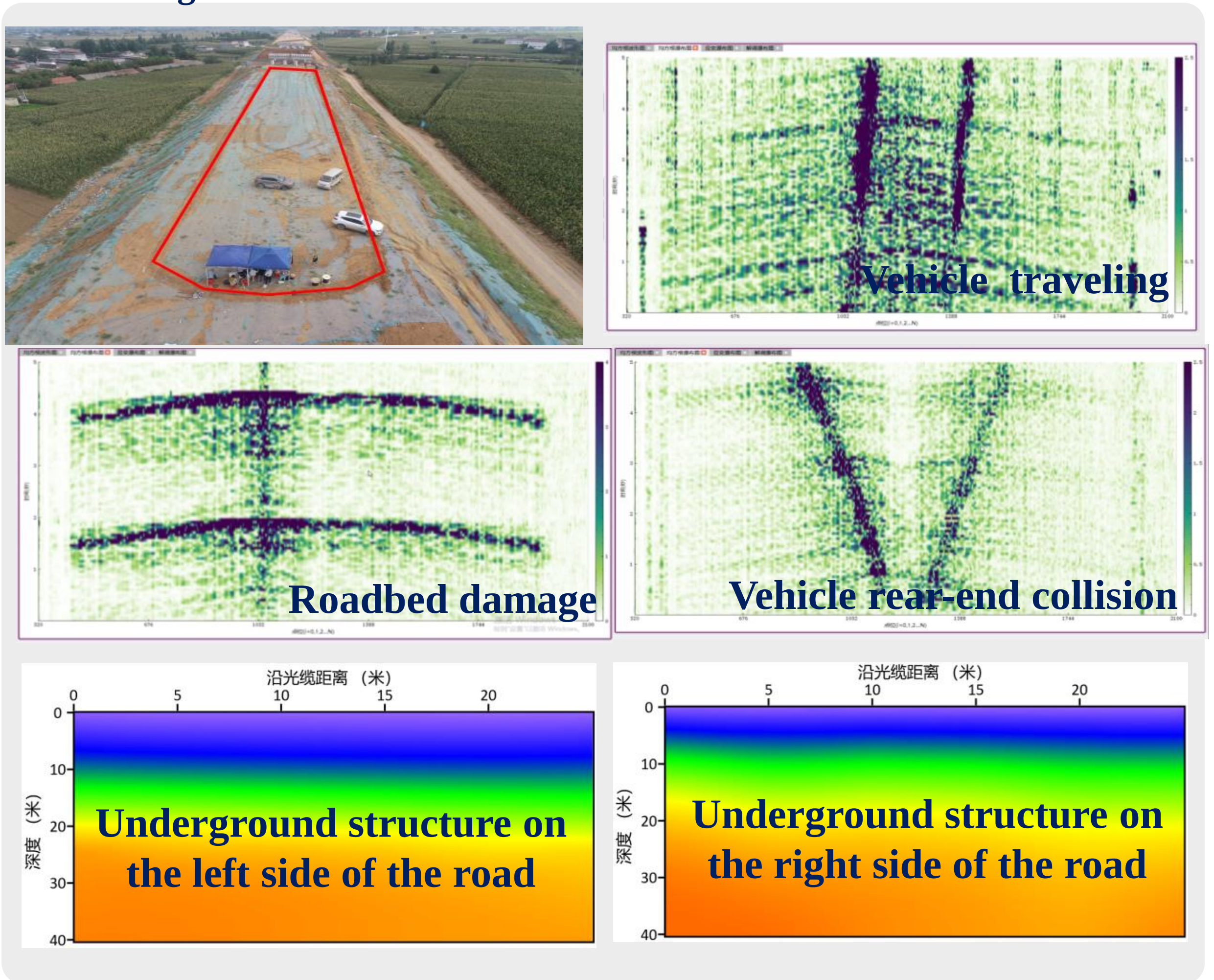
New material sensing

Ⅲ. Traffic Facility Monitoring - Practical Case 1

Distributed fiber optic acoustic, vibration, and strain equipment are installed on the Anhe Expressway under construction, and real-time monitoring system tests are carried out to monitor high slope disasters, roadbed safety, and vehicle operation trajectories during rainfall, so as to accurately identify landslide disasters, vehicle operation, accidents, and other events during rainfall, as well as the underground structure of the roadbed.



High slope monitoring



Road Monitoring

Ⅲ. Traffic Facility Monitoring - Practical Case 2

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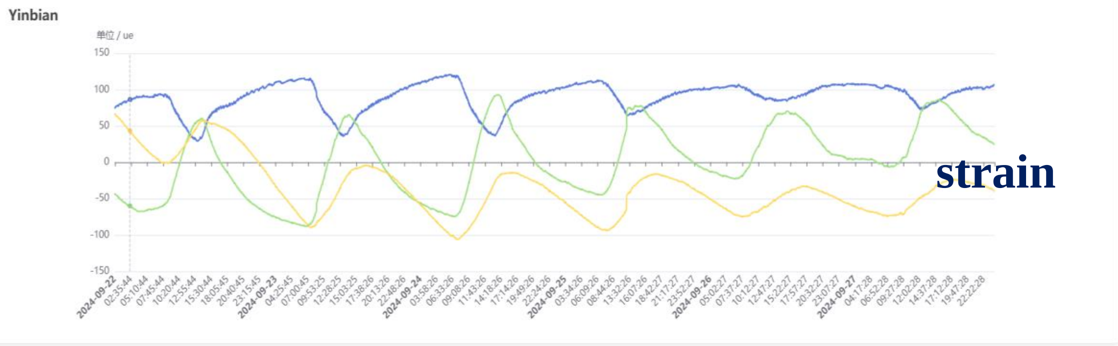
A geological disaster optical fiber monitoring and early warning system is installed on the high slope at the entrance of Xiaobaiyu Tunnel on the Anhe Expressway under construction. The safety of the slope is monitored in real time based on parameters such as slope surface displacement, three-dimensional strain in the slope, and soil pressure in the slope.

Fiber Optic Monitoring and Early Warning System for High Slope at the Entrance of Xiaobaiyu Tunnel

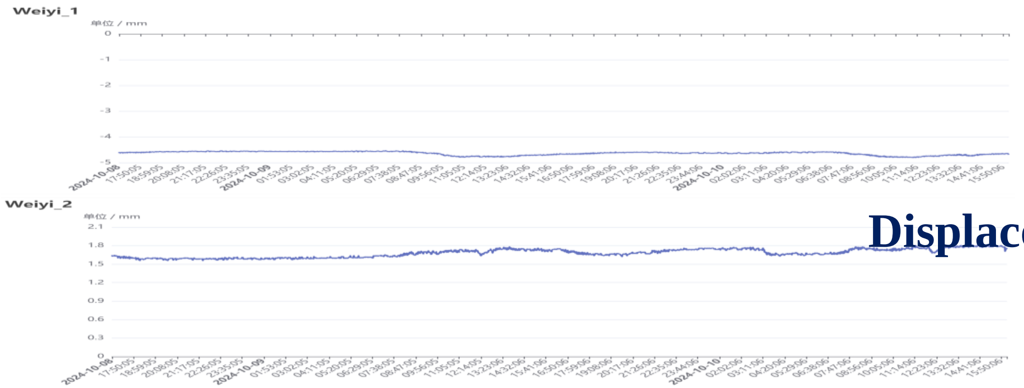
光纤土压力计 光纤三维应变计 光纤位移计

Geological disaster optical fiber monitoring and early warning system

Pressure



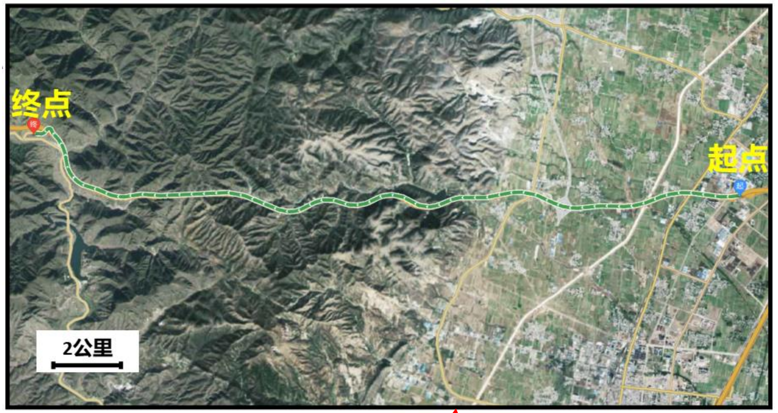
strain

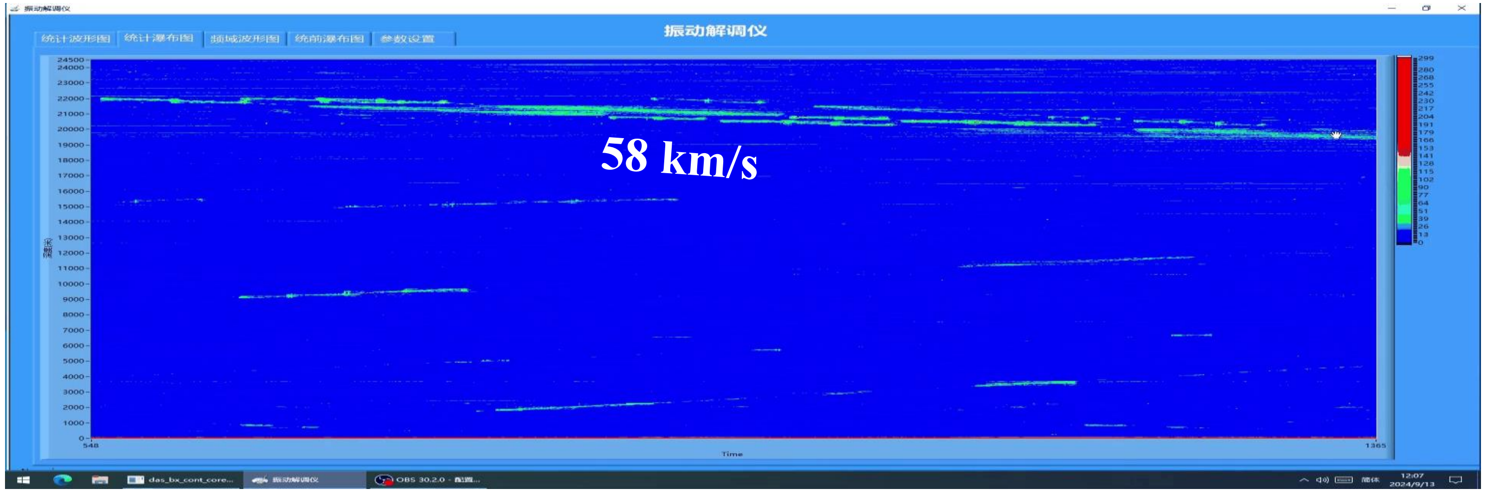


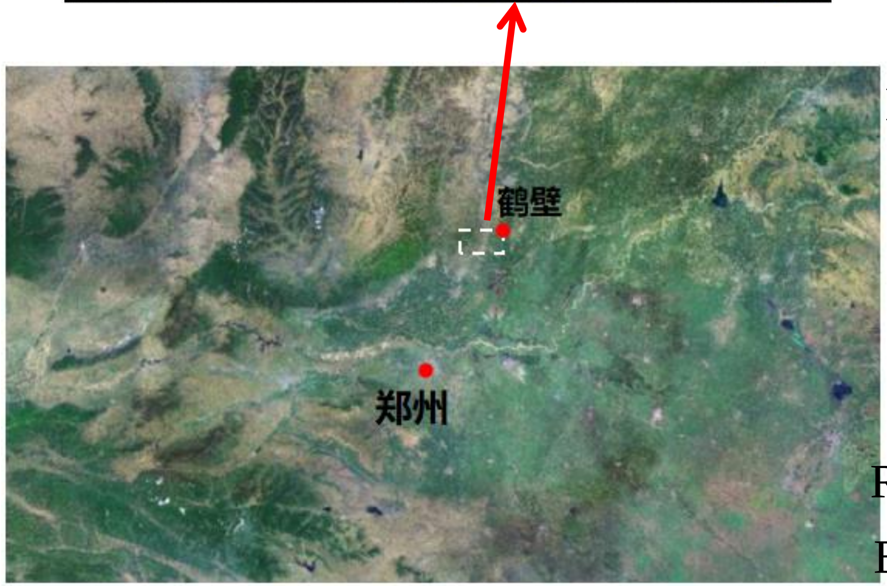
Displacement

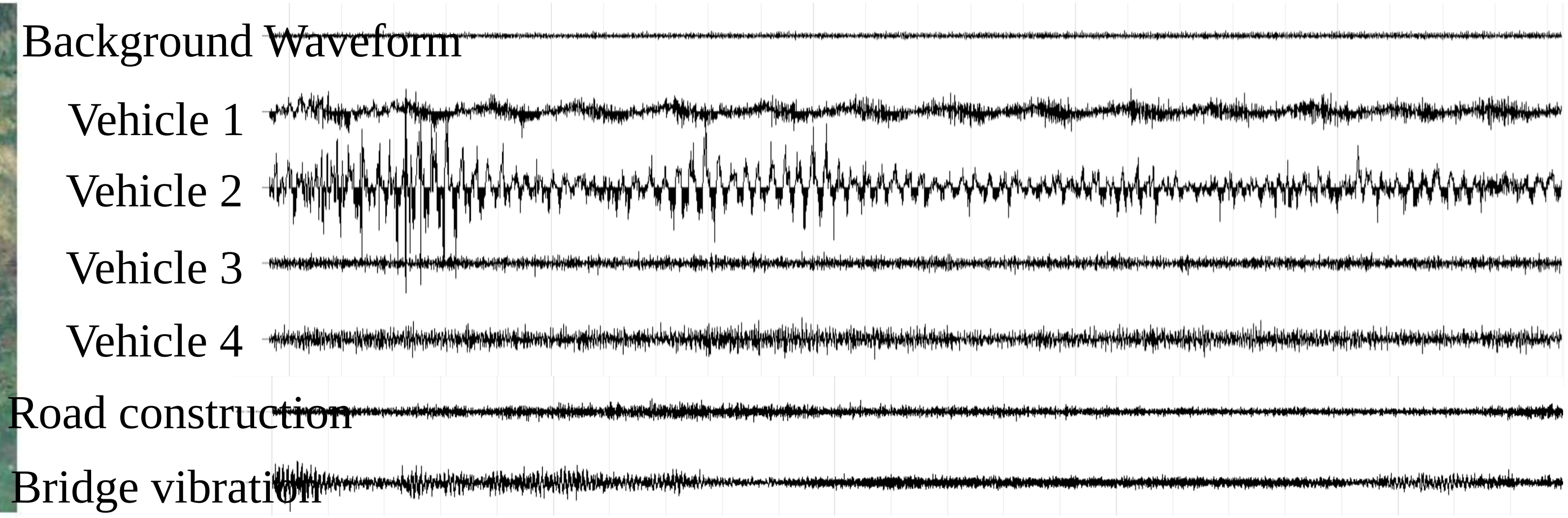
Ⅲ. Traffic Facility Monitoring - Practical Case 3

An intelligent fiber optic real-time monitoring system is deployed on Taihui Expressway to carry out real-time monitoring of road safety and operational safety, and to identify vehicle operation trajectory and speed, bridge status and road construction location.









An intelligent optical fiber real-time monitoring system is deployed on Taihui Expressway to carry out real-time monitoring of the safe operation of roads, bridges, tunnels, etc. based on comprehensive observation and data analysis of multiple parameters. It can identify the safe operation status of the highway, construction locations, and vehicle trajectories.

Real-time Monitoring Results of the Monitoring System

THANK YOU