National Applied Research Laboratories Taiwan

FLOOD MITIGATION GRID IN TAIWAN

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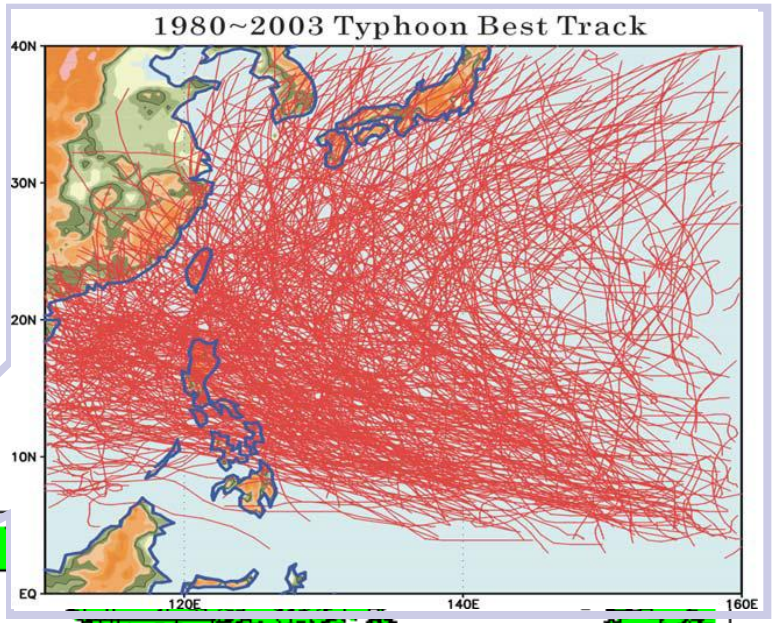
Outline

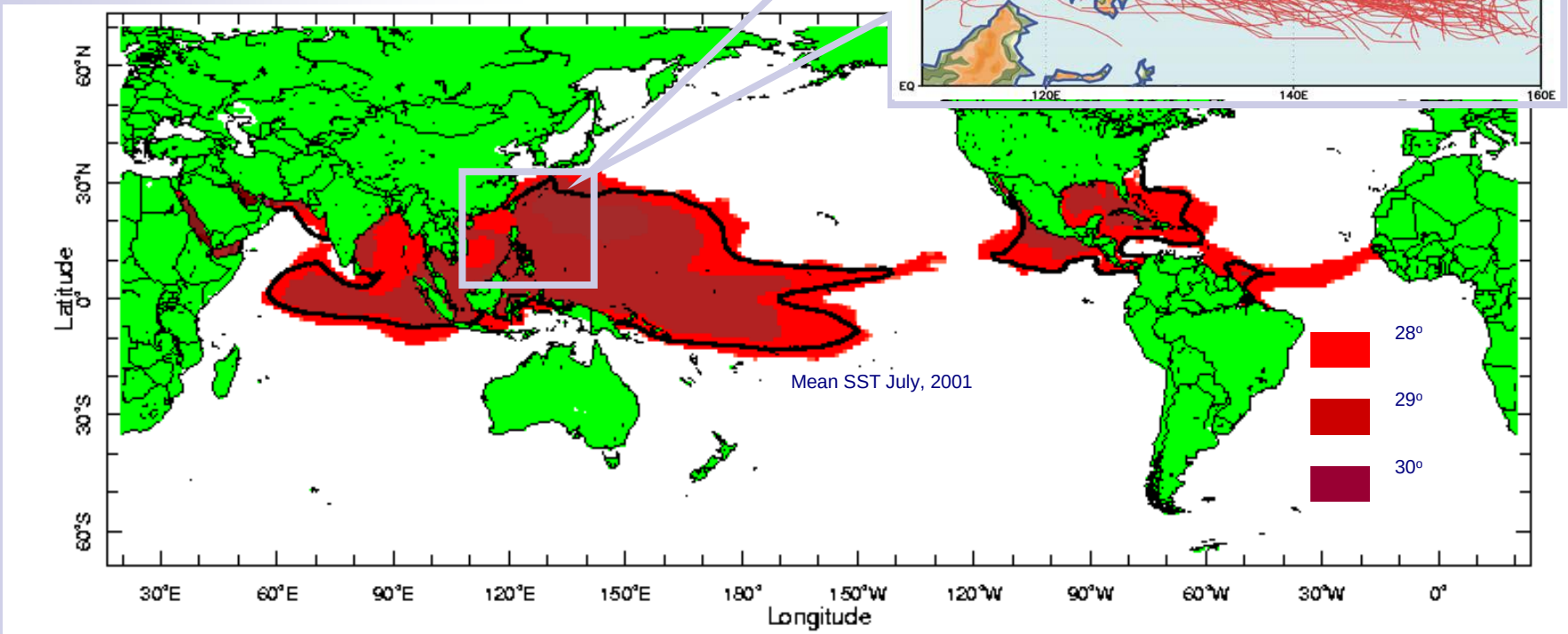
- **Typhoon & Flood in Taiwan**
- **Flood Mitigation Grid in Taiwan**
  - Human Centric Cyberinfrastructure
  - Co-life Collaborative & Communication System
  - Flood Forecast System
  - Flood Monitoring Sensor Network
  - 3D GIS Taiwan Platform
- **Demo from Taiwan**
- **Summary**

Hydrometeorology Challenges

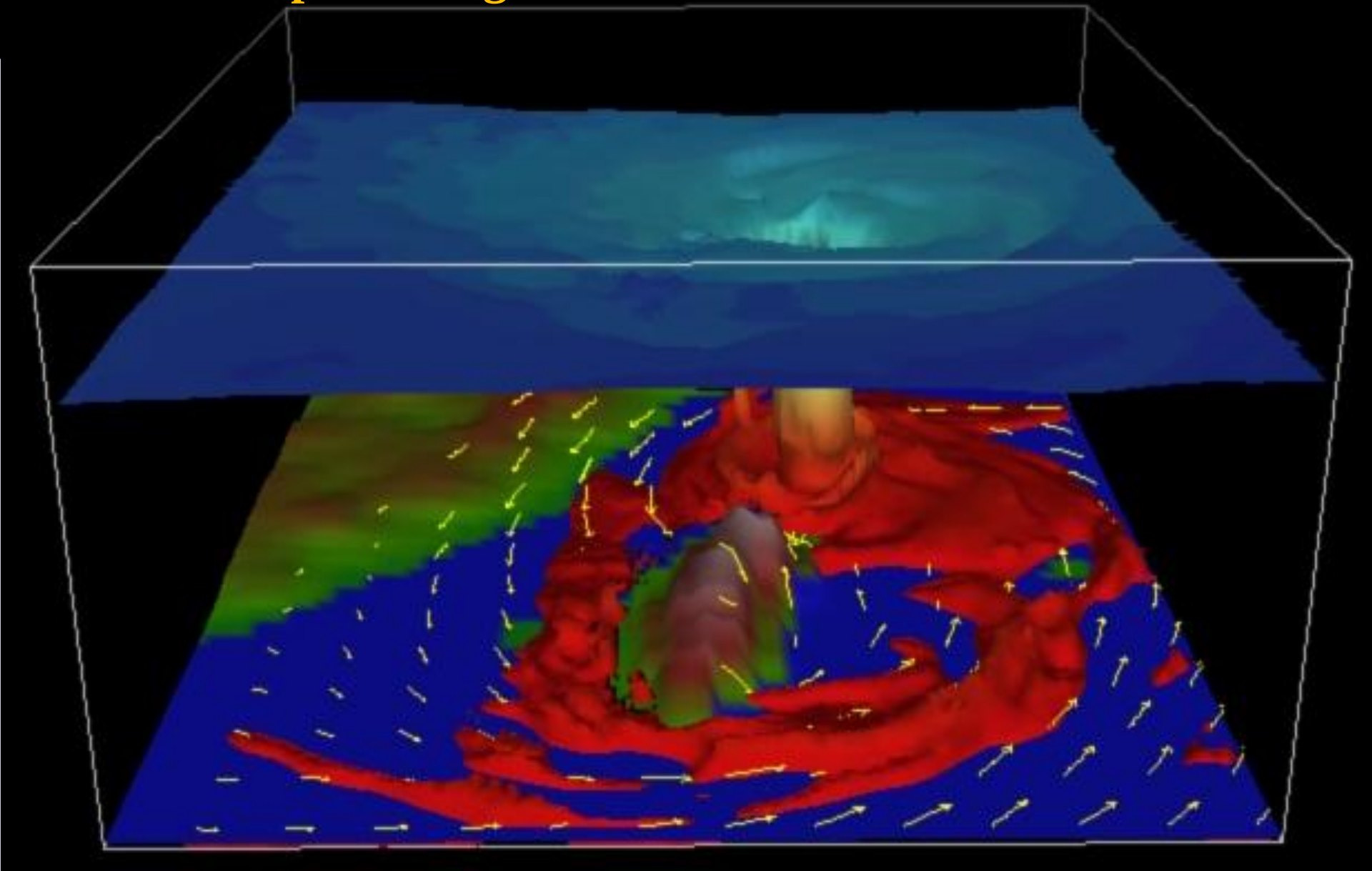
On the average, Taiwan is struck by 3.5 typhoons/year

Warm NW Pacific sea surface temperature produces the highest Typhoon Maximum Potential Intensity on earth.



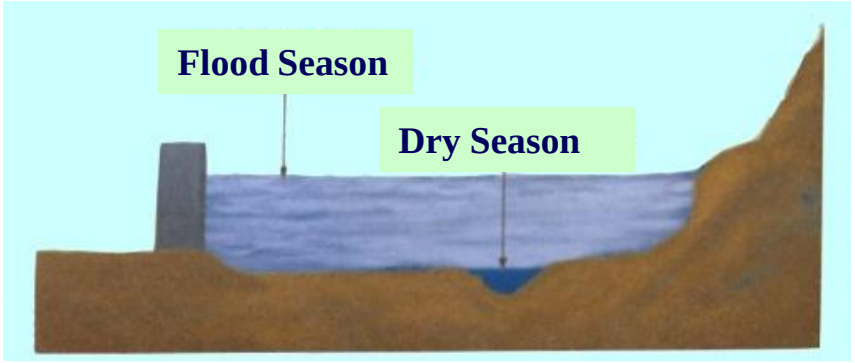


Diameters of typhoon may be Larger than the length of Taiwan Island, which means the circulation is unblocked and can keep drawing moist air from sea surface

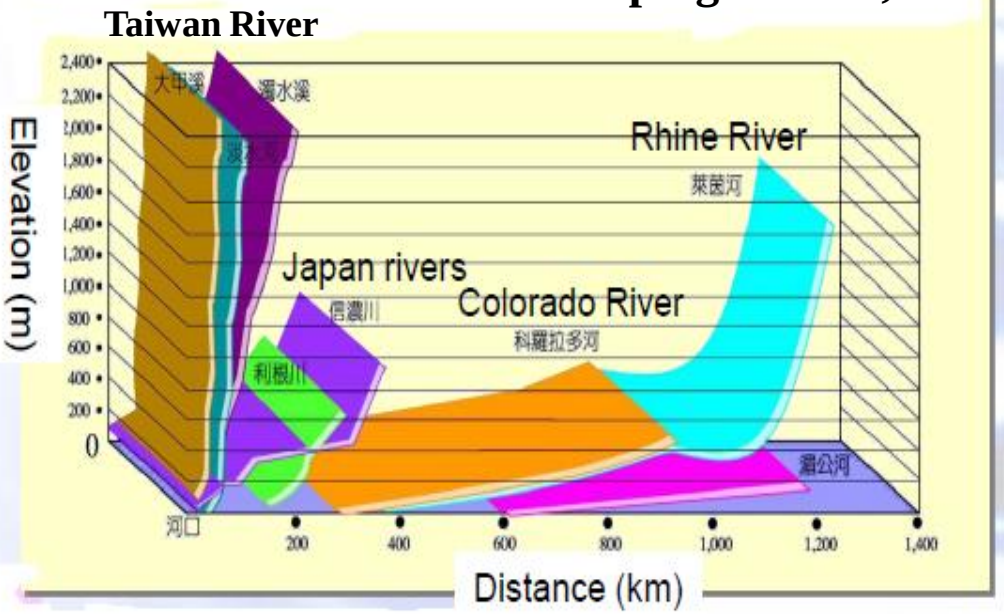


Flash Flood in Taiwan

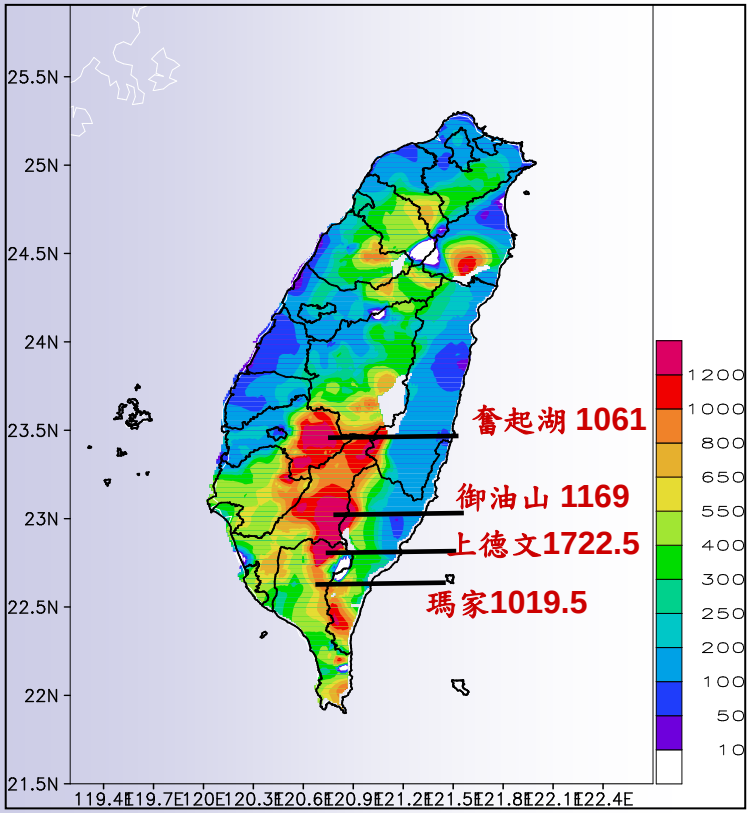
- River with steep slope feature
- Typhoon-induced rainfall

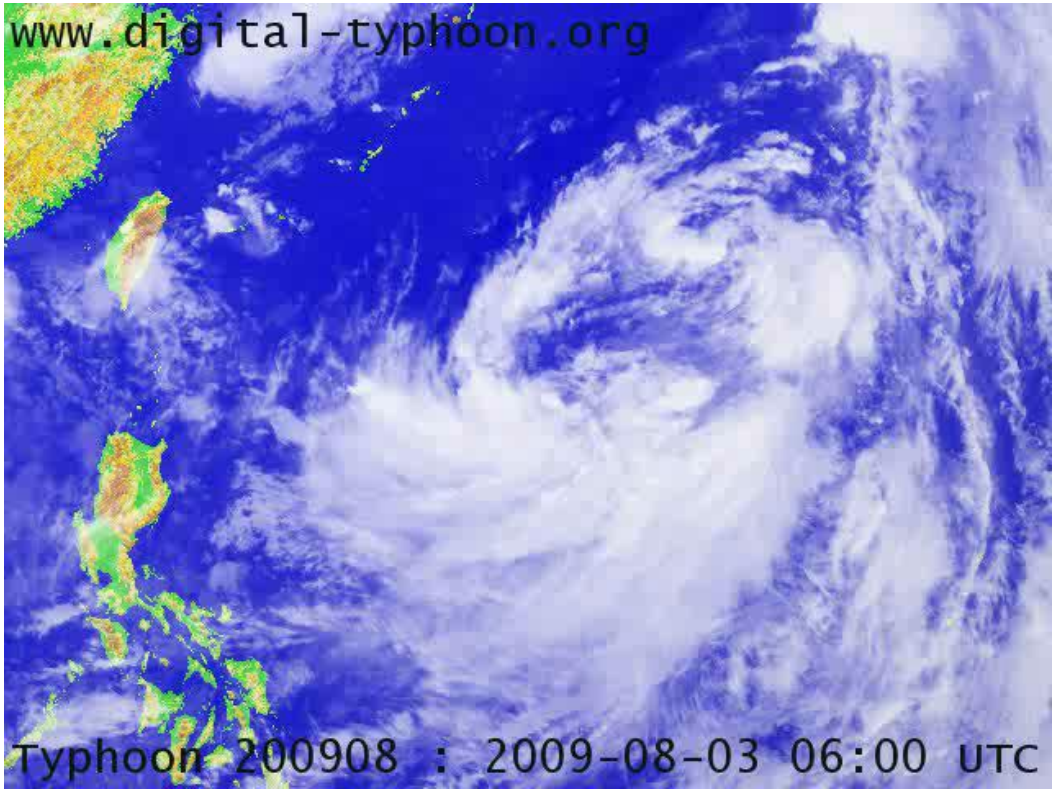


- **Only 6 rivers longer than 100 KM;**
- **the longest Jhuoshuei River 186.4 KM**
- **Maximum Watershed Kaoping River 3,257 K²**



Typhoon Morakot 2009

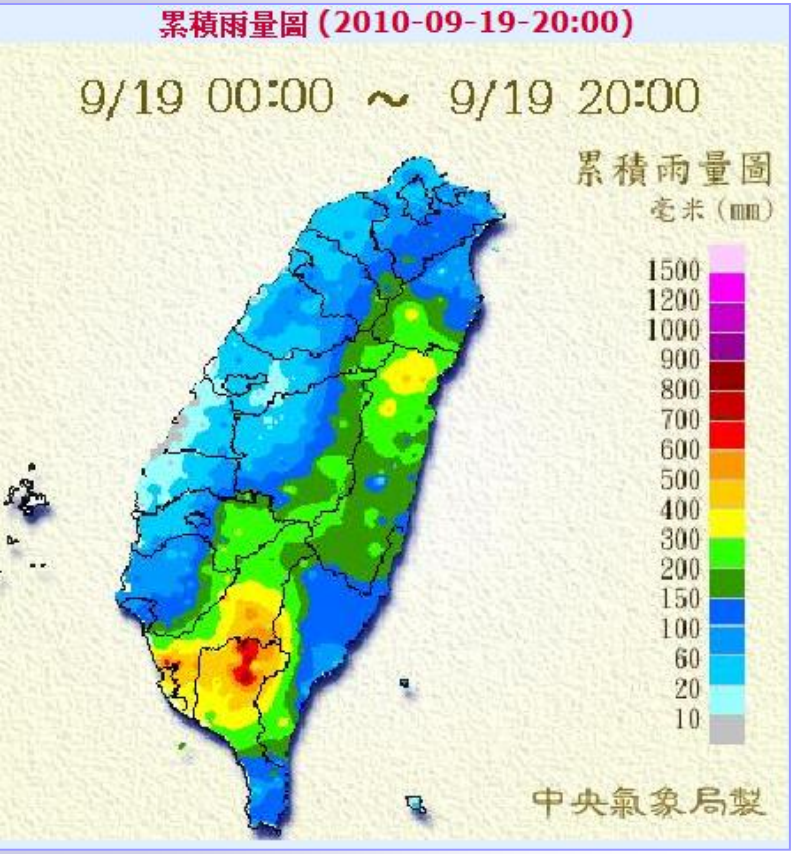


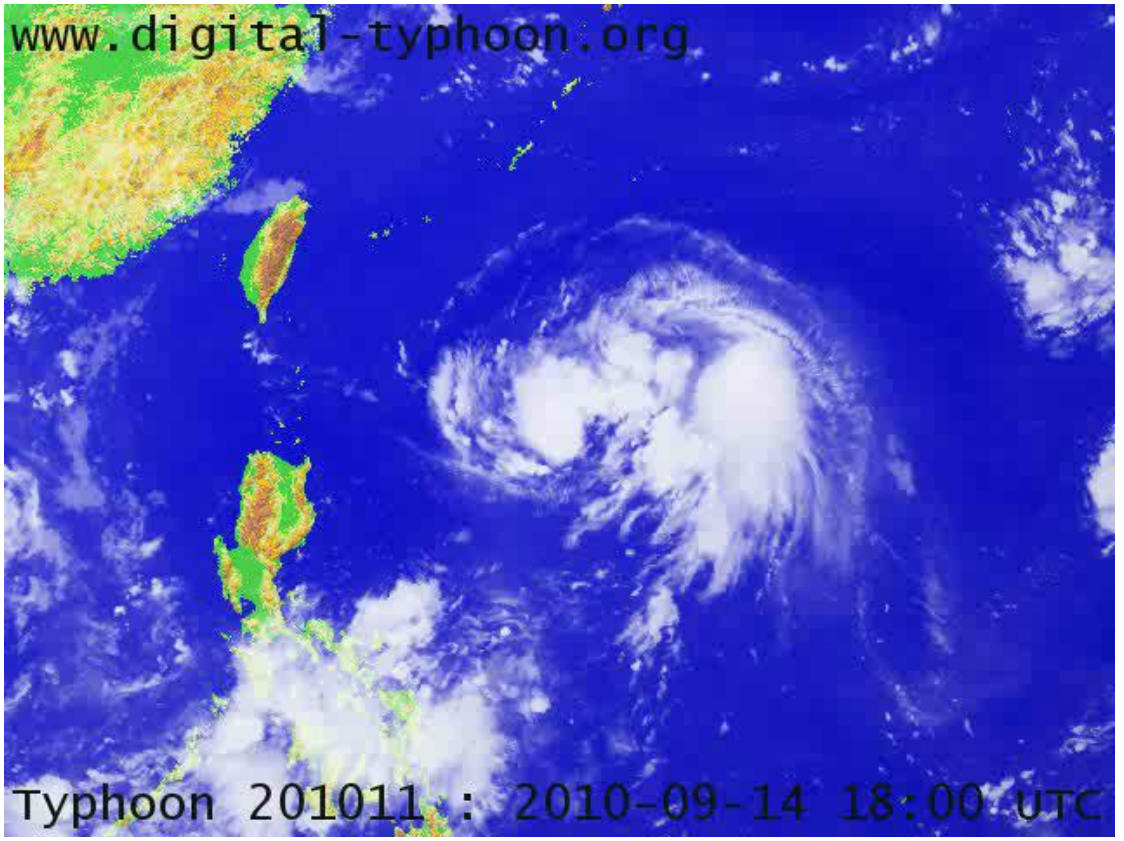


Accumulated Precipitation 2500 mm in Southern Taiwan, a historical record, caused serious inundation and landslide

Source: JWA

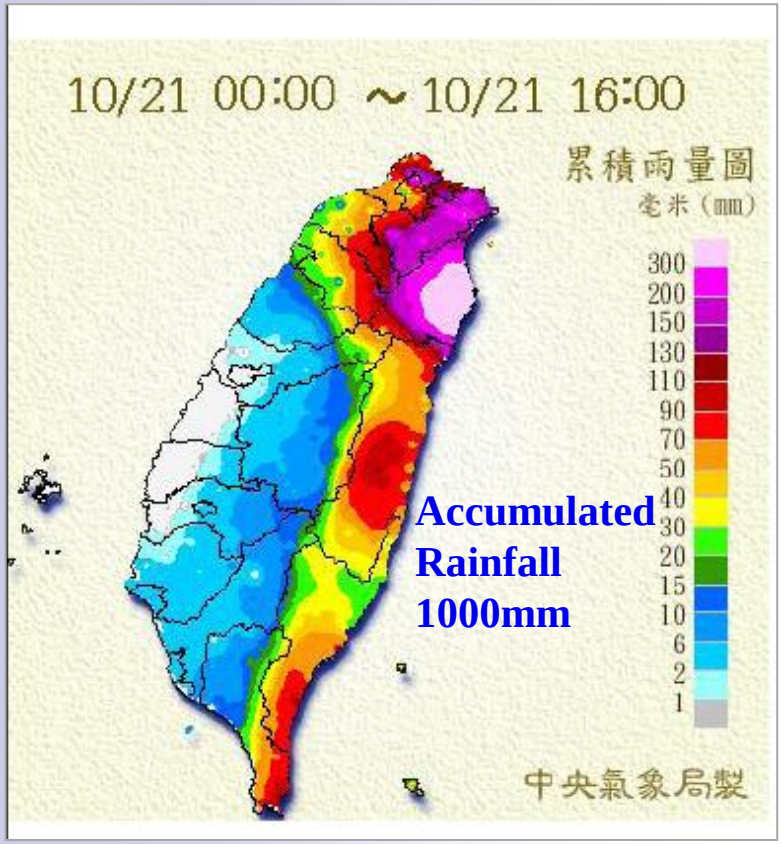
Typhoon Fanapi 2010

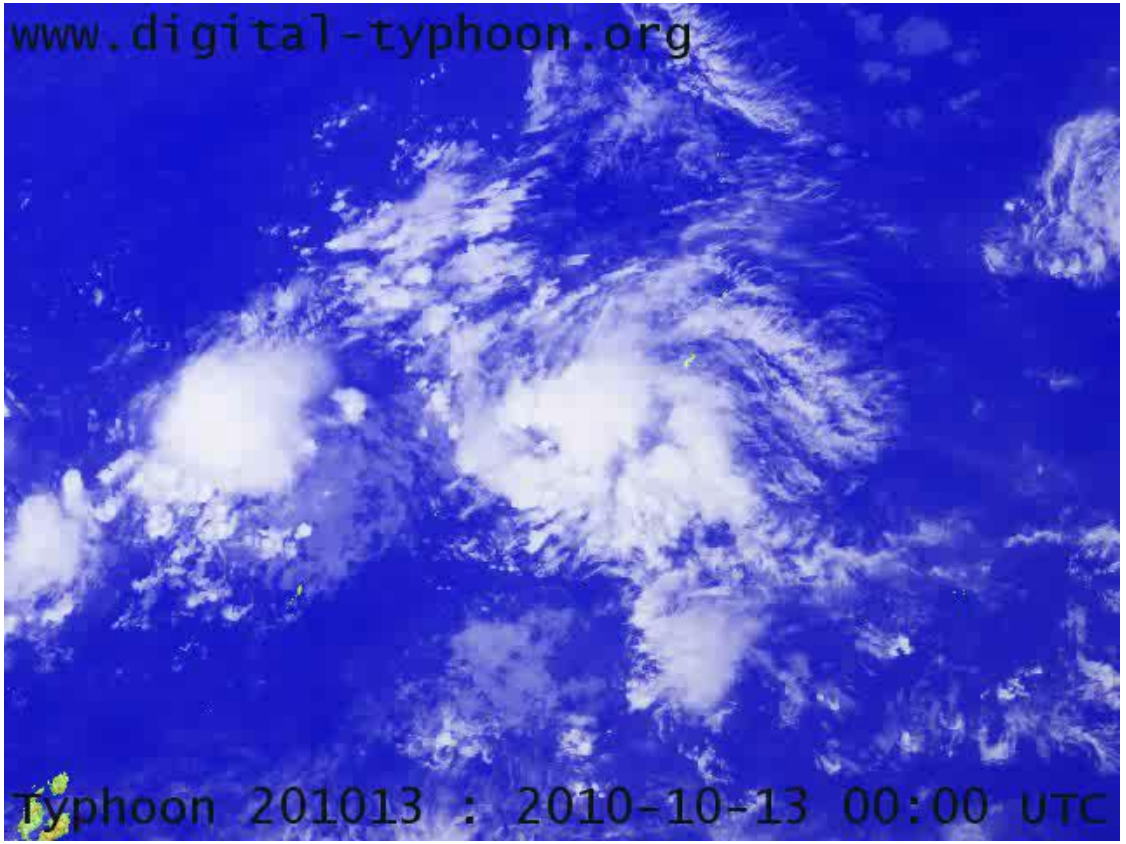




Typhoon Fanapi caused serious inundation in Kaohsiung area; especially in Nantsu area of Kaohsiung City accumulated rainfall 618mm in couple of hours, approached 200 years of return period

Typhoon Megi 2010



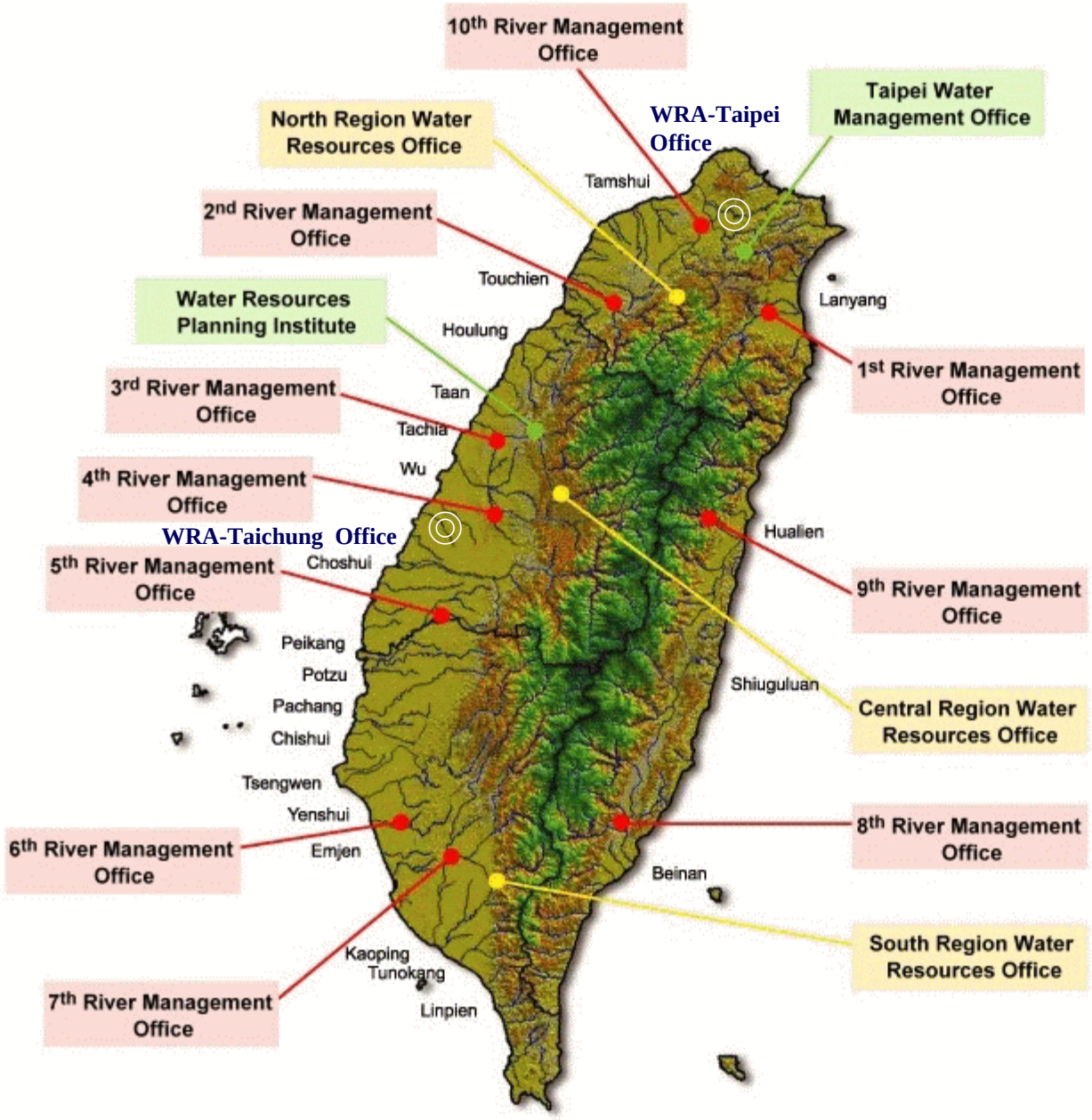


Typhoon Megi brought intensive rainfall, caused serious inundation and landslide in East Taiwan

Flood, Landslide, and Damage Caused by Typhoon

Flood Mitigation Grid-Goal

- The modern decision support system (DSS) for flood mitigation comprises of the knowledge from different disciplines, such as forecasting models, GIS models, visualization systems, communication and sensor network systems.
- The development of DSS requires, due to the heterogeneity of models and systems, a friendly user interface or platform to hide the complexity of various tools from users.
- DSS is expected to increase decision effectiveness of decision-makers. Due to advance of CI and associated network bandwidth and computing resources, DSS is applicable to the real-time problems, especially for hazard-related issues.
- To increase the user satisfaction and regret avoidance, Water Resource Agency (WRA) has included above requirements in the development of flood mitigation grid, through the collaboration with national laboratories, such as NCHC, and universities in Taiwan, as well as international partners.



- WRA-Taipei Office
- WRA-Taichung Office
- 10 River Management Offices
- 3 Region Water Resources Offices

Collaboration, communication, and share real-time information among distributed agencies are very crucial for disaster mitigation decision support

Geographically Distributed Water Resource Agency & Affiliated Agencies

Flood Emergency Information System in WRA, Taiwan

- Development of DSS comprises of heterogeneity of models and systems
- A friendly user interface or platform is required to hide the complexity of various tools from users
- Easily to let geographically distributed people working together

Role of Flood Mitigation Grid?

Weather Information

Precipitation Monitoring

River level Monitoring

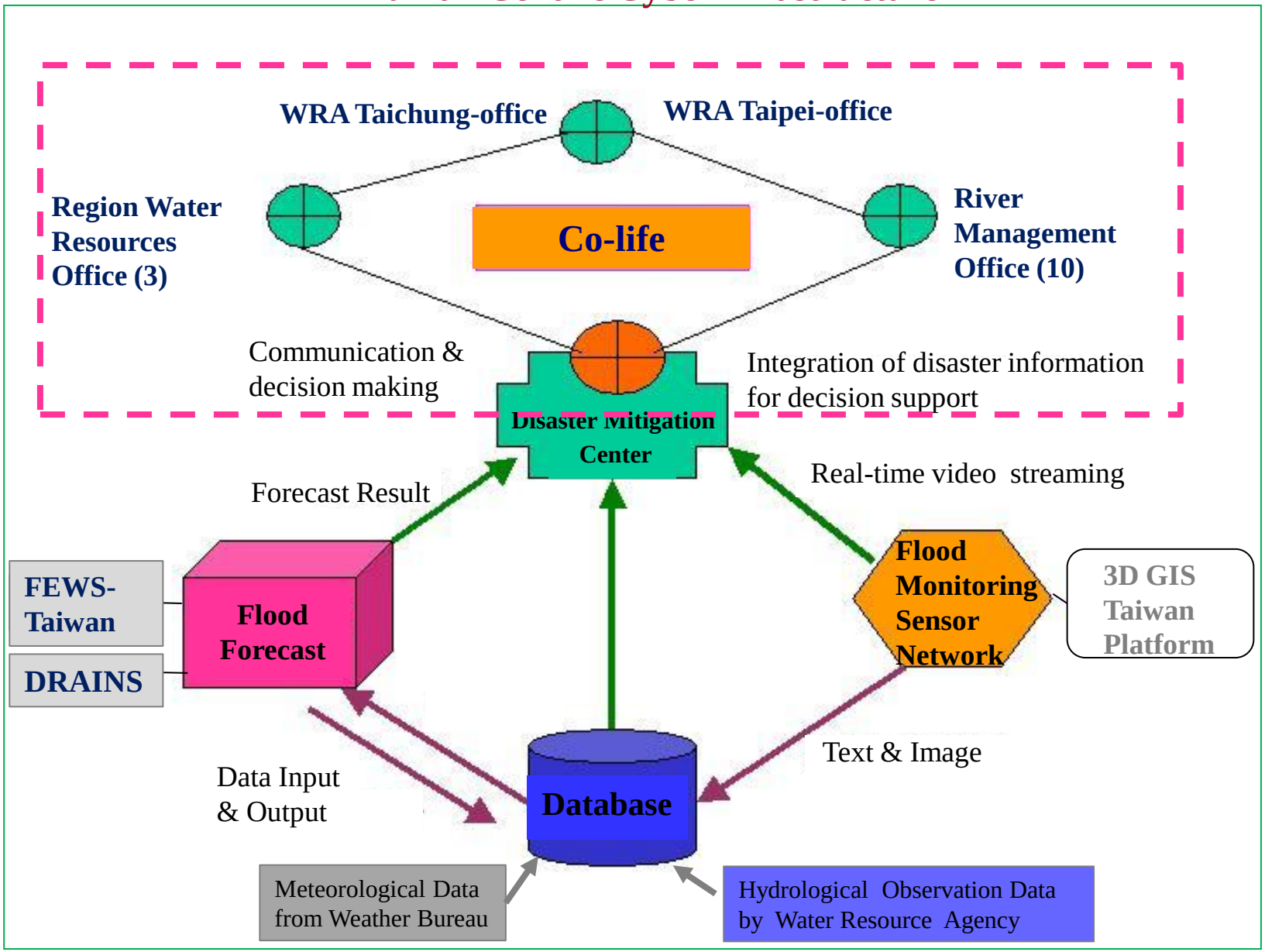
Reservoir Monitoring

Coastal Monitoring

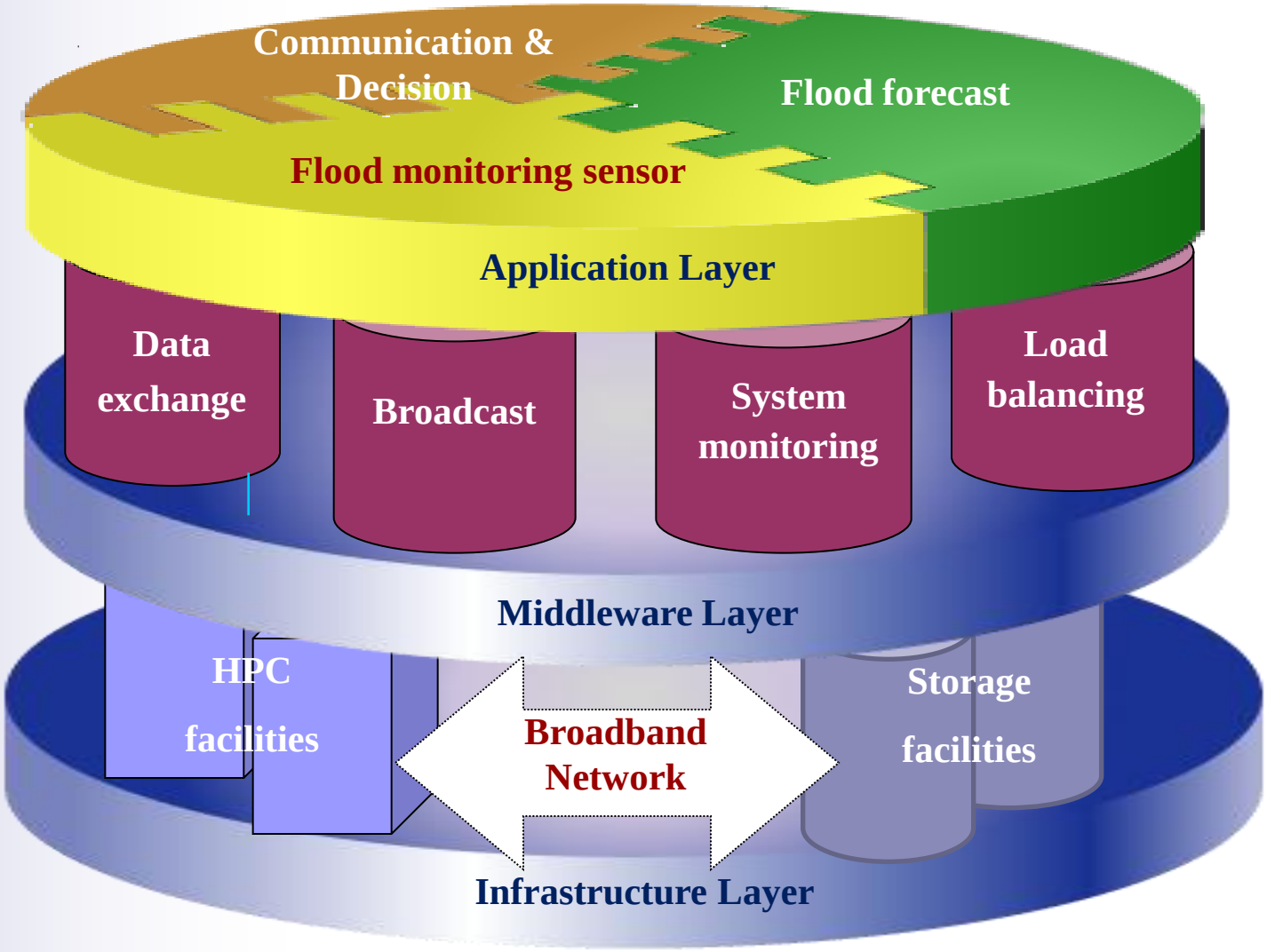
Flood Forecasting

Flood Mitigation Grid in WRA

Human Centric Cyberinfrastructure

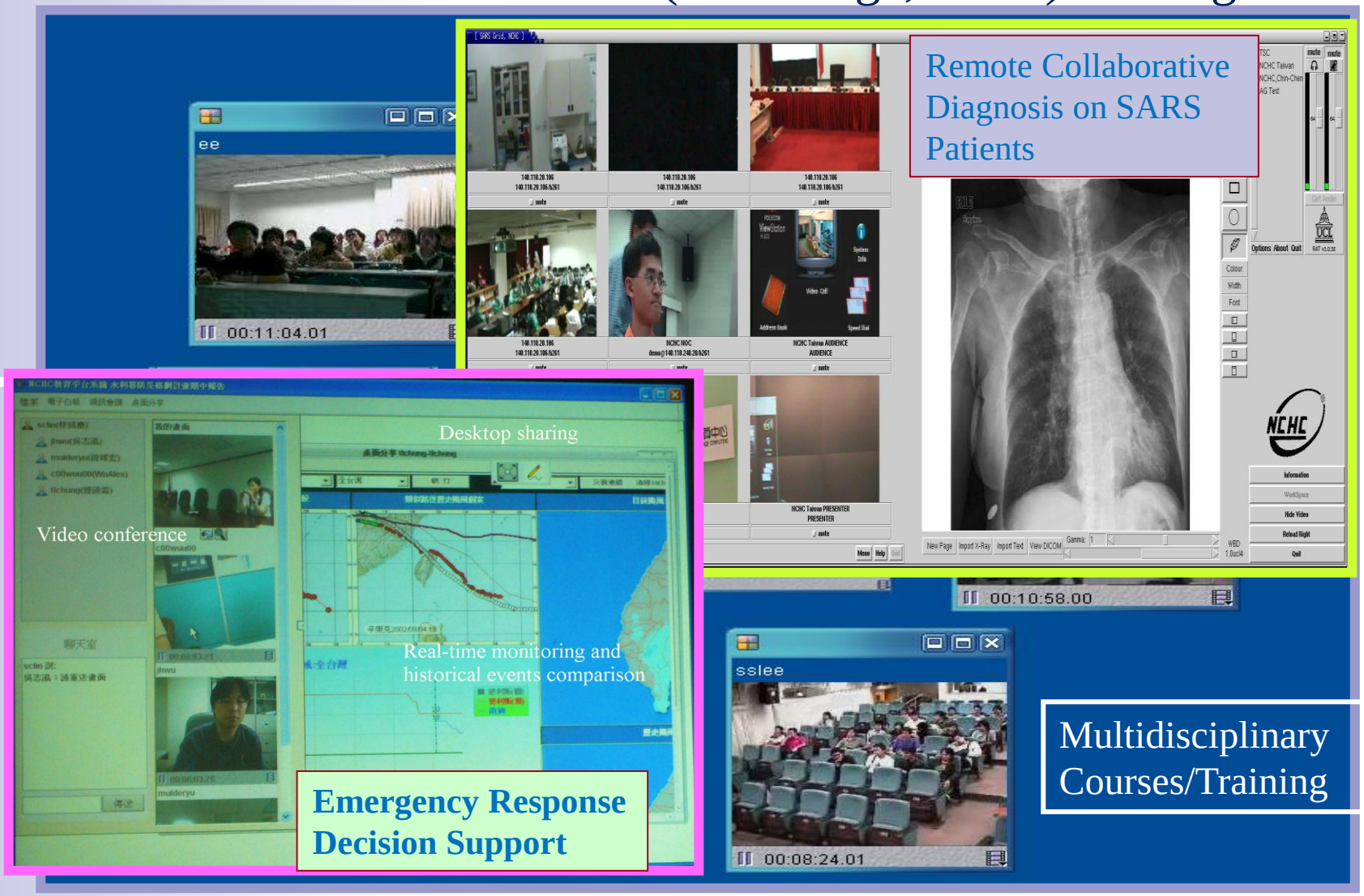


Layers of Flood Mitigation Grid

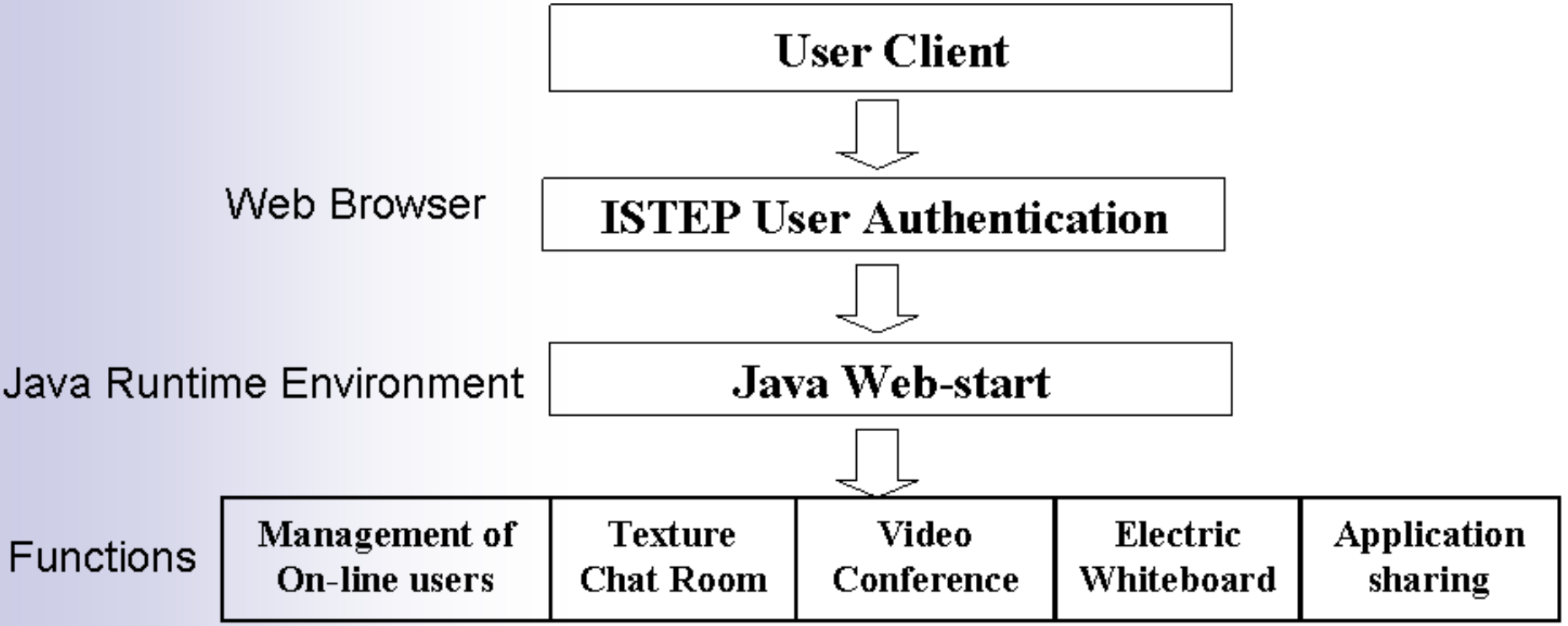


Co-Life: Collaboration Through Life

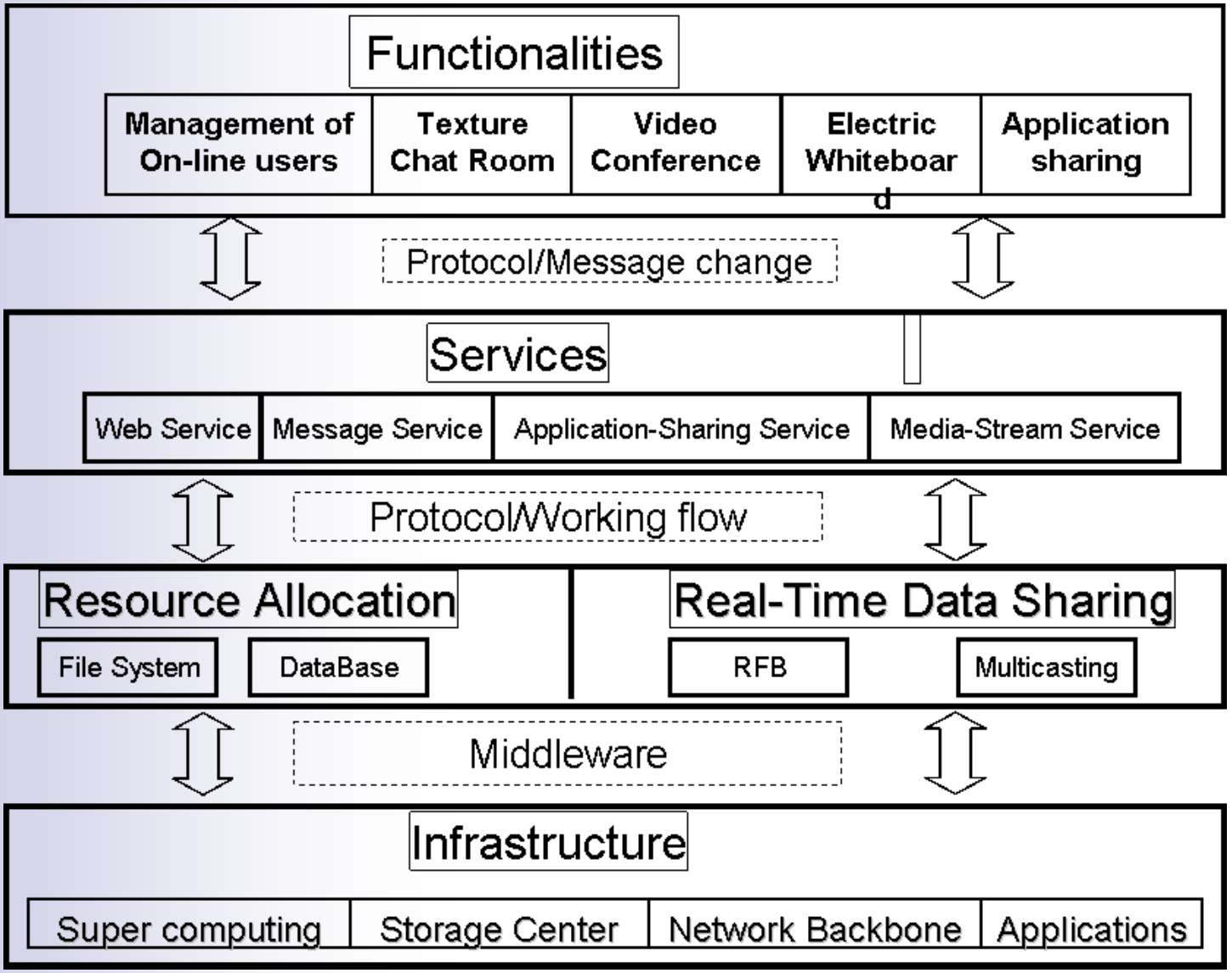
Developing Grid Middleware Co-life: Real-time Communication, Collaboration and Information (data image, video) Sharing



Co-life System Architecture



Co-life System Architecture (Cont'd)



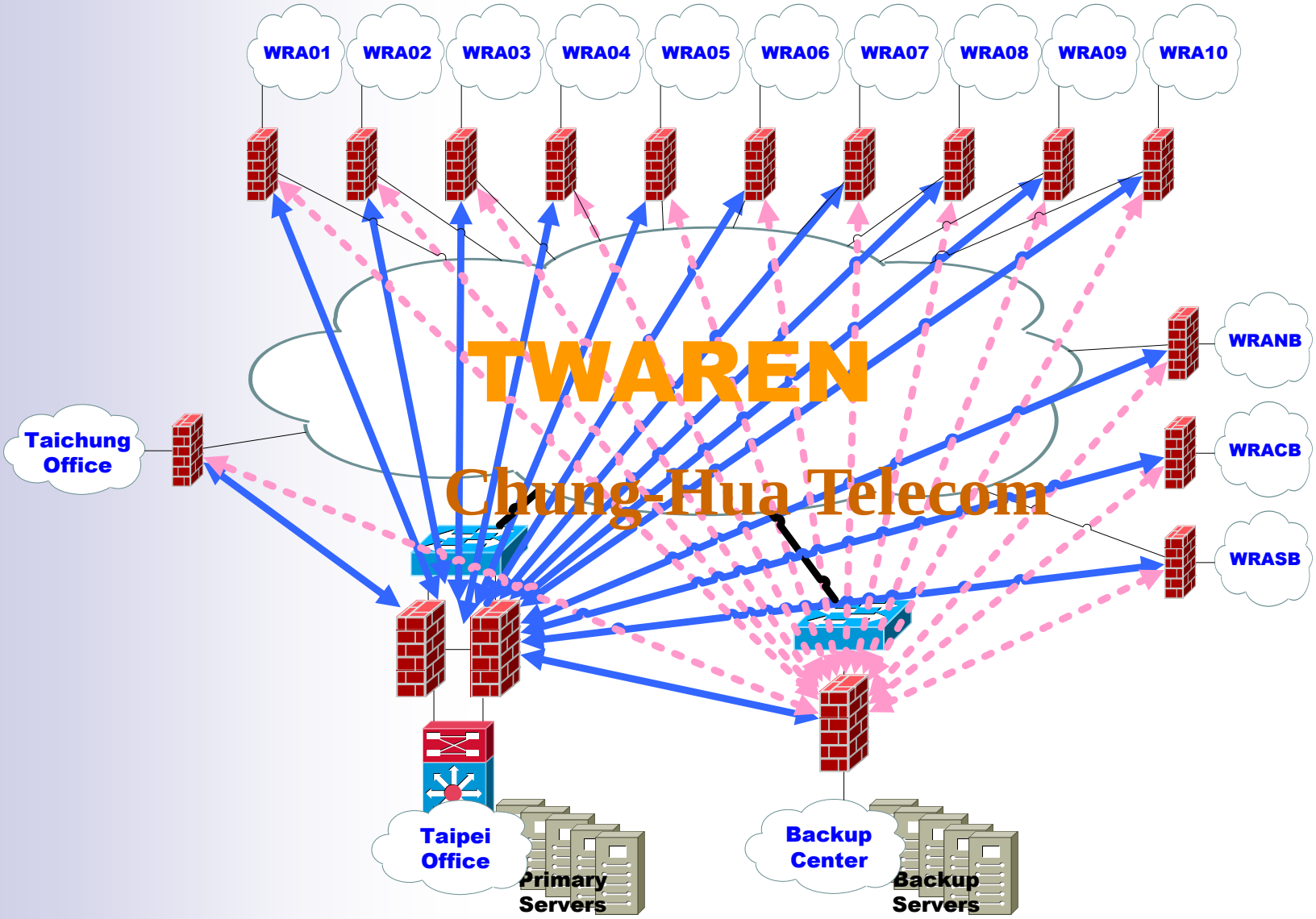
Pressure Test: 29 Participants on-line

User Interface

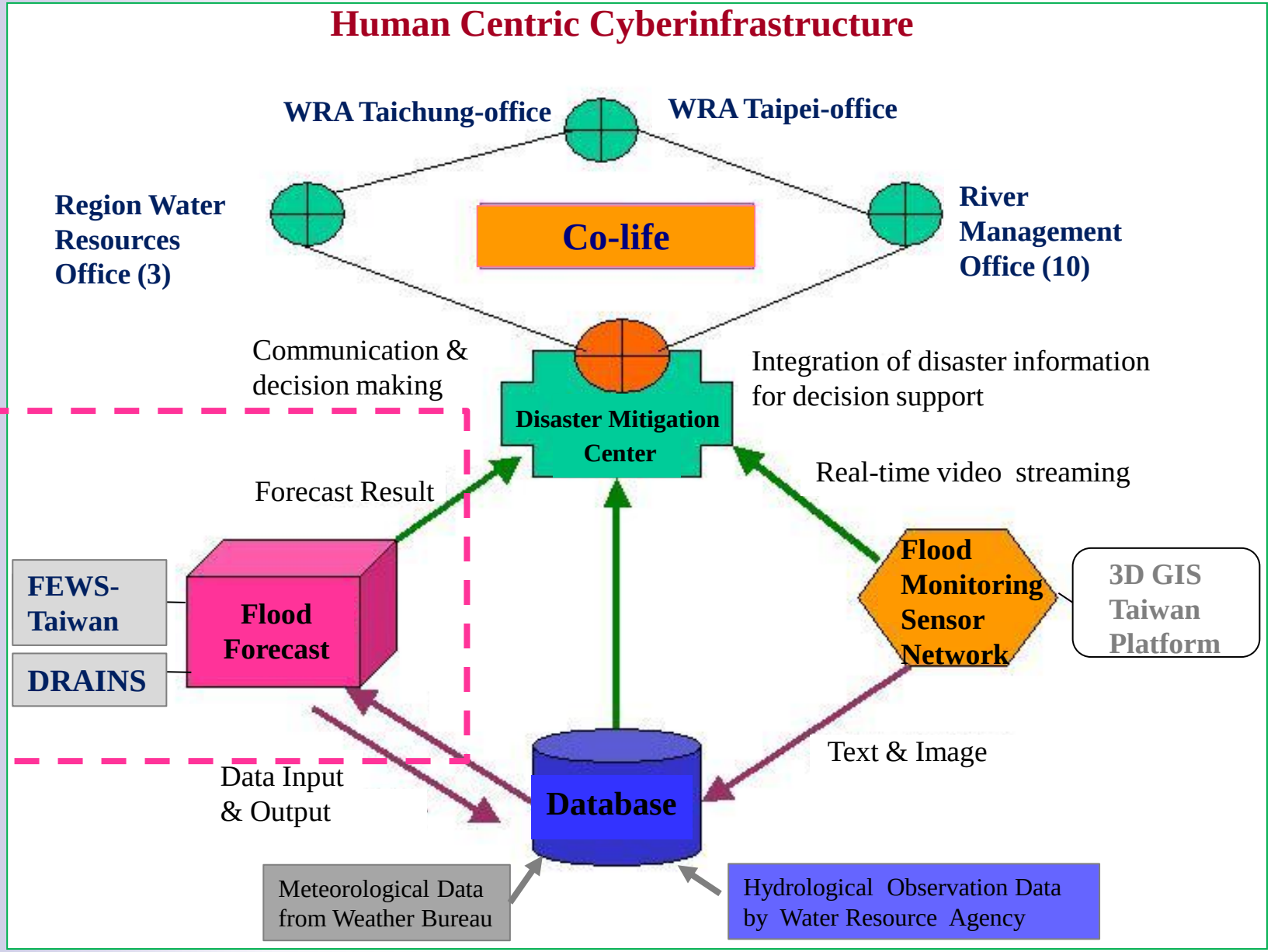
Participants Desktop Sharing by VNC Video

Text Chat

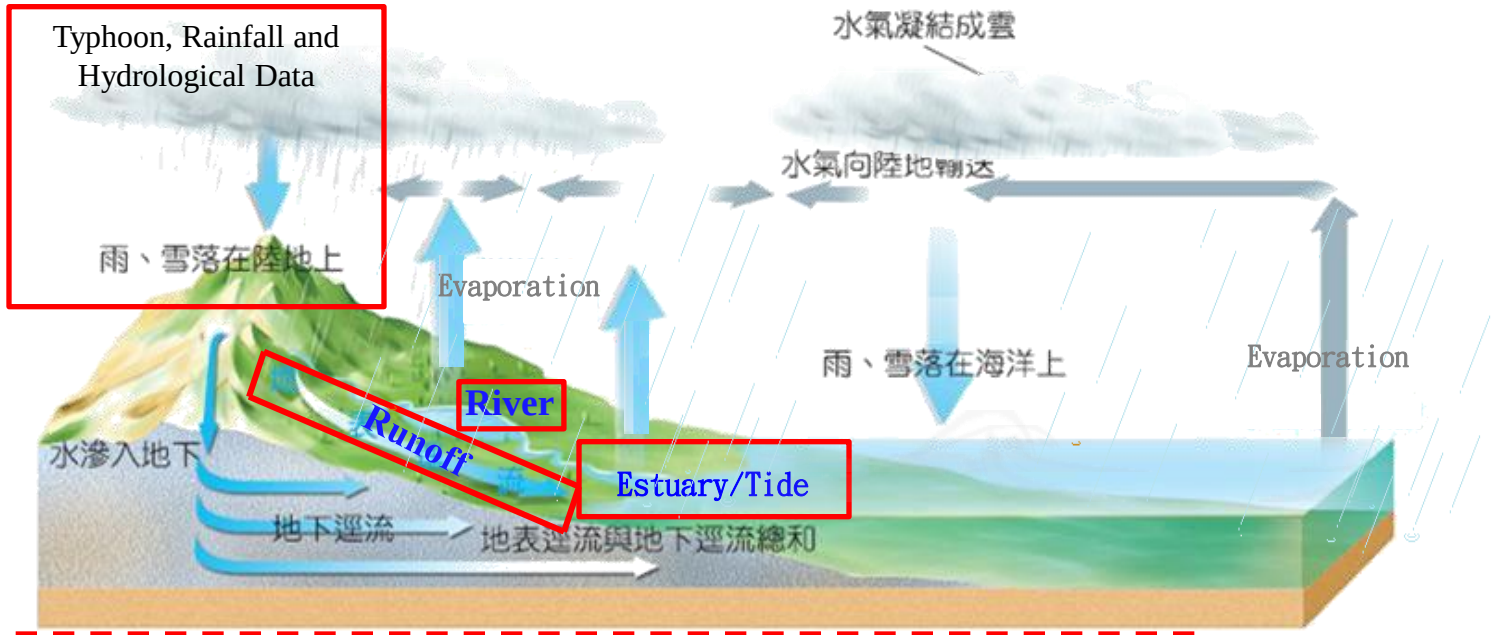
Network Infrastructure of WRA for Co-life Application



Flood Mitigation Grid in WRA



Schematic Flood Forecast in Watershed



Runoff **Forecast**

River **Forecast**

Tidal **Forecast**

•Weather
•Hydrology
•Other database

FEWS Taiwan

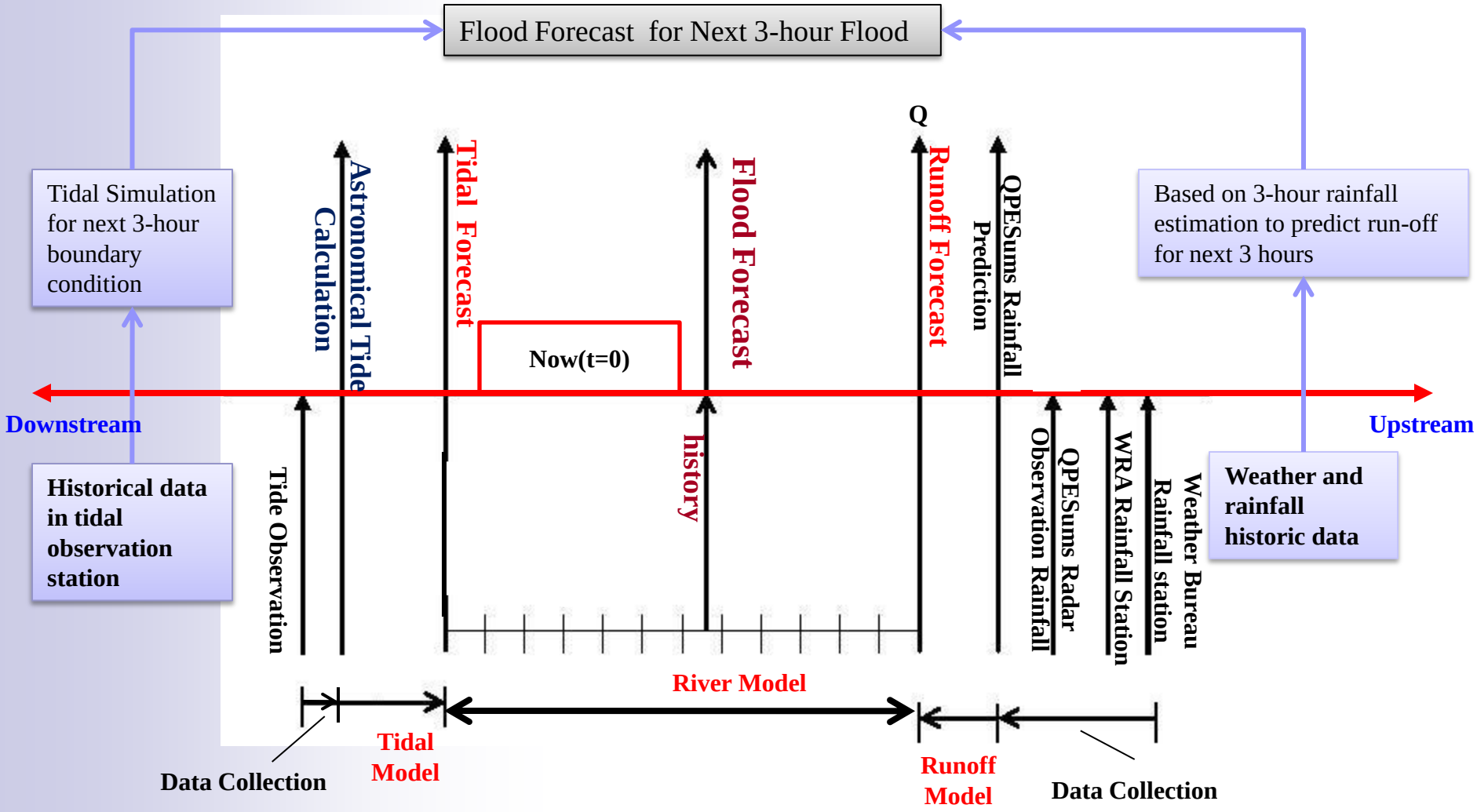
3-hour Pre-warning Forecast of river water level

Flood Monitoring Sensor & Real-time Communication

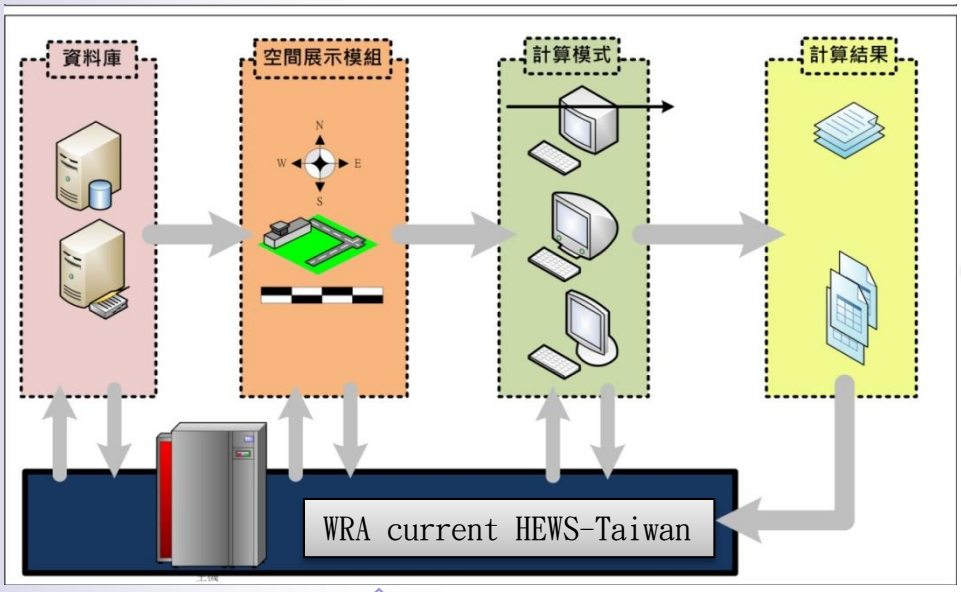
Open & Multi-model adaptive Platform, connecting multiple database & heterogeneous Information-support platforms

Flood Forecast linked with Disaster Information System

Flood Early Warning System-Taiwan



Flood Early Warning System-Taiwan

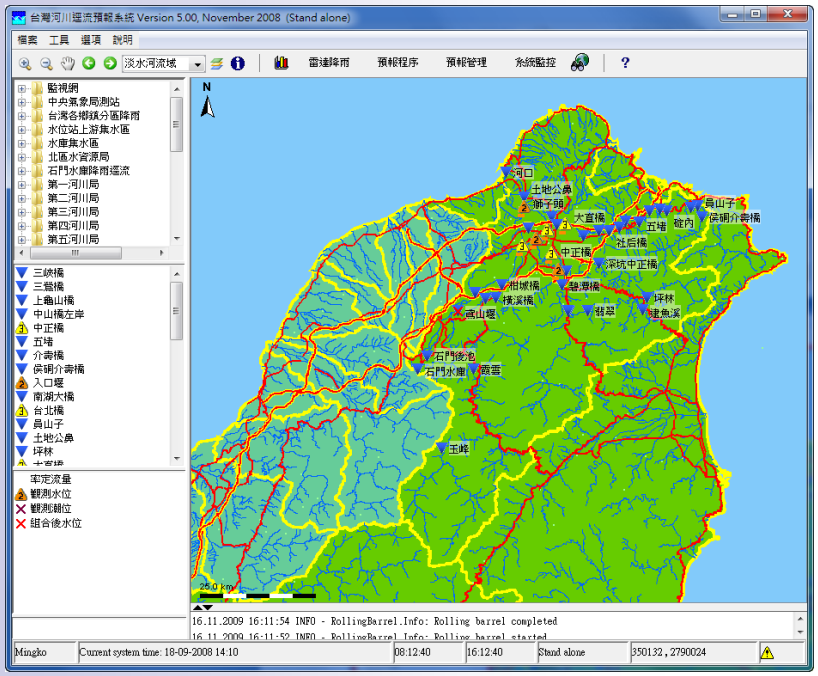


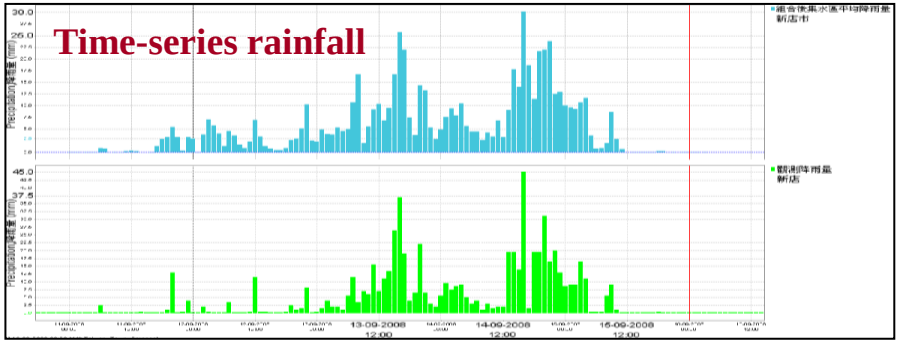
Single function model allows Single-code adaption

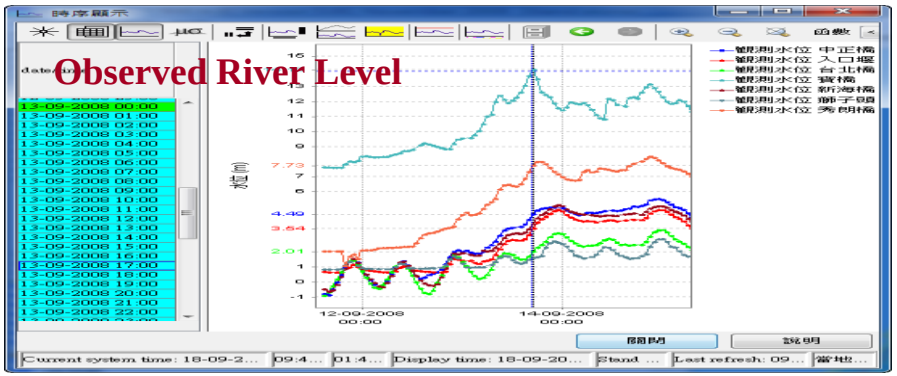
Open platform, Single function model allows Multi-code adaption

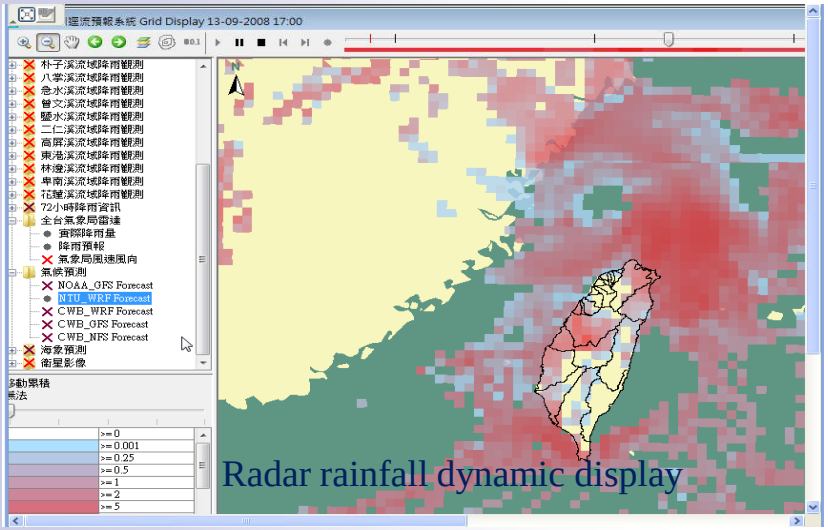
Ensemble Average Approach

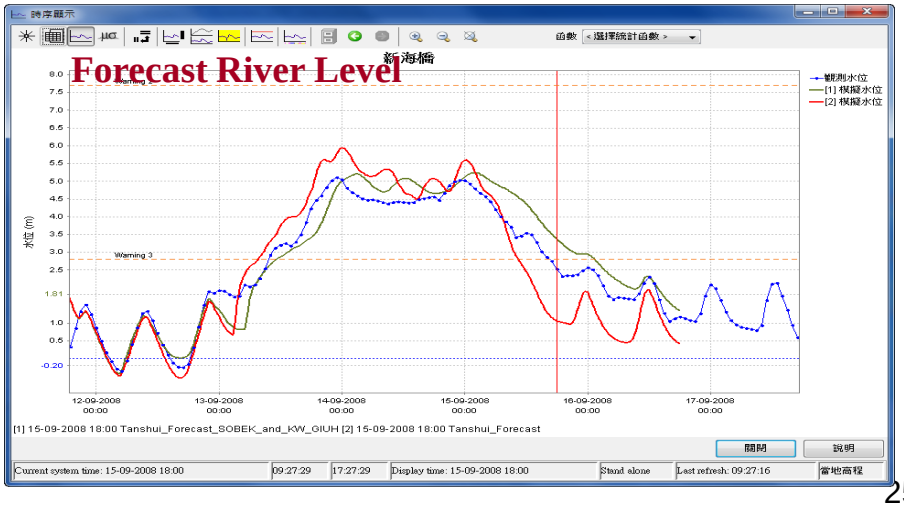
HEWS-Taiwan User Interface











DRAINS, Distributed Runoff And Inundation Nowcast System

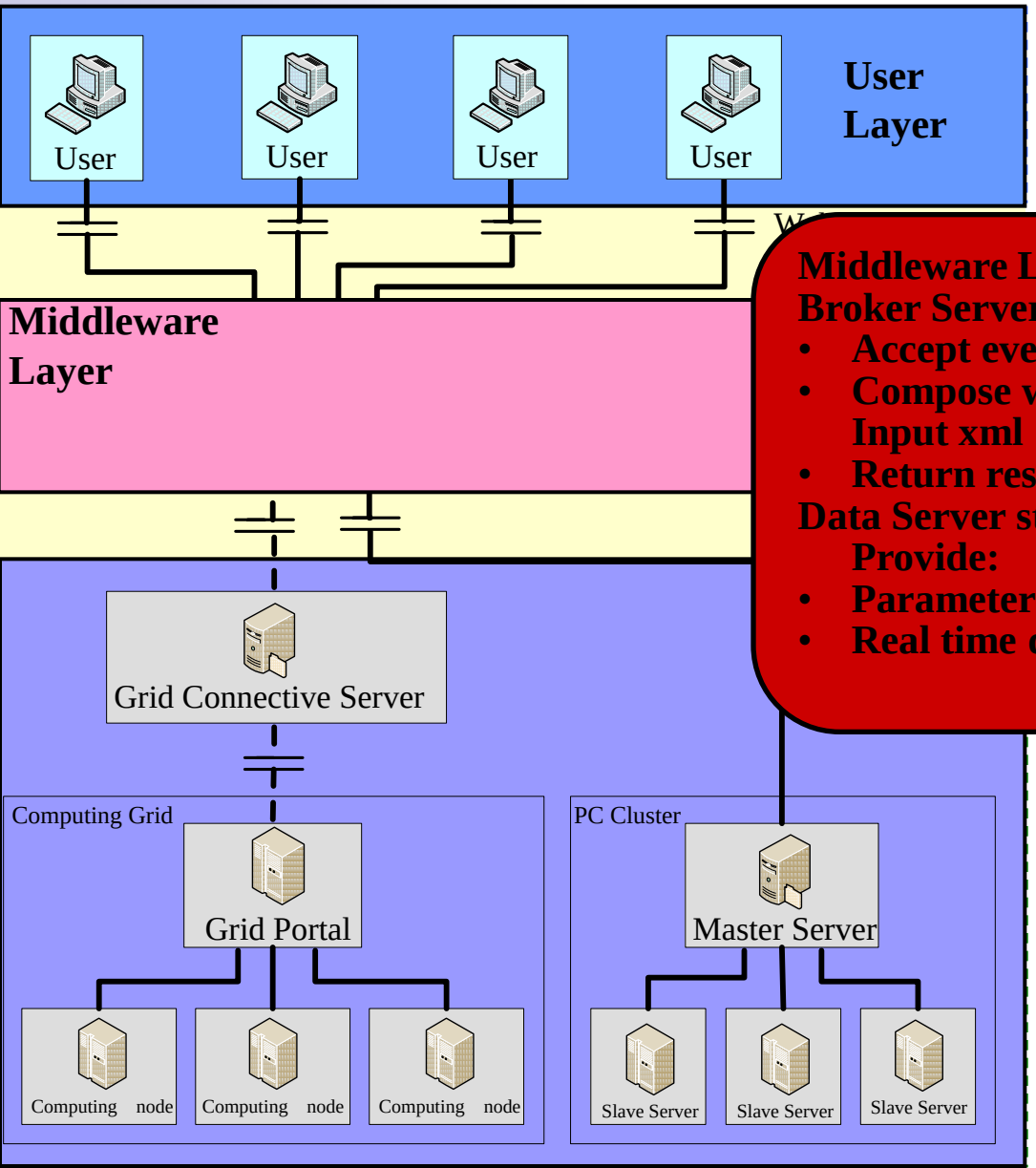
Single function model single code, but multi watersheds

- System Design
- Climatologic Typhoon QPF Module
- Two-reservoir Flood Discharge Decision Support System (DSS)
- Variation of Typhoon Route (DSS)
- Geomorphologic Runoff Module
- NewC Channel Routing Module
- XML-Based I/O files, Adapters & Workflows

Contact: Prof. Tim-Hau Lee, Dept. of Civil Engineering, National Taiwan University
Email: thlee@ccms.ntu.edu.tw

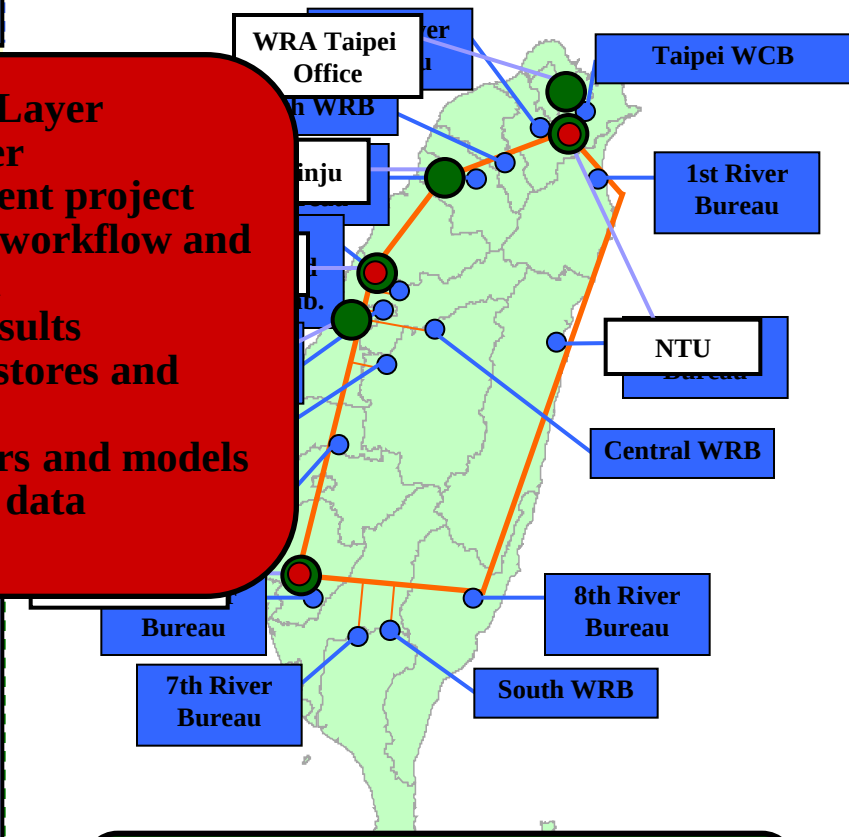
System Desig

User Layer
- Define model I/O
- Define event project
- Submit job
- Display result



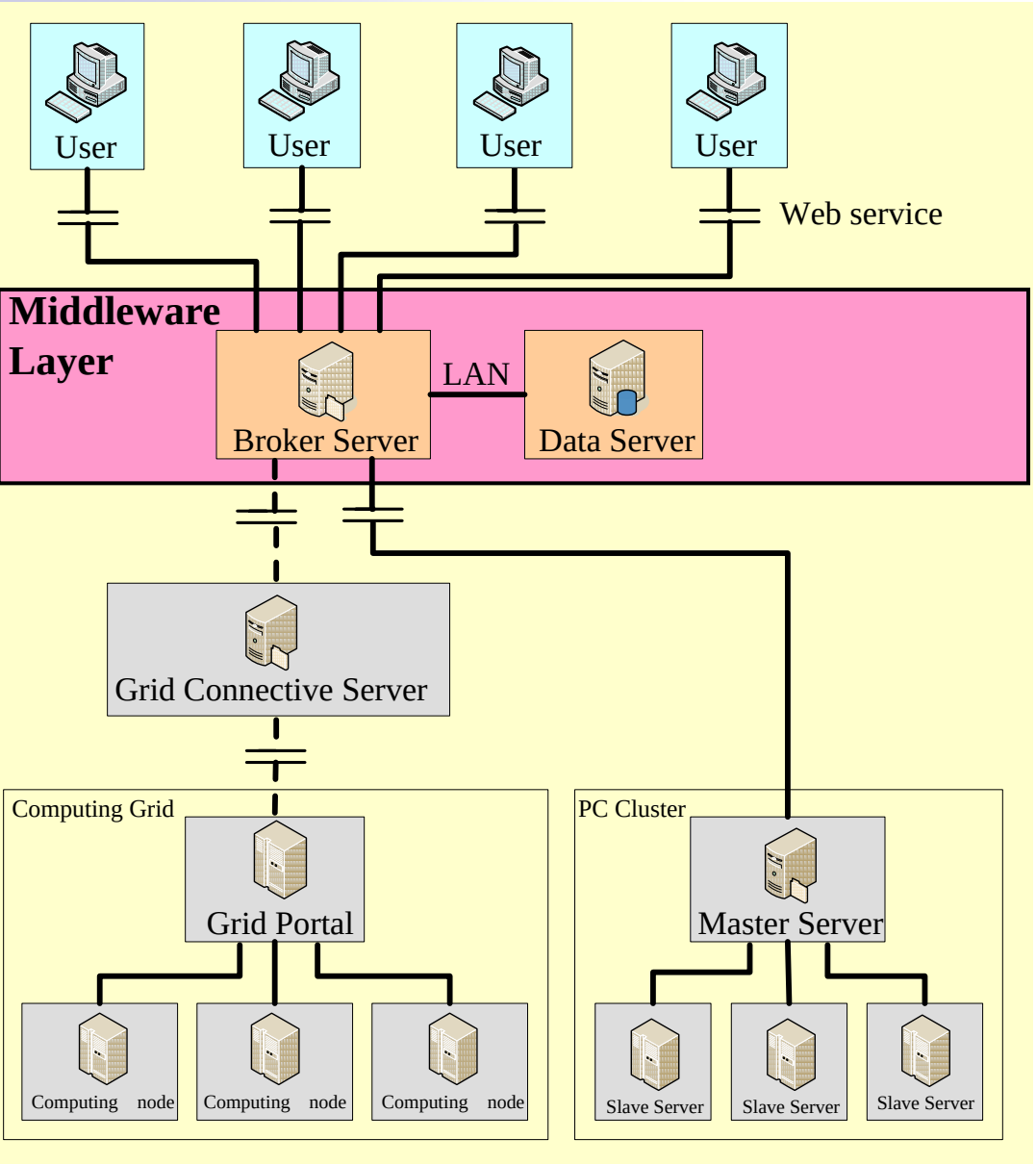
Middleware Layer
Broker Server
- Accept event project
- Compose workflow and Input xml
- Return results

Data Server stores and Provide:
- Parameters and models
- Real time data

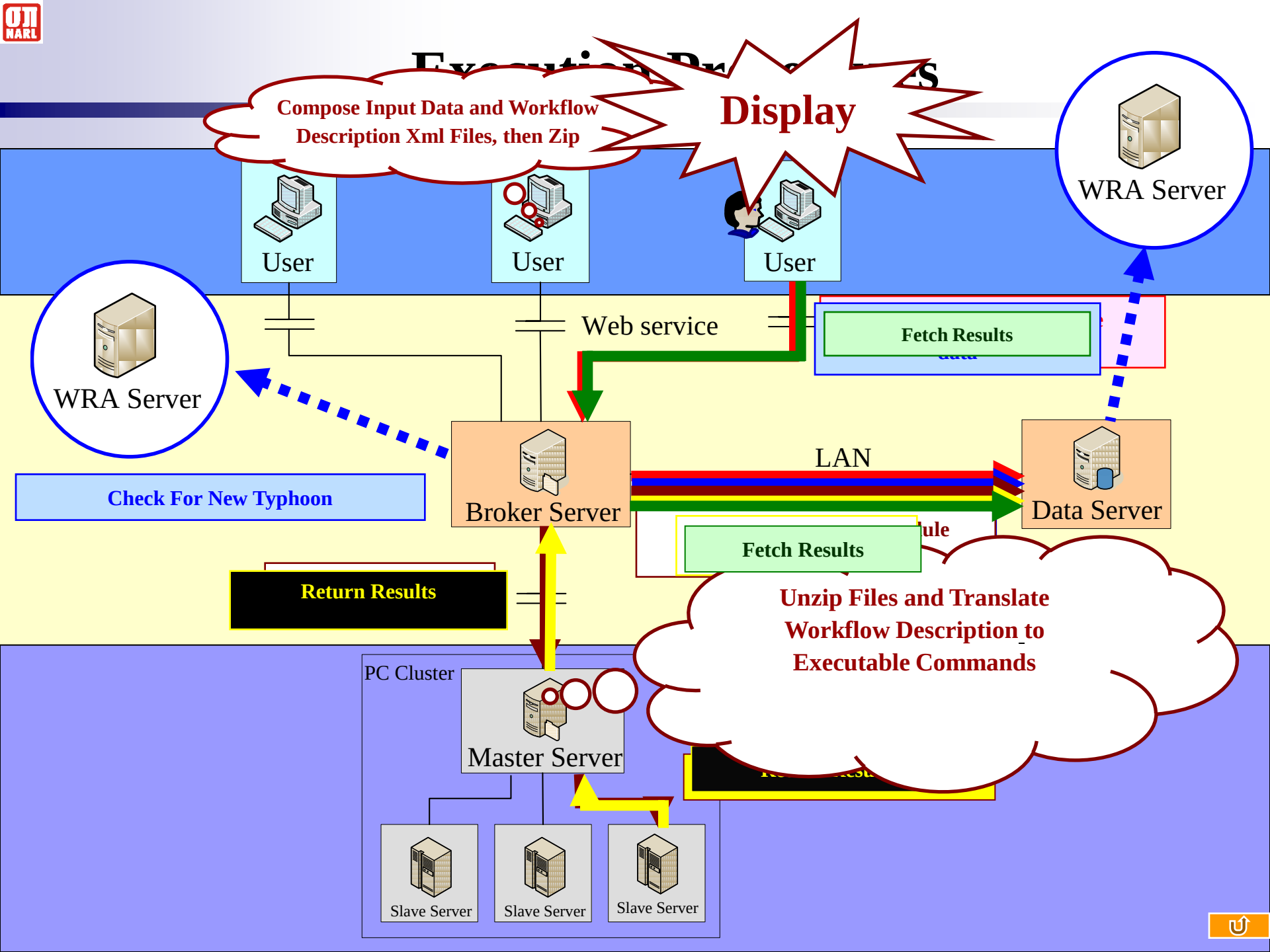


Computing Facility Layer:
- Interpret workflow script
- Execute simulations

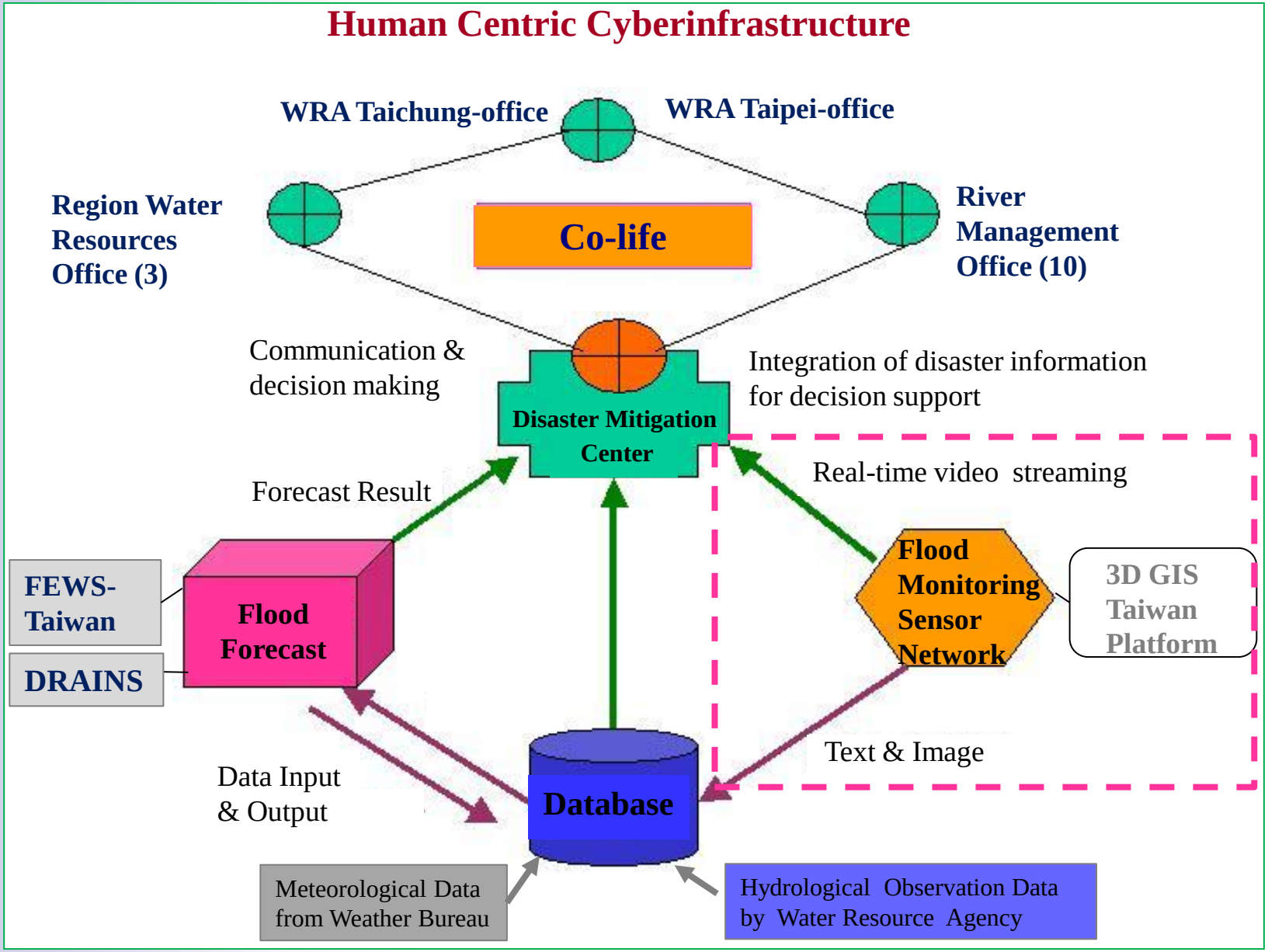
System Design (2/2)



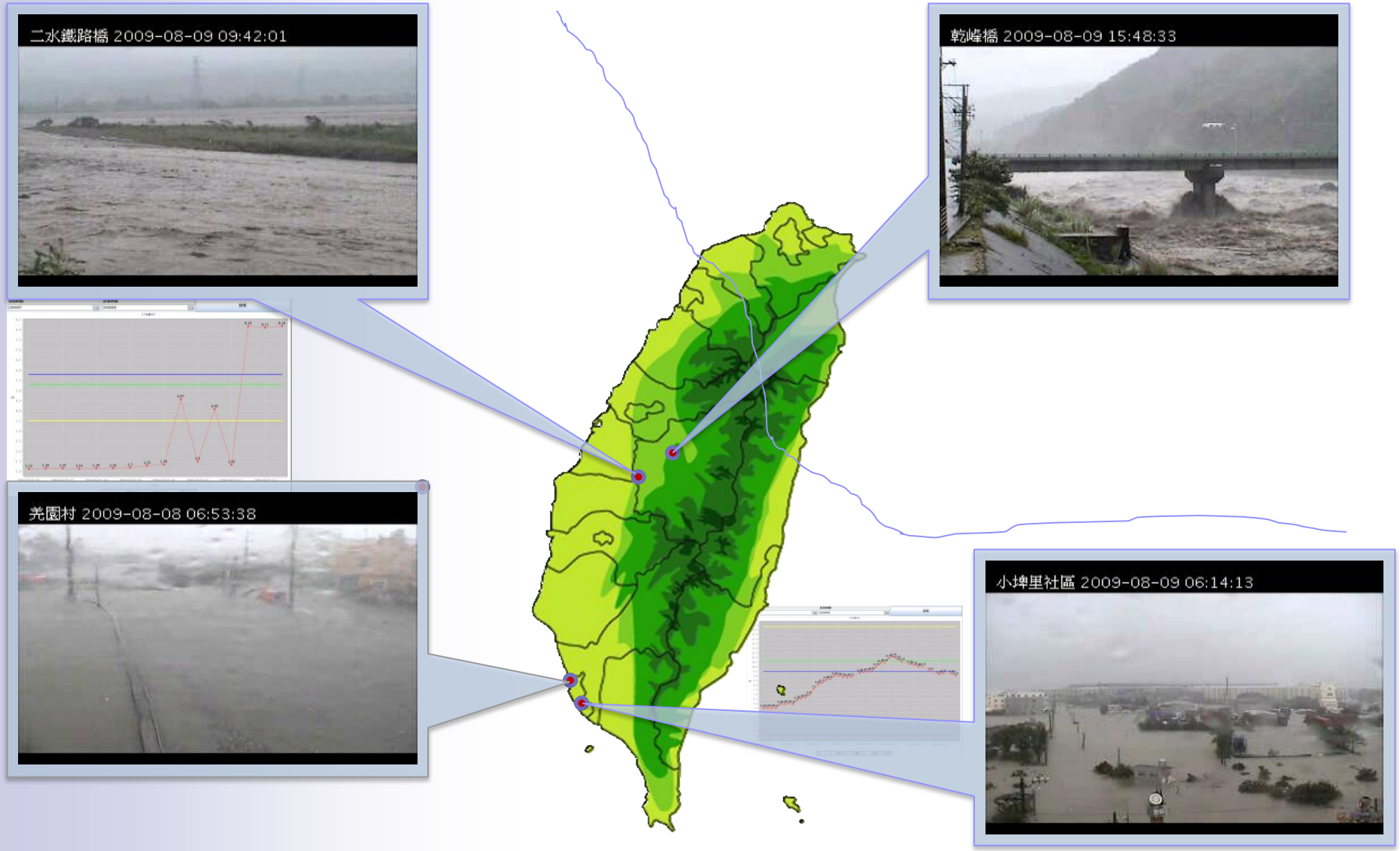
- The middleware, Broker Server and Data Server, are connected via LAN (Local Area Network) for efficiency.
- The XML-based Web Service protocols are used for inter-layer communication.


Compose Input Data and Workflow Description Xml Files, then Zip
Display
WRA Server
User
User
User
WRA Server
Web service
Fetch Results
Check For New Typhoon
Broker Server
LAN
Data Server
Fetch Results
Return Results
Unzip Files and Translate Workflow Description to Executable Commands
PC Cluster
Master Server
Slave Server
Slave Server
Slave Server

Flood Mitigation Grid in WRA

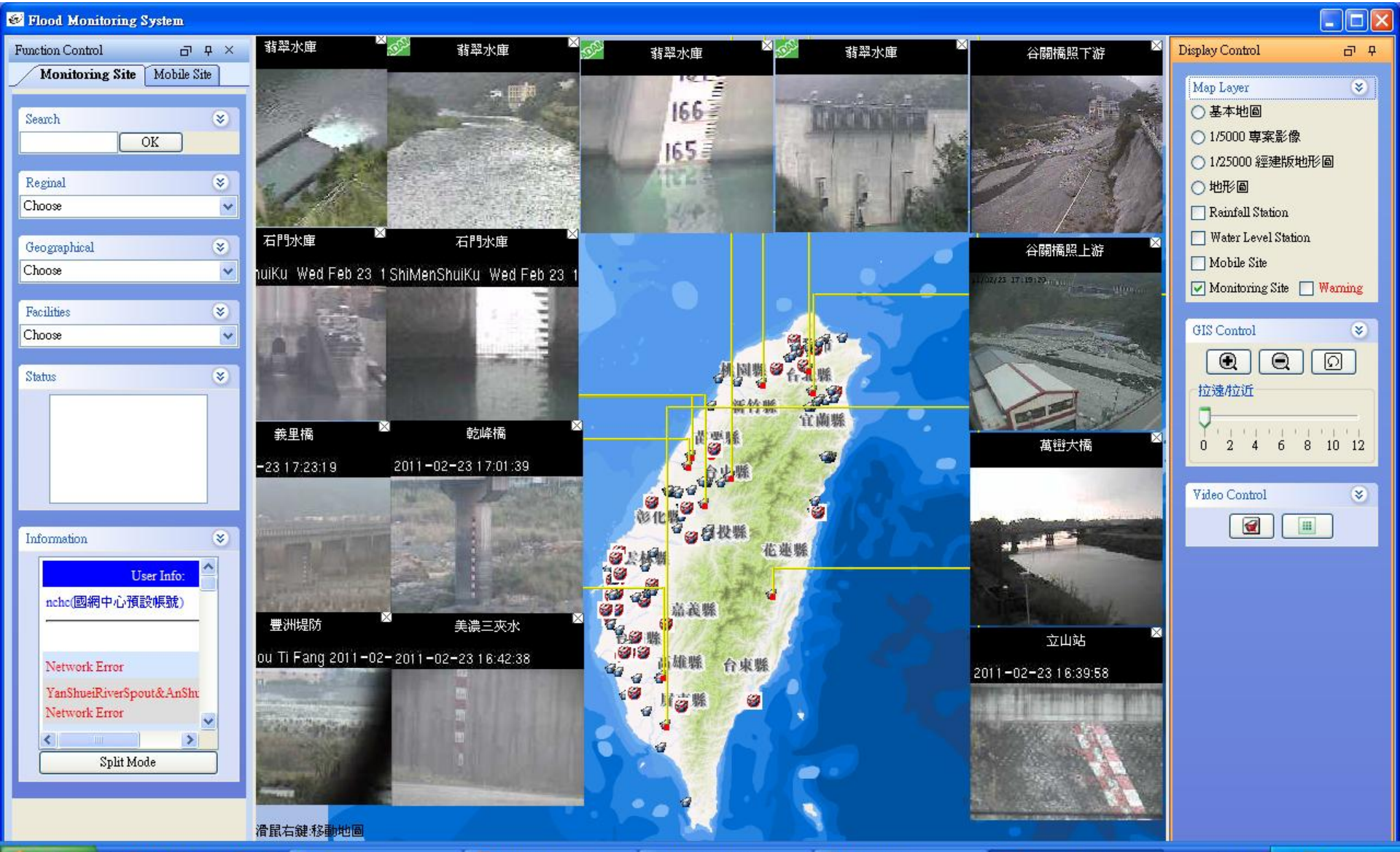


Flood Monitoring Sensor Network

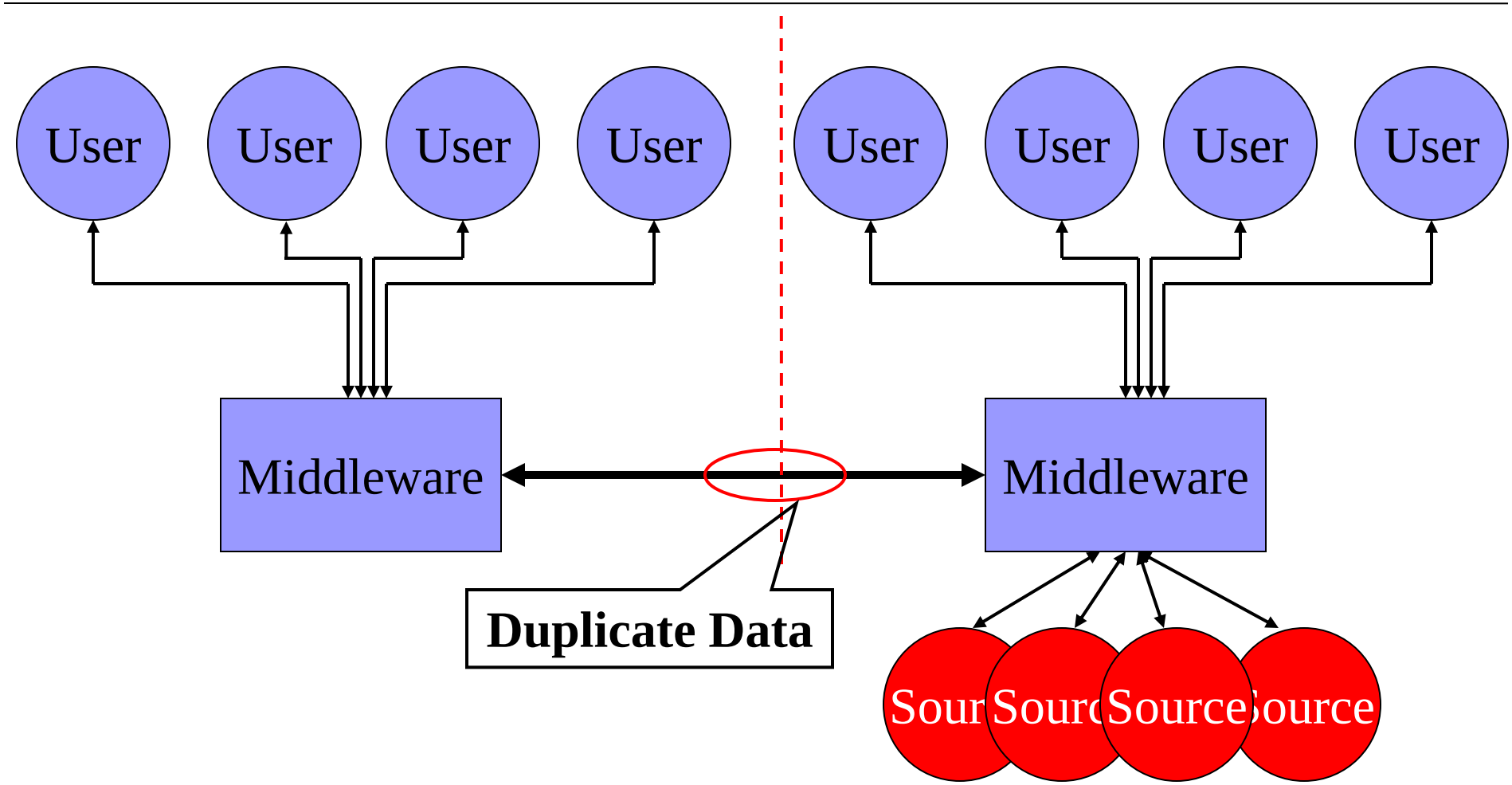


Flood Monitoring Sensor Network

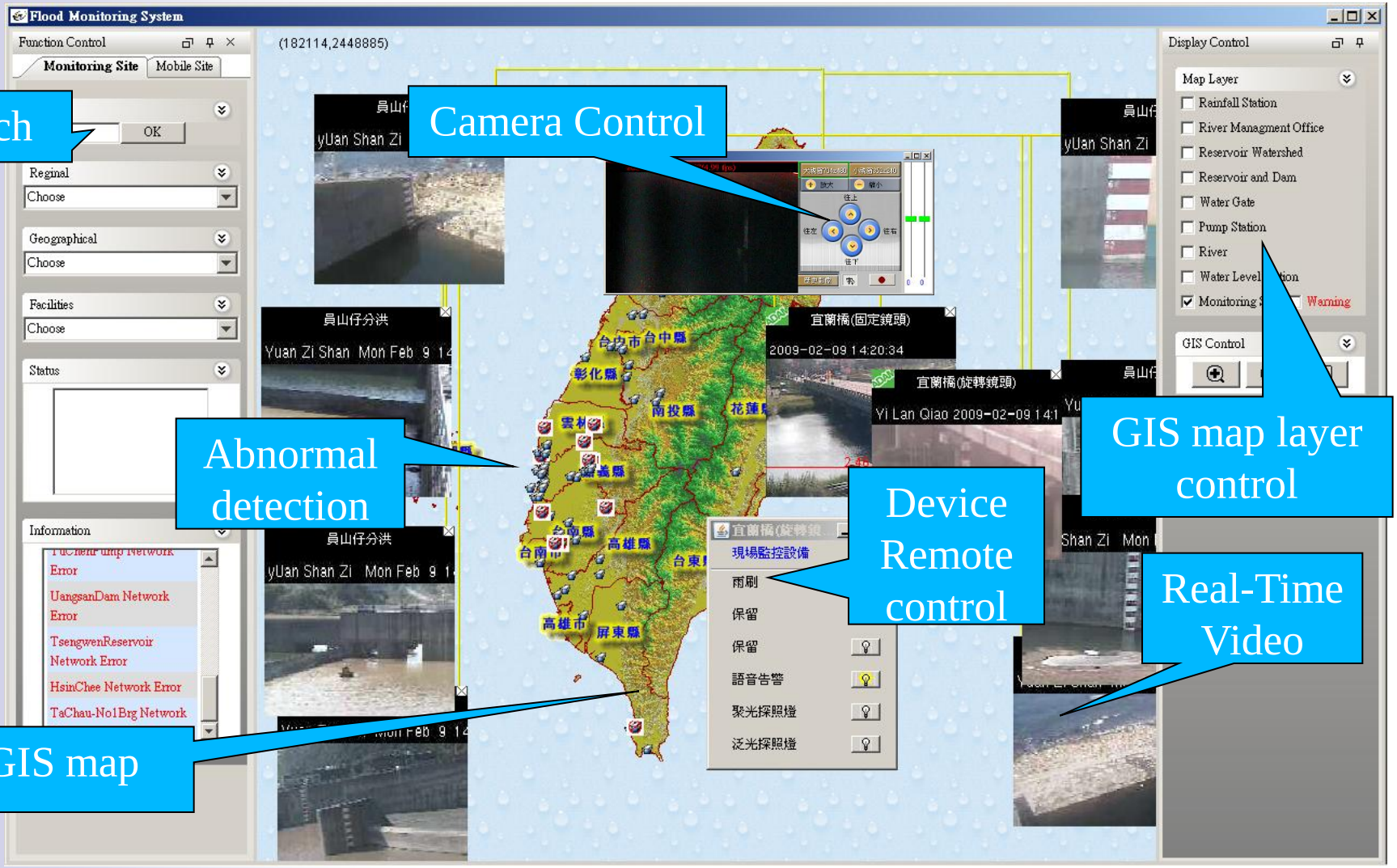
(WRA) Mission oriented, NOT open to public yet



Multicasting – improve the loading of data source
P2P - share middleware's loading

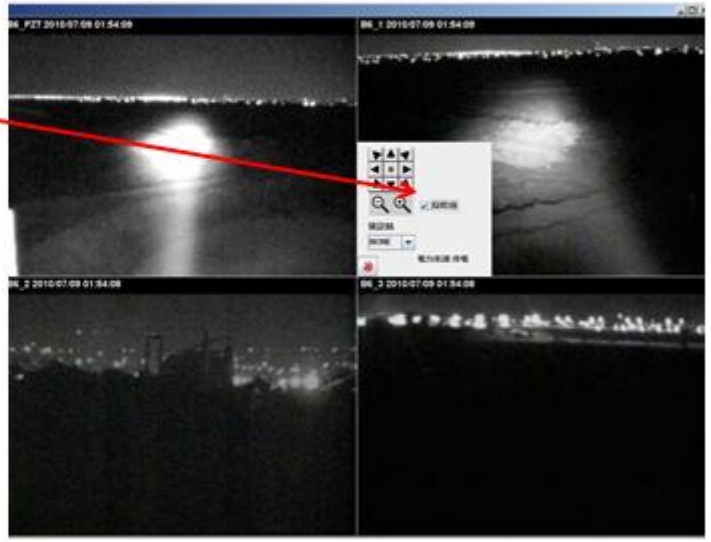


Real-Time Flood Monitoring System

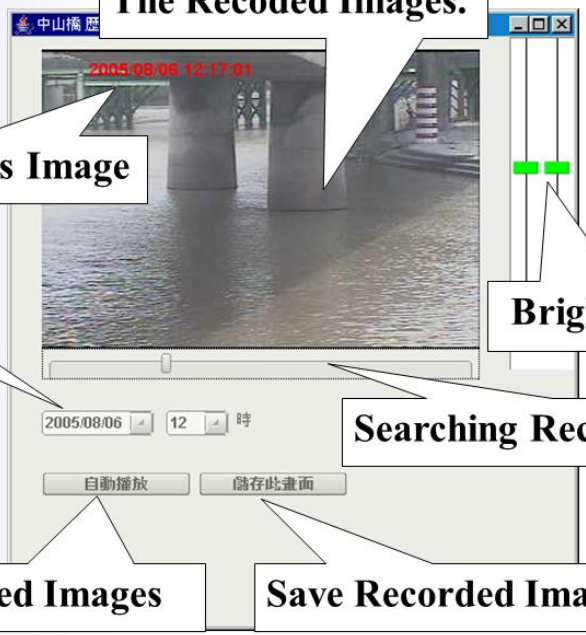


Device Remote Control

Searchlight, wiper turn on/off



Historic Recorded Images



Auto-Recognition of Water Level

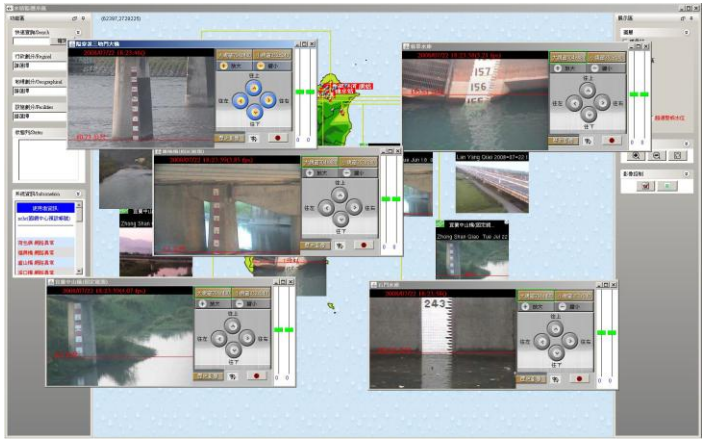
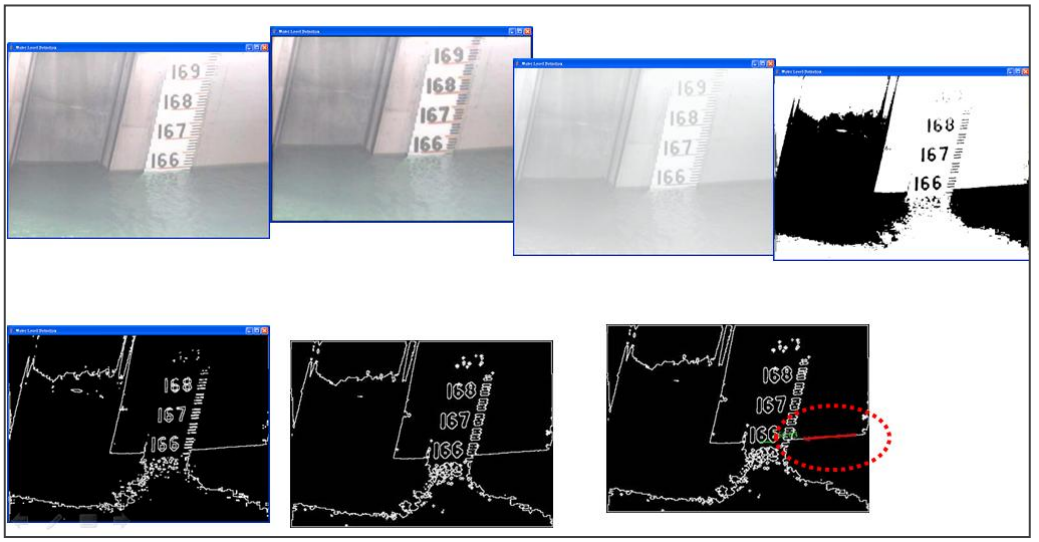


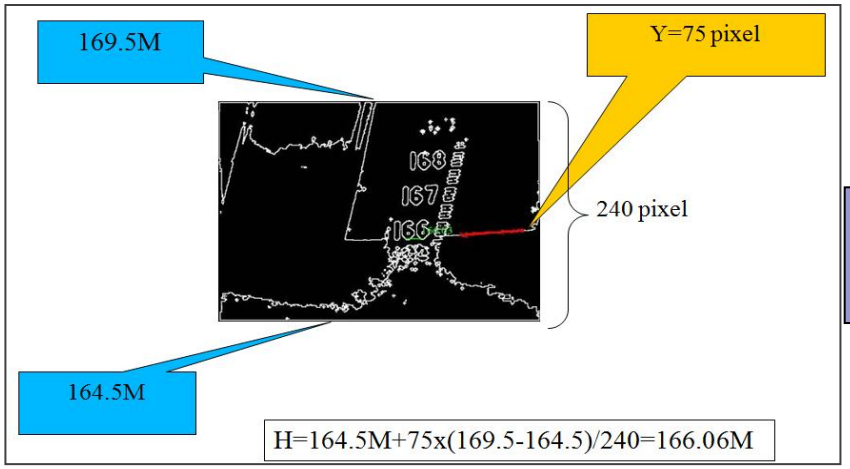
Image of water level



Lens Image capture

Water level identification module

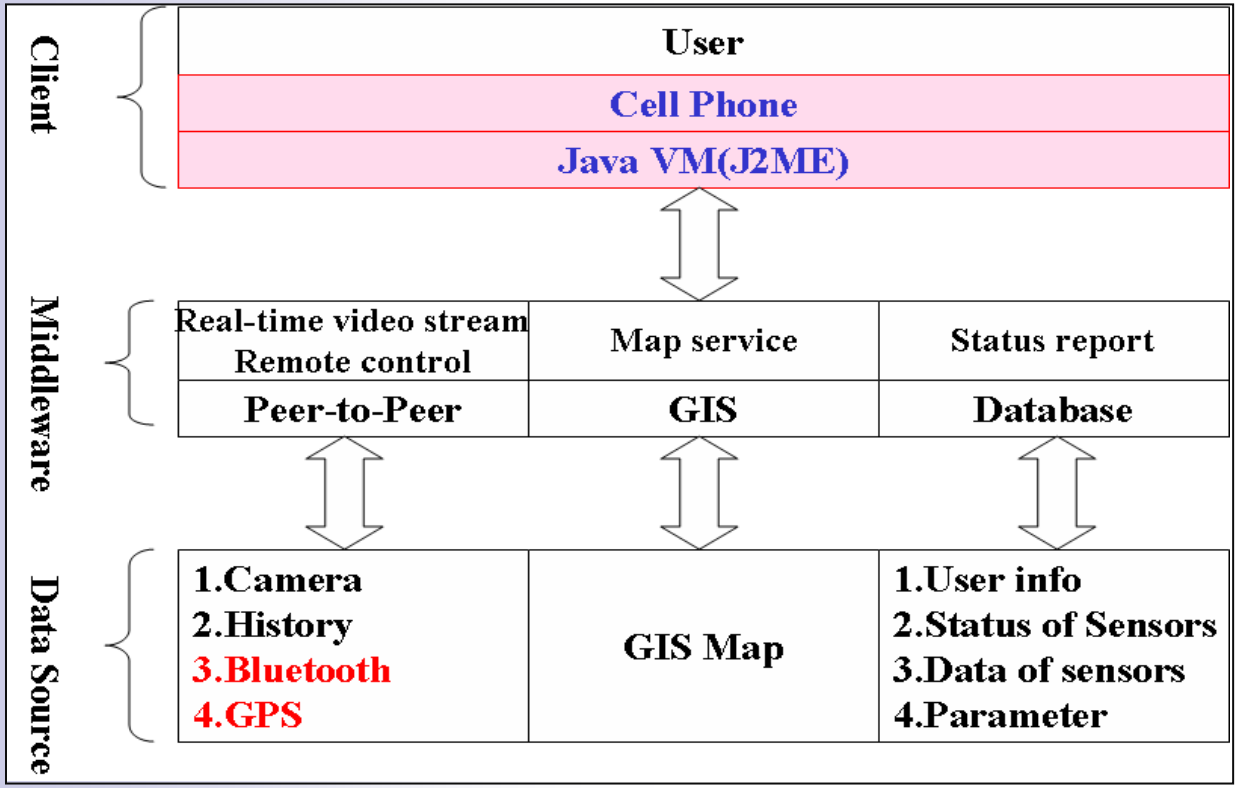
Architecture

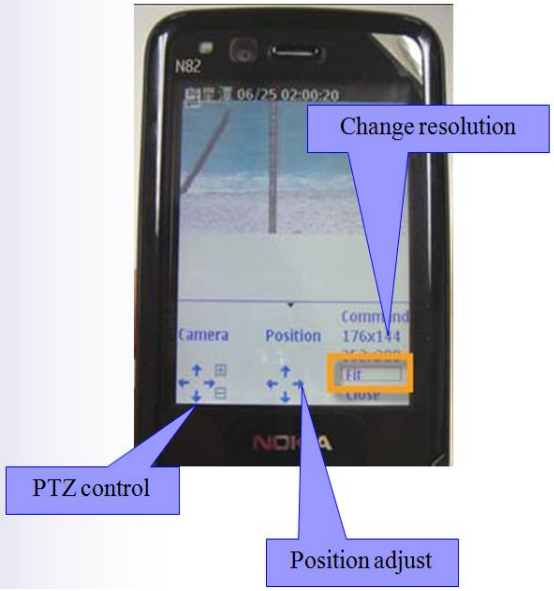


Water Level Interpolation

Mobile Real-time Flood Watching System

Architecture

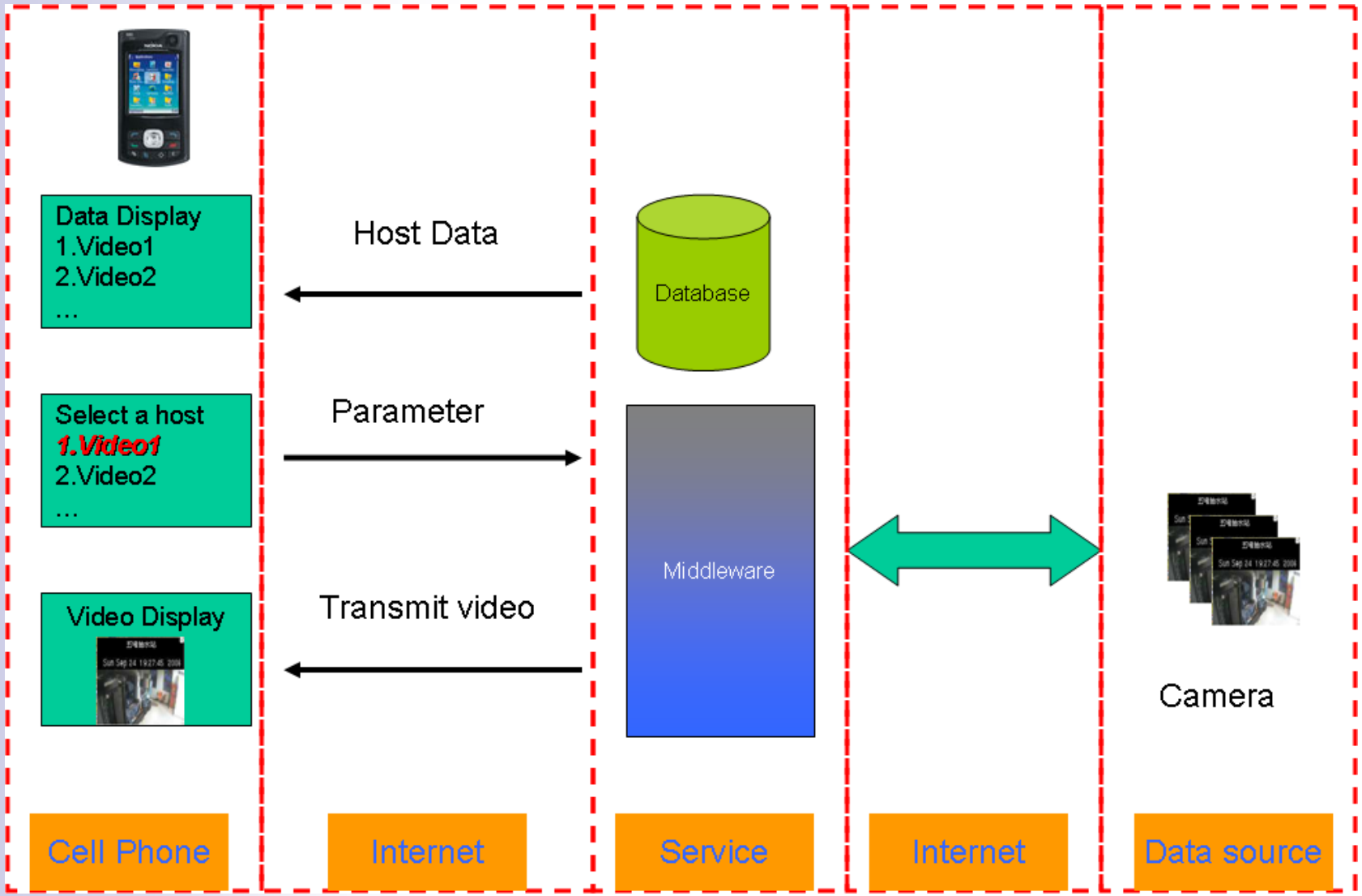




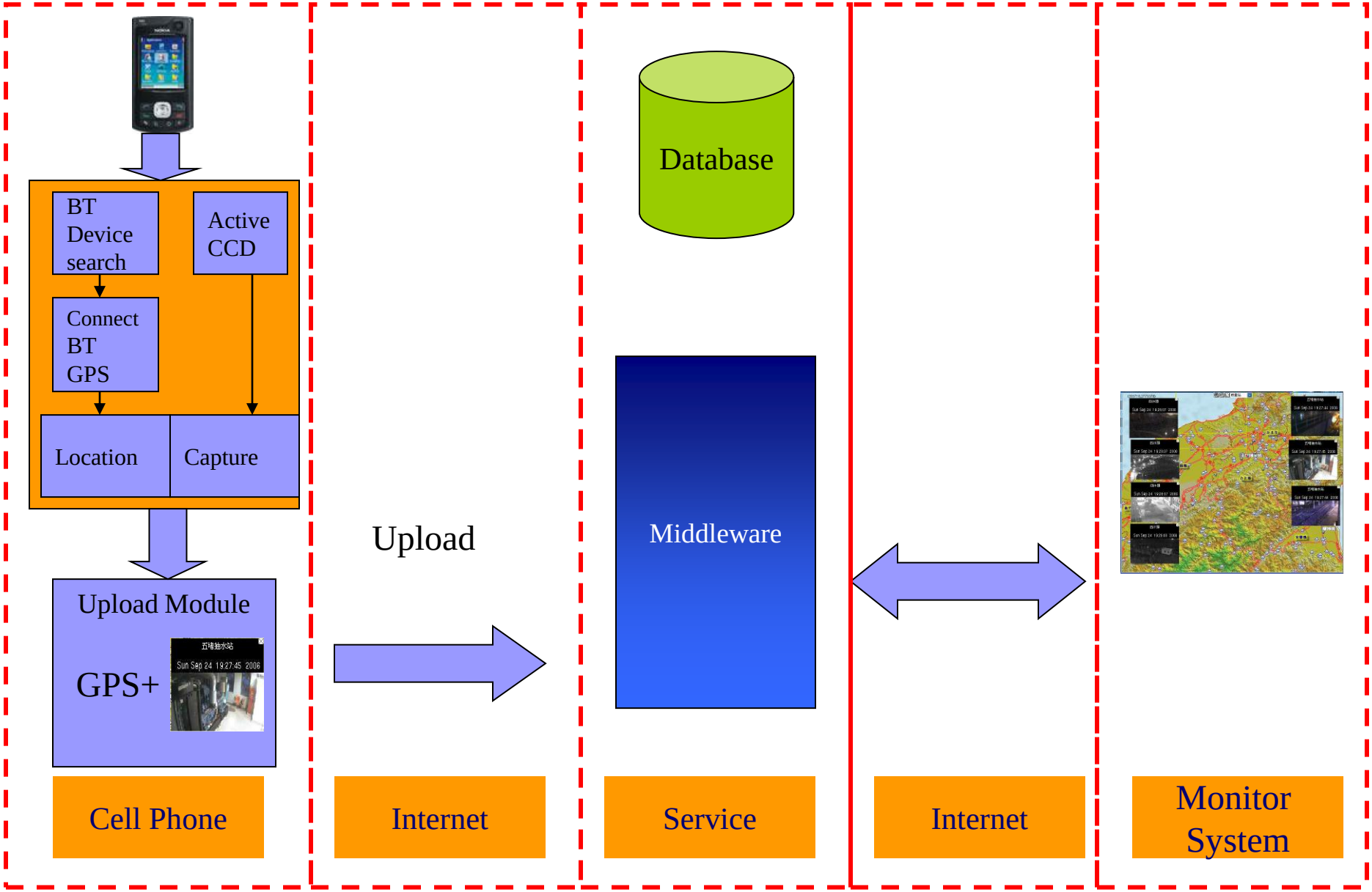
Advantages

- Small size
- Computing is more and more powerful
- Mobility
- LCD,CCD, Bluetooth, Internet, GPS
- Popularity

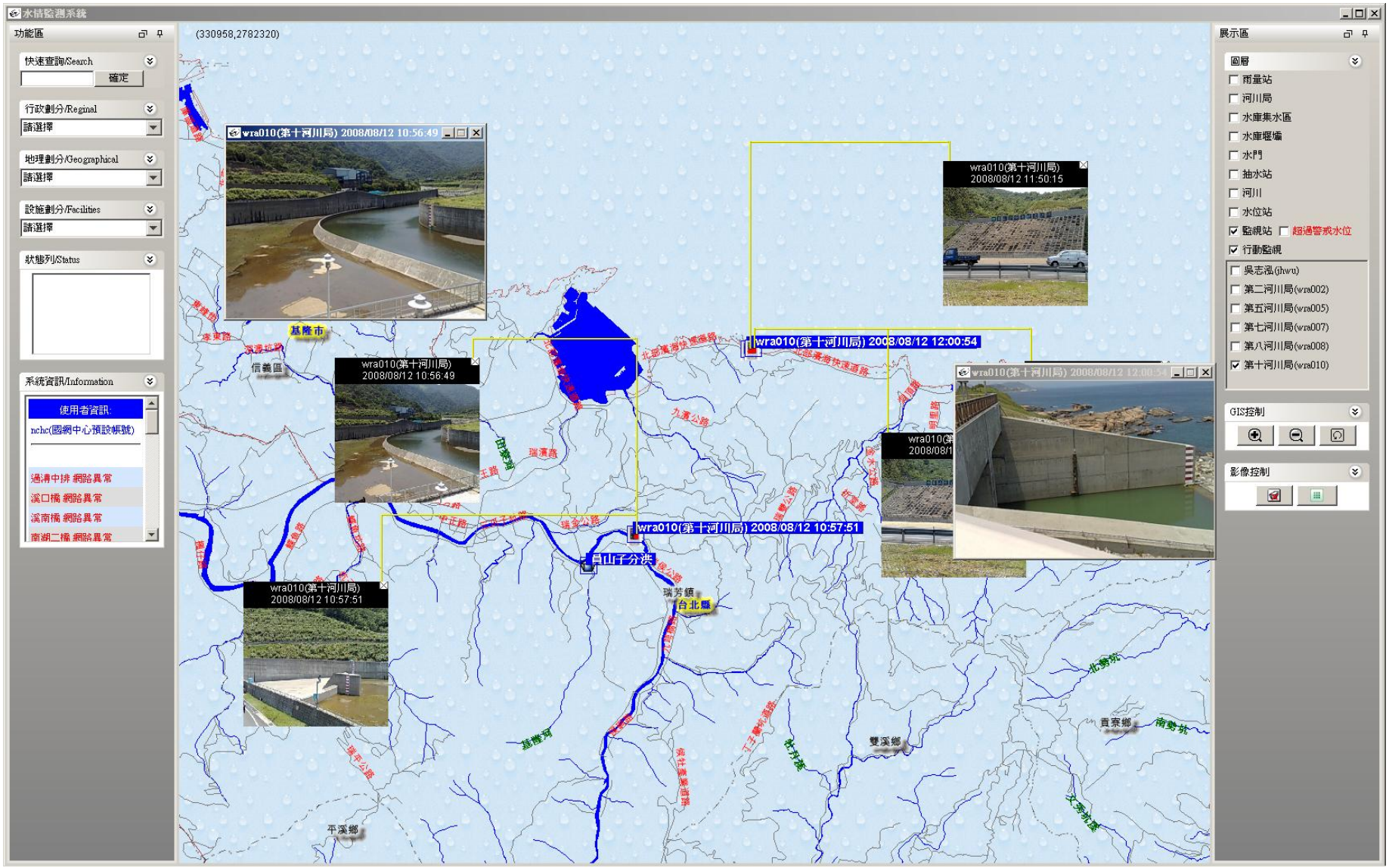
Workflow of Mobile Flood Watch



Workflow of Flood Report

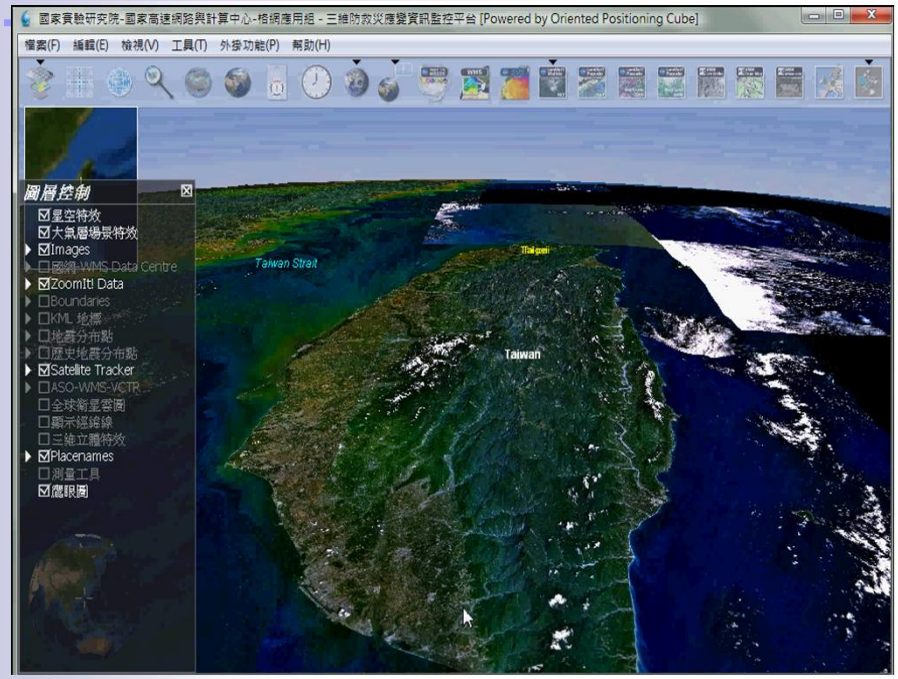


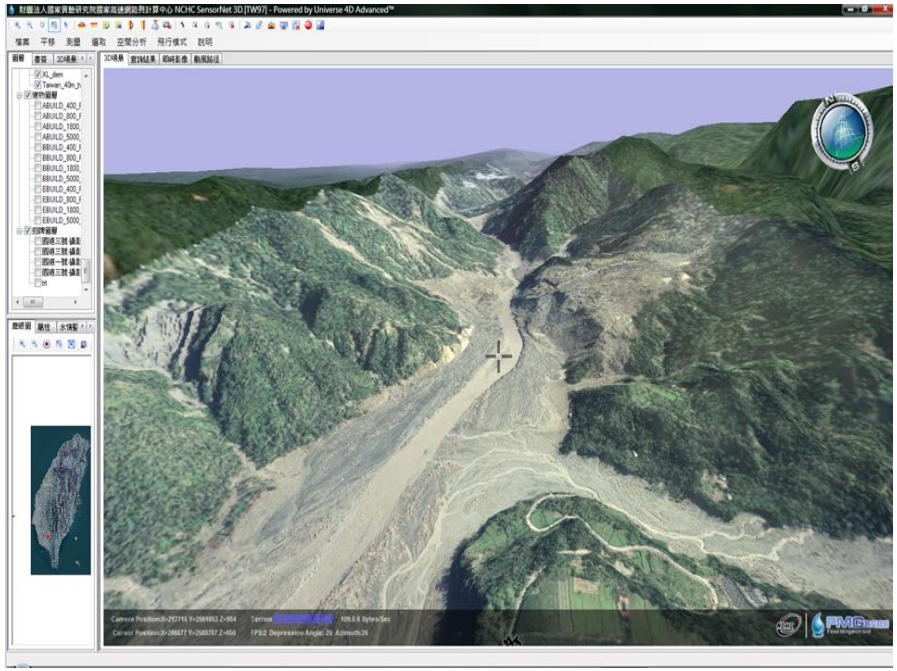
Watch Mobile Data via Flood Monitoring Sensor Network



The Web 3D GIS Taiwan Platform

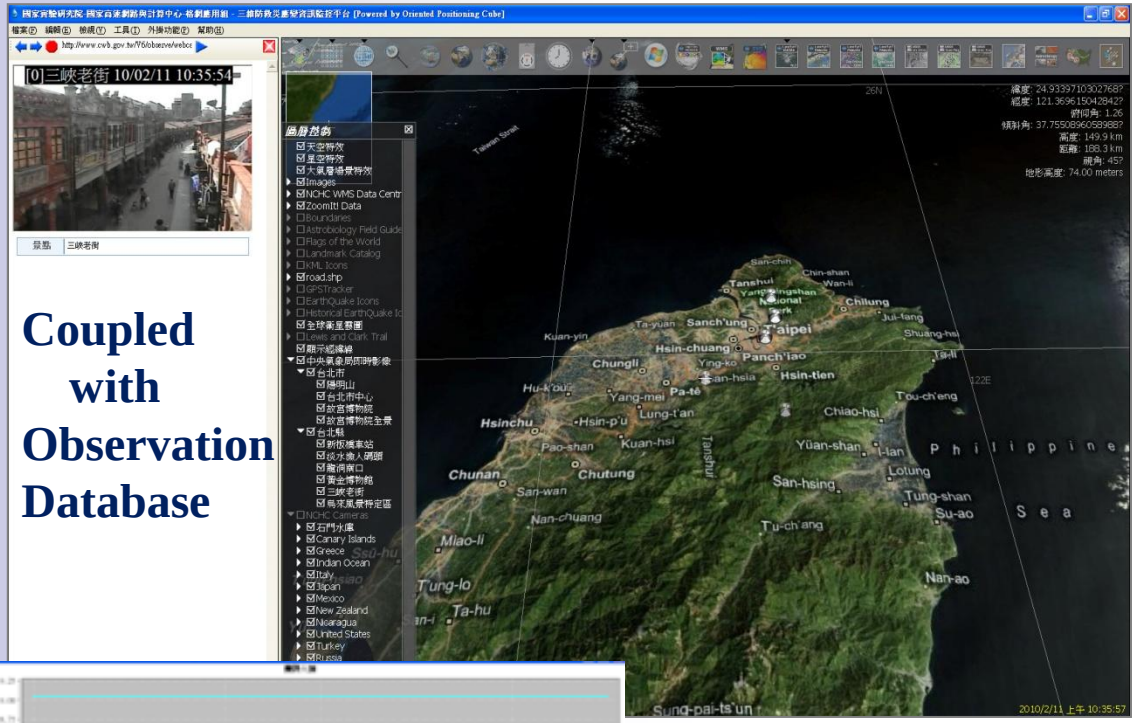
- Developed by modification of NASA World Wind system
- Encompassing Formosat-2 space borne and airborne images incorporated with data warehouse/fusion and high-performance visualization technologies.
- Linking with end-user disaster prevention database, sensor network, and analyzed model for decision support to disaster assessment and scenario identification

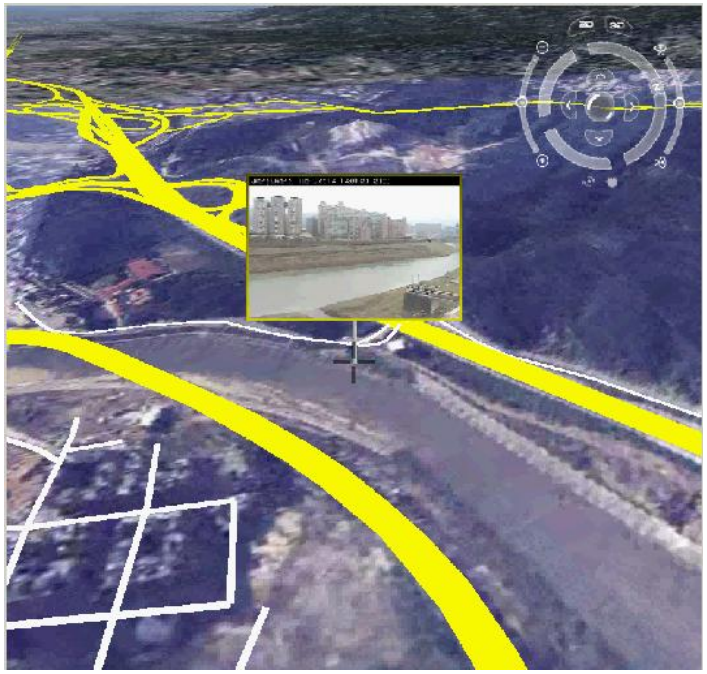


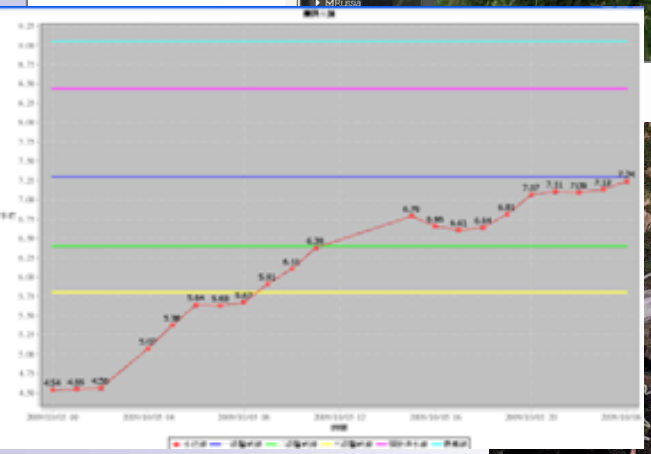


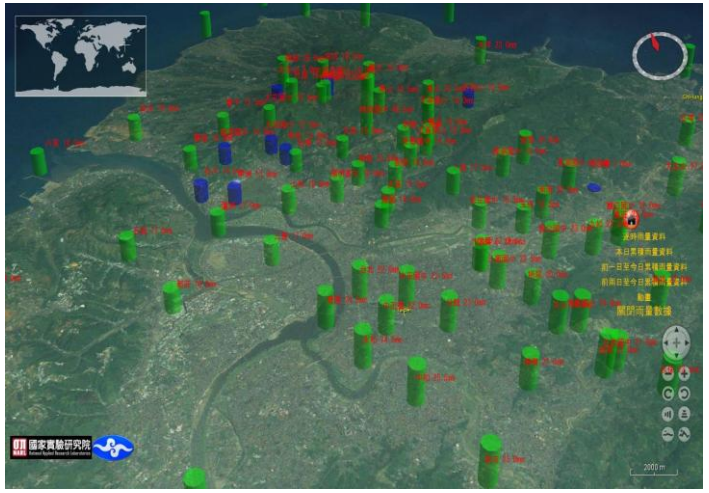
Integrated with Flood Monitoring Sensor Network

Coupled with Observation Database



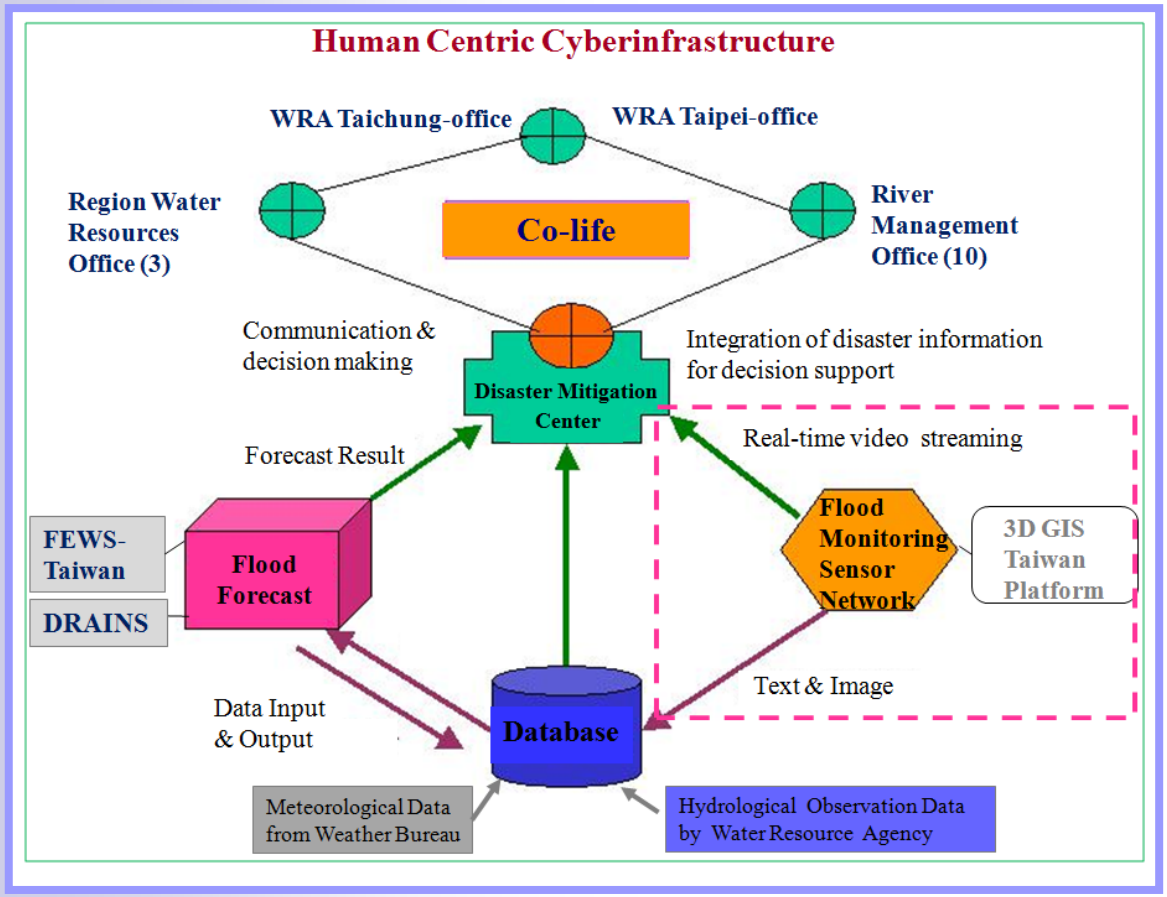






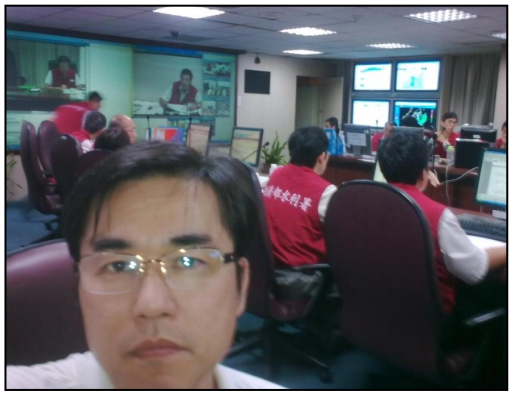
DEMO from Taiwan

Using Co-life for real-time communication and disaster scenario information sharing to support decision making in a flood event



Demo By

- *Hsi-Ching Lin*
- *Jen-Gaw Le*
- *Mulderyu Yu*
- *Stoca Chang*

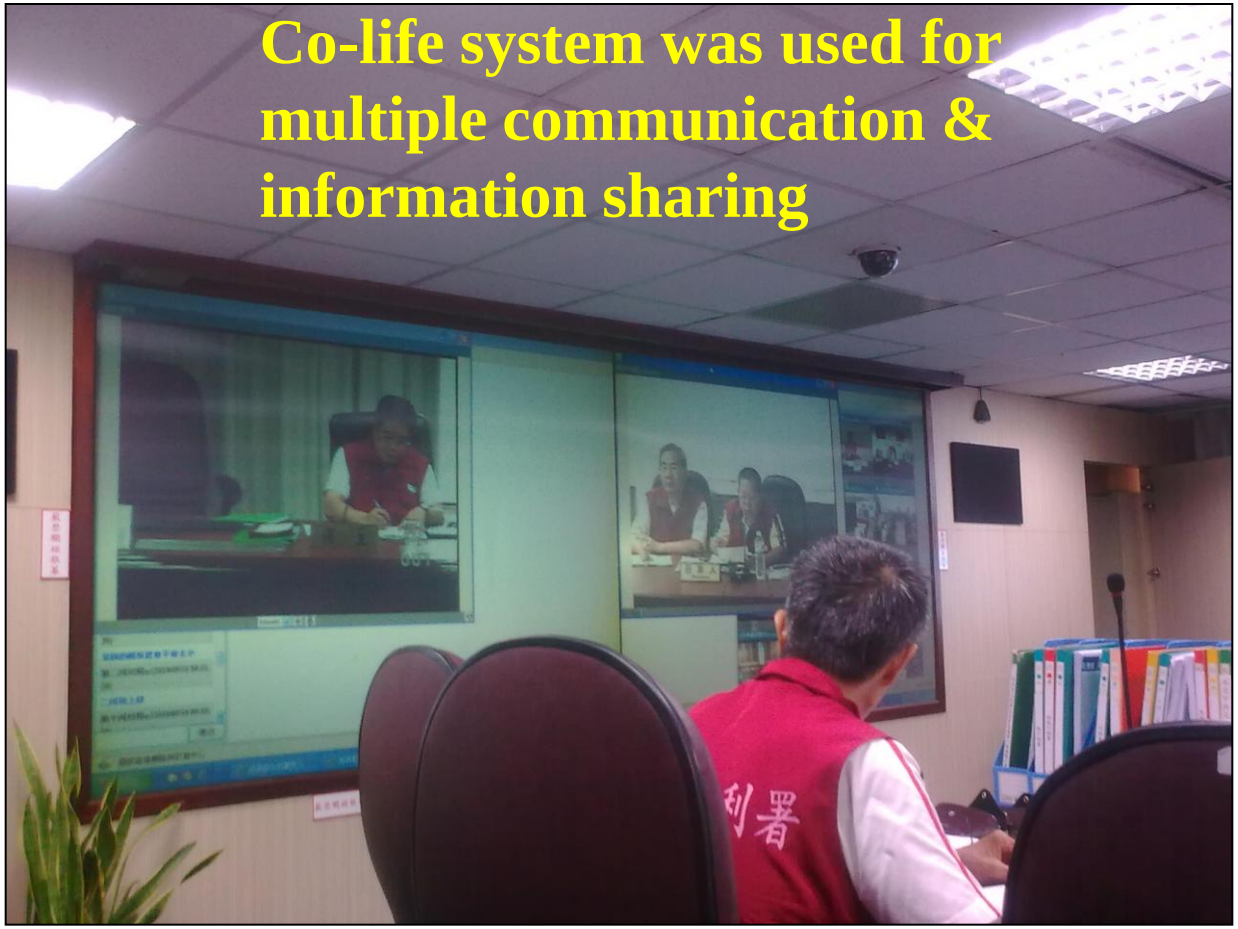


Flood Mitigation Operation in WRA during Typhoon Fanapi

Operation Sequence

1. WRA Chair attended the National Disaster Prevention & Rescue meeting (chaired by president) and brought back assignment.
2. WRA Chair calls a decision making meeting using Co-life system, WRA-Taipei office is the headquarter, WRA-Taichung office, 10 river management offices and 3 region water resource offices joint the communication meeting.
3. Meantime, all local-office members watch the real-time flood monitoring sites located in areas of duty.
4. WRA Chair first announces the assignment with support of relevant document s, and flood monitoring web directs to associated emergency sites
5. Local offices (River & water resource management offices) feed back to WRA chair, and report local disaster situation through documents (ppt, Word,..) and flood monitoring web.
6. After receiving message from local offices, WRA Chair makes decisions for necessary response to the flood event.

Flood Mitigation Operation in WRA during Typhoon Fanapi

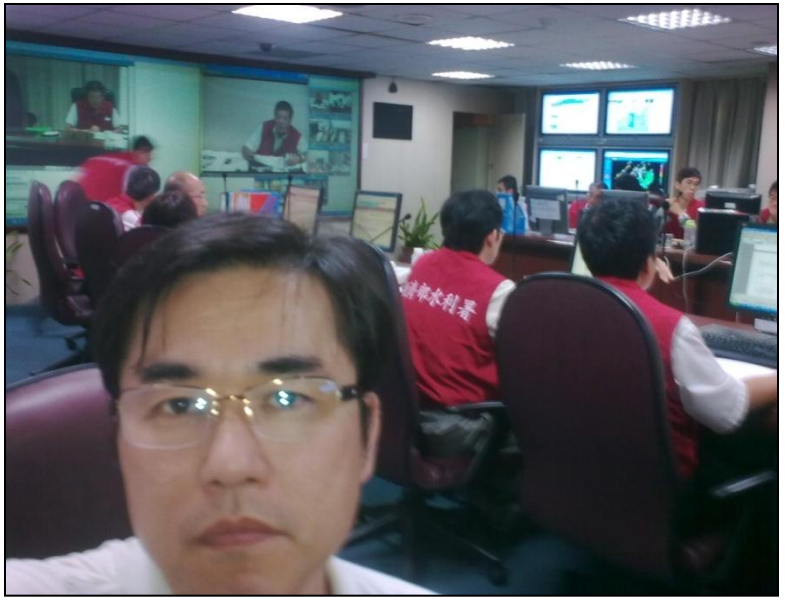


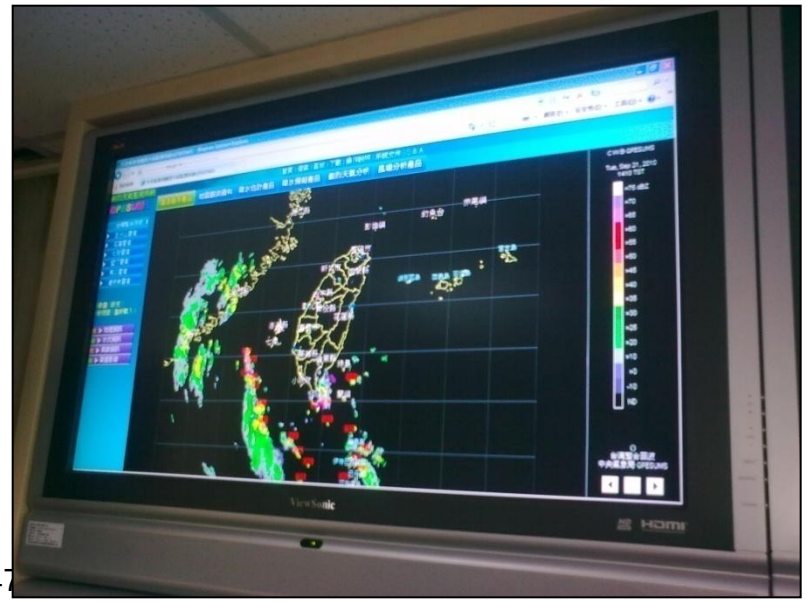
Decision Making Using Co-life Collaboration System

Chair of decision meeting, Director-General, Water Resources Agency; plus 13 River and Water Resource Management Offices

鳳凰颱風期間員山仔分洪情況

Flood Mitigation Operation in WRA during Typhoon Fanapi





Summary

- **Features of current Flood Mitigation Grid (FMG)**
  - **Highly available (Mission oriented)**
  - **Scalable**
  - **Dynamic**
  - **Real-time (monitoring & communication)**
  - **Integrity and the synergy of all above**
- **FMG is a human-centered synthetic system, a full-scale FMG has been adopted as DSS for practical flood mitigation, although robustness of overall components in FMG can be continuously improved.**
- **The usefulness and benefit of the Flood Mitigation Grid is ratified by Water Resource Agency in each flood event. Extensive research on improvement of system automation is still on going.**

Contacts

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Thank you for Your Attention