

## **Disclaimer**

This report was compiled by an ADRC visiting researcher (VR) from ADRC member countries.

The views expressed in the report do not necessarily reflect the views of the ADRC. The boundaries and names shown and the designations used on the maps in the report also do not imply official endorsement or acceptance by the ADRC.

## Application of Geographic Information System (GIS), Remote Sensing, and Information & Communication Technology for Disaster Risk Reduction in Bhutan

*"Disaster Risk Management can be more efficaciously addressed with the support of Geo-spatial technologies and Spatial Decision Support Systems"*

**Pema Thinley**

pemaddm@gmail.com



April 22, 2014

Response & Relief Division  
Department of Disaster Management  
Ministry of Home & Cultural Affairs  
Royal Government of Bhutan

Visiting Researchers Program  
January - April, 2014  
Asian Disaster Reduction Center (ADRC)  
Kobe, Japan

Hazard and Vulnerability Mapping

Emergency Response System

Disaster Management Information System



Emergency Operation Center

Emergency Communication System

Early Warning System

Hazard and Vulnerability Mapping

Emergency Response System

Disaster Management Information System



Emergency Operation Center

Emergency Communication System

Early Warning System

# Hazard and Vulnerability Mapping

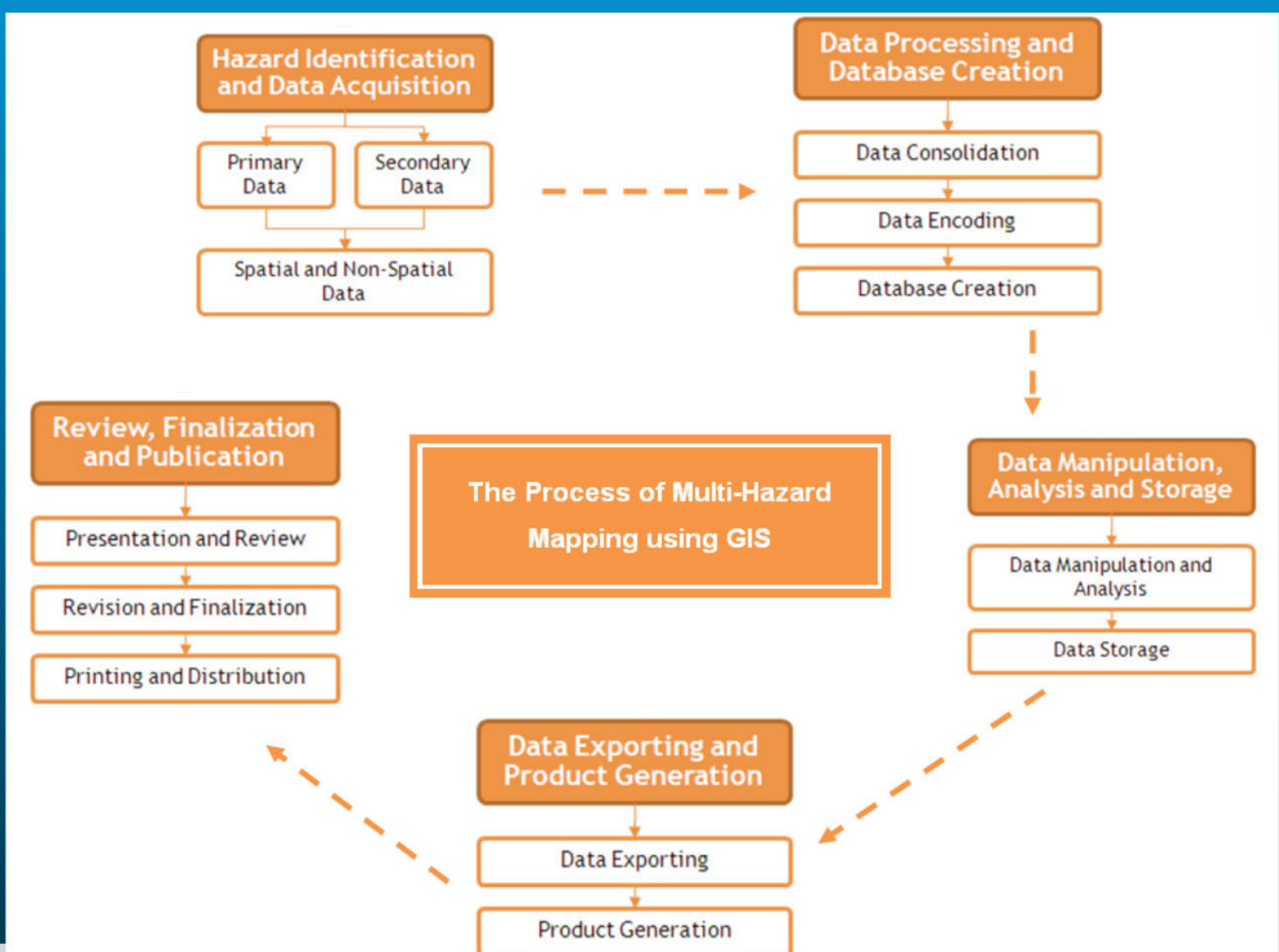
## Hazard Mapping carried out till now

Sl. No.	Agency	Hazard Assessments
1	Survey & GIS Division, DHS, MoWHS	Geotechnical study (floods & landslides) for Bumthang, Duksum, Deothang and Trashigang towns
2	Geotechnical Unit, DoR, MoWHS	Landslide or Geomorphologic maps of Highway roads
3	DGM, MoEA	Earthquake Probabilistic Seismic Hazard Assessment (on-going project with Norsar, Norway); Flood Hazard Zonation & Risk Assessment along Punatshang Chu & Chamkhar Chu (GLOF induced floods); Landslide zonation mapping of Kabreytar, Phuentsholing; Dagana and Sarpang towns; & landslide mapping along highways (Pasakha to Phuntsholing; Phuntsholing to Samtse; Samdrup Jongkhar to Tashigang; Gelephu to Trongsa; Sarpang to Tserang)
4	DHMS, MoEA	Flood Assessment for Chamkhar river & Punatsangchu; Landslide assessment in Southern foothill watersheds; & Windstorm assessment as part of Daily Weather forecast
5	Soil Service Unit, NSSC, DoA, MoAF	Landslide & soil erosion for particular agricultural centers: Bhur, Zhemgang; Lingmethang, Mongar; Ramtokto, Thimphu; Radhi, Trashingang and Lami Gonpa, Bumthang.

# Actors involved in Hazard and Vulnerability Mapping

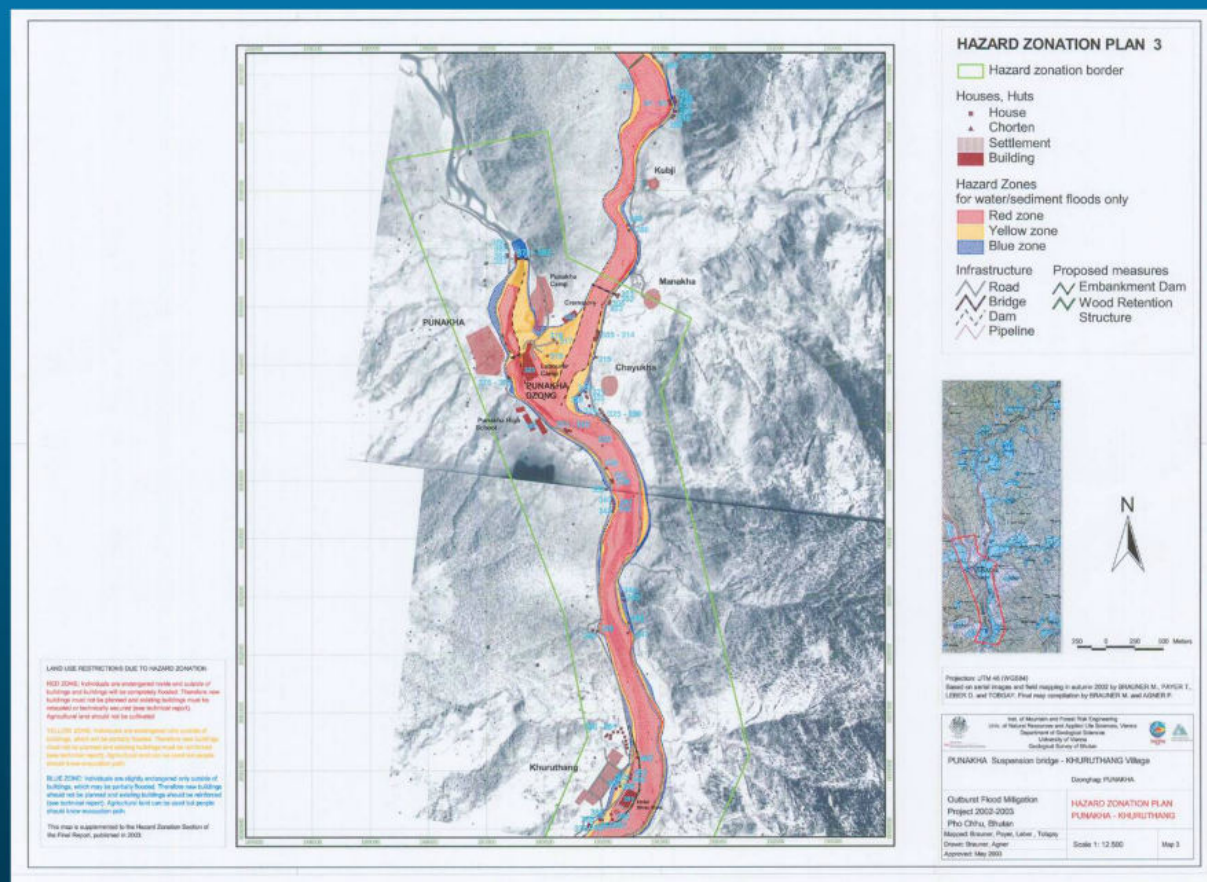
Sl. No	Agency	Mandate (Nature of Hazard)
1	Engineering Adaption & Risk Reduction Division, DES, MoWHS	Structural vulnerability assessment and post earthquake safety assessment
2	Flood Engineering Management Division, DES, MoWHS	Flood risk assessment (all major rivers)
3	Survey & GIS Division, MoWHS	Multi-Hazard risk assessment (all Human Settlements)
4	Geotechnical Unit, DoR, MoWHS	Landslide assessment along National Highways
5	Department of Geology and Mines, MoEA	Earthquake, Floods (GLoF) and Landslide assessment
6	Department of Hydro-met Services, MoEA	Flood (all major rivers), Landslide, Windstorm (need based)
7	GIS Section, Forest Resource Management Division, Department of Forest and Park Services, MoAF	Fire hazard assessment (need based)
8	Soil Service Unit, National Soil Service Centre, Department of Agriculture, MoAF	Soil Survey and Land Evaluation (includes Landslide and Soil Erosion on need based)
9	GIS Division, Thimphu Thromde	Disaster Risk Assessment (Thimphu city)

## Process of Hazard Mapping using GIS Tool





1. Lack of access to quality data
2. Conventional maps
3. Unclear roles and responsibilities of government agencies for hazard mapping
4. Insufficient appropriate equipments and
5. Lack of technical capacity with relevant agencies.



pemaddm@gmail.com

# Emergency Operation Center

pemaddm@gmail.com

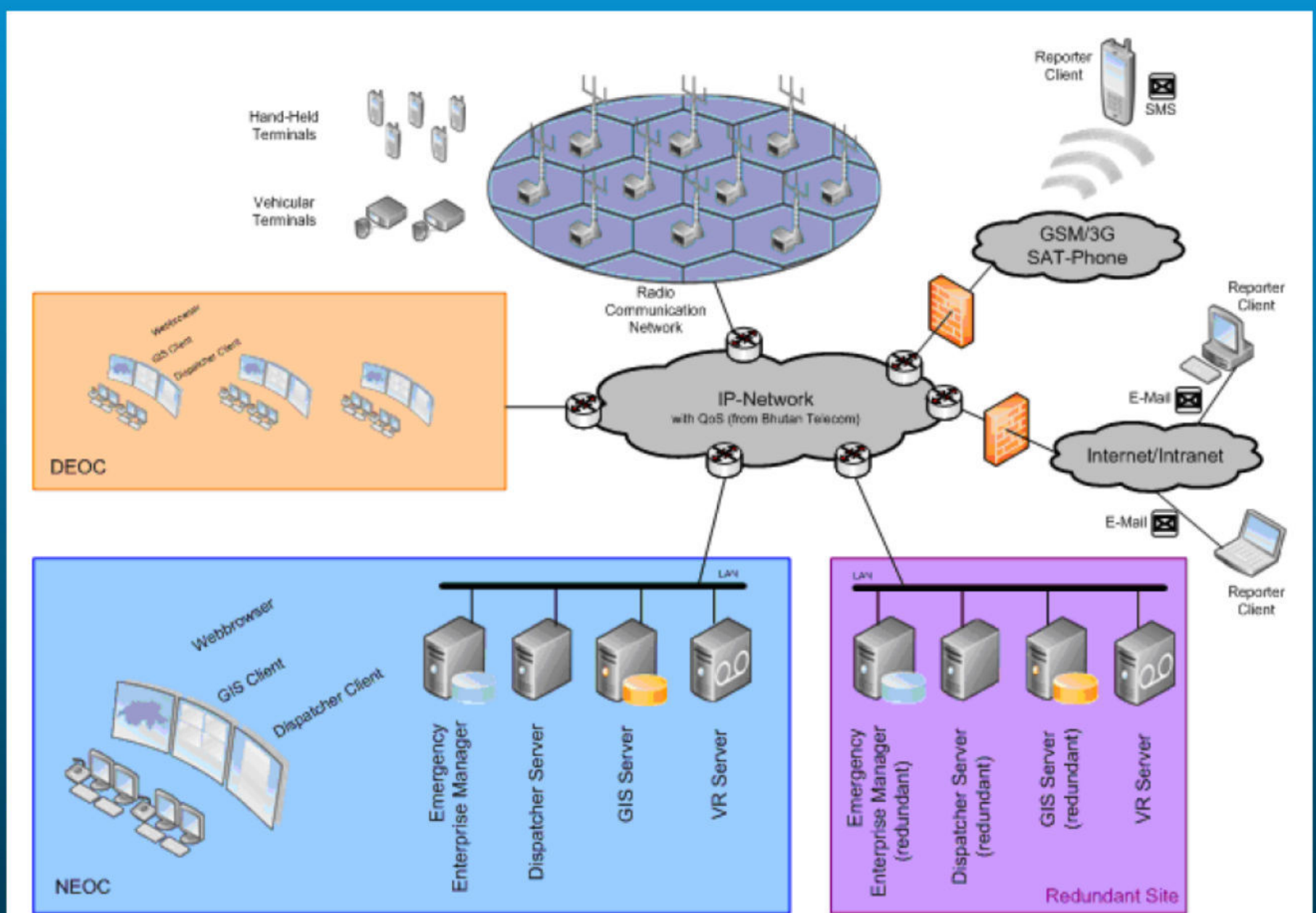
The Chapter 10 of the DDM Act mandates the DDM to setup EOC at the national and district level.

**“There shall be a National Emergency Operation Centre established by the Department of Disaster Management including Dzongkhag Emergency Operation Centres”**

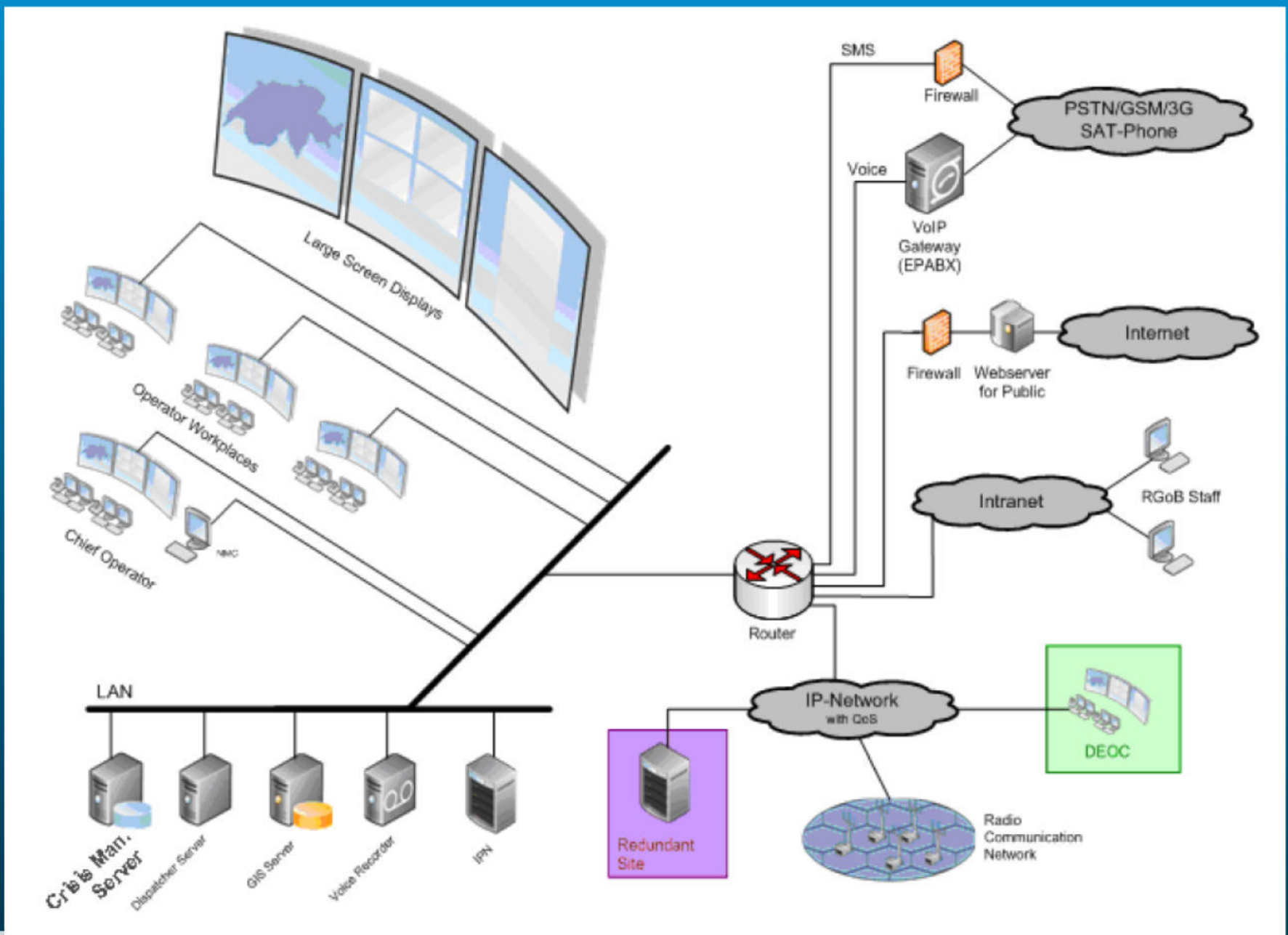
## Basic roles of EOC

- Maintain up-to-date and relevant data/information/documents on DRR.
- Detailed inventory of emergency resources.
- Contact details of the members of Disaster Management Committee at different level
- Link up to National Emergency Communication network.
- Invoke incident management steps to generate the quickest and effective response.

## System layout for National and District Emergency Operation Center





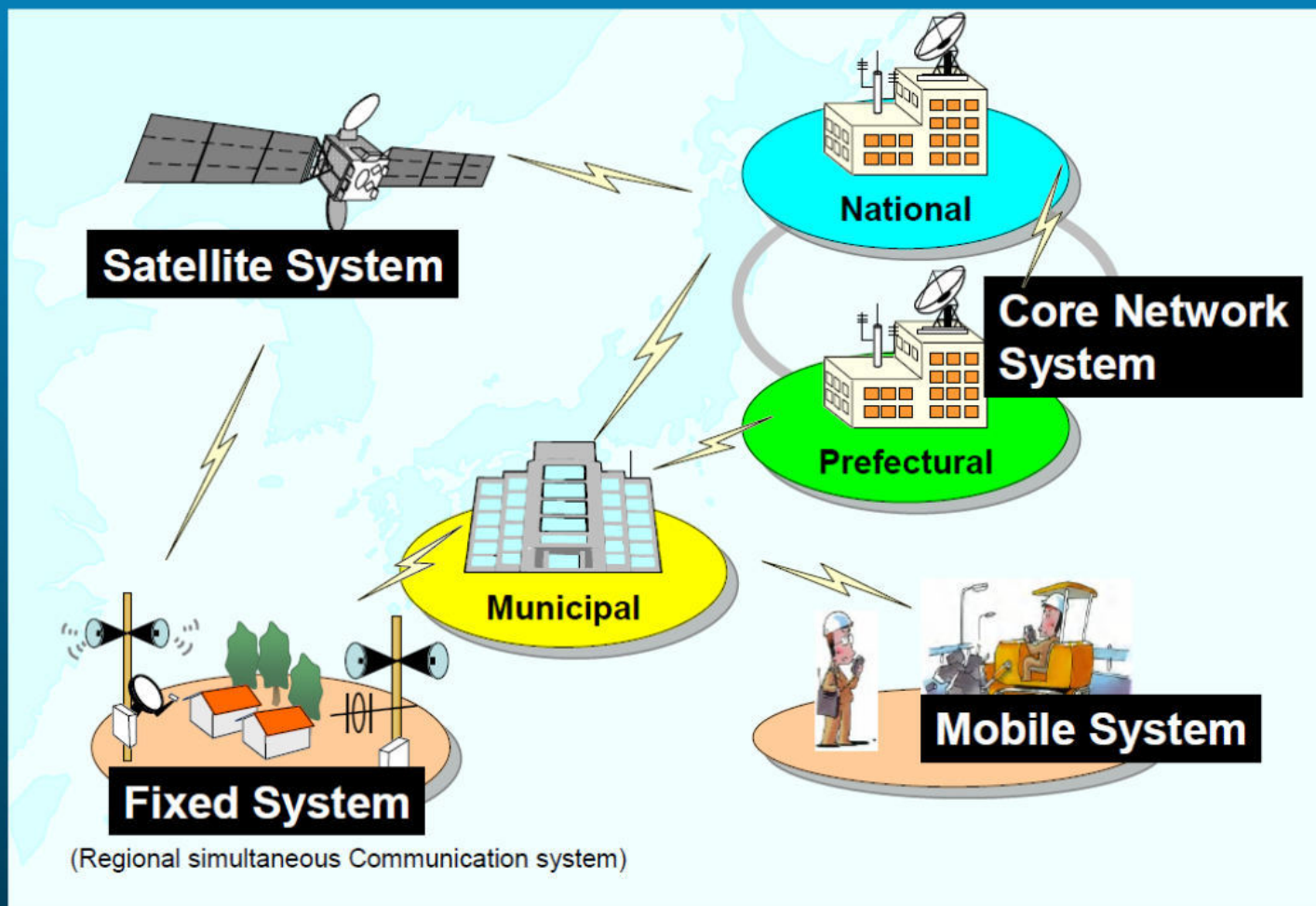




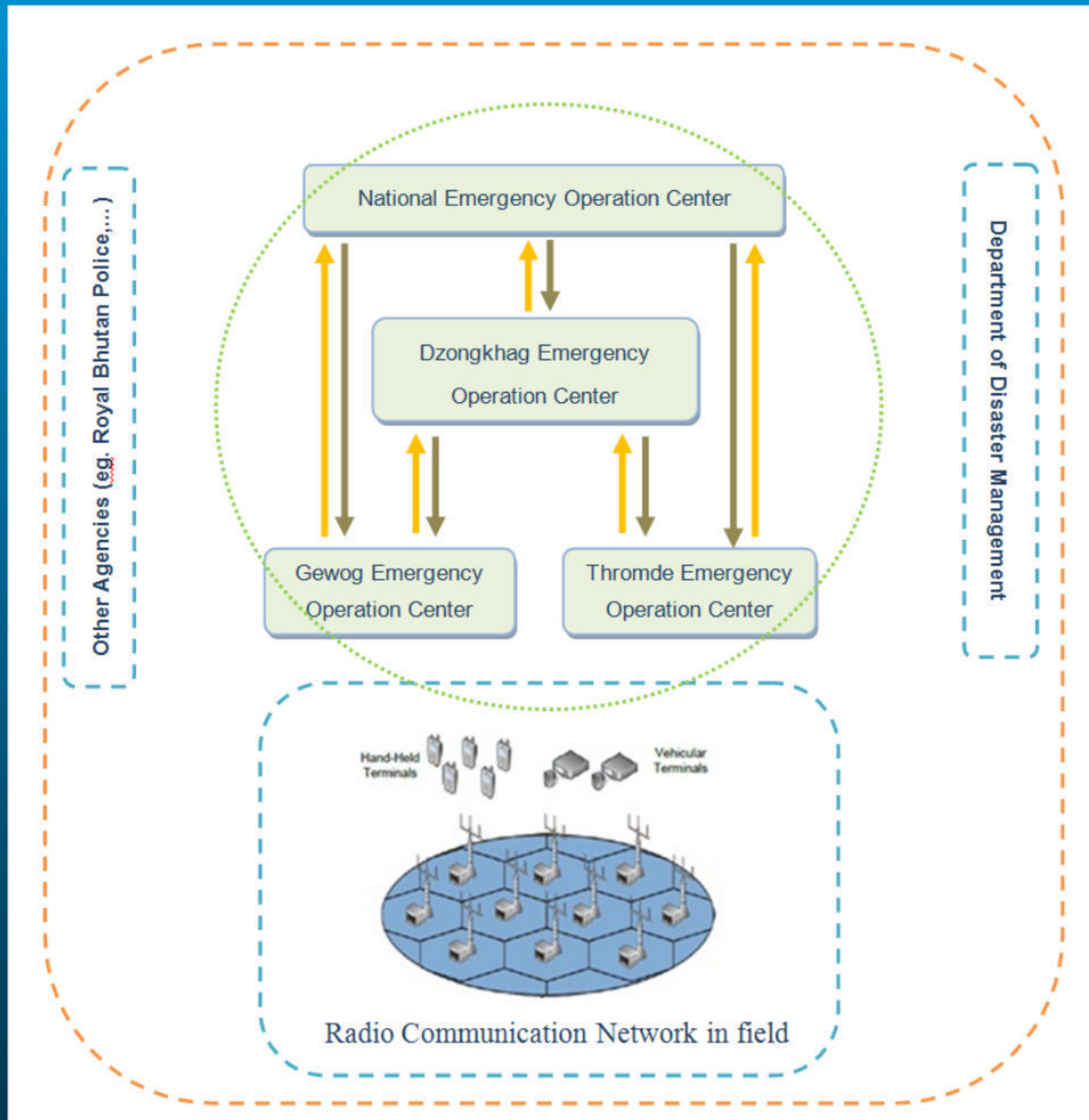
# Emergency Communication System

## Emergency Communication System

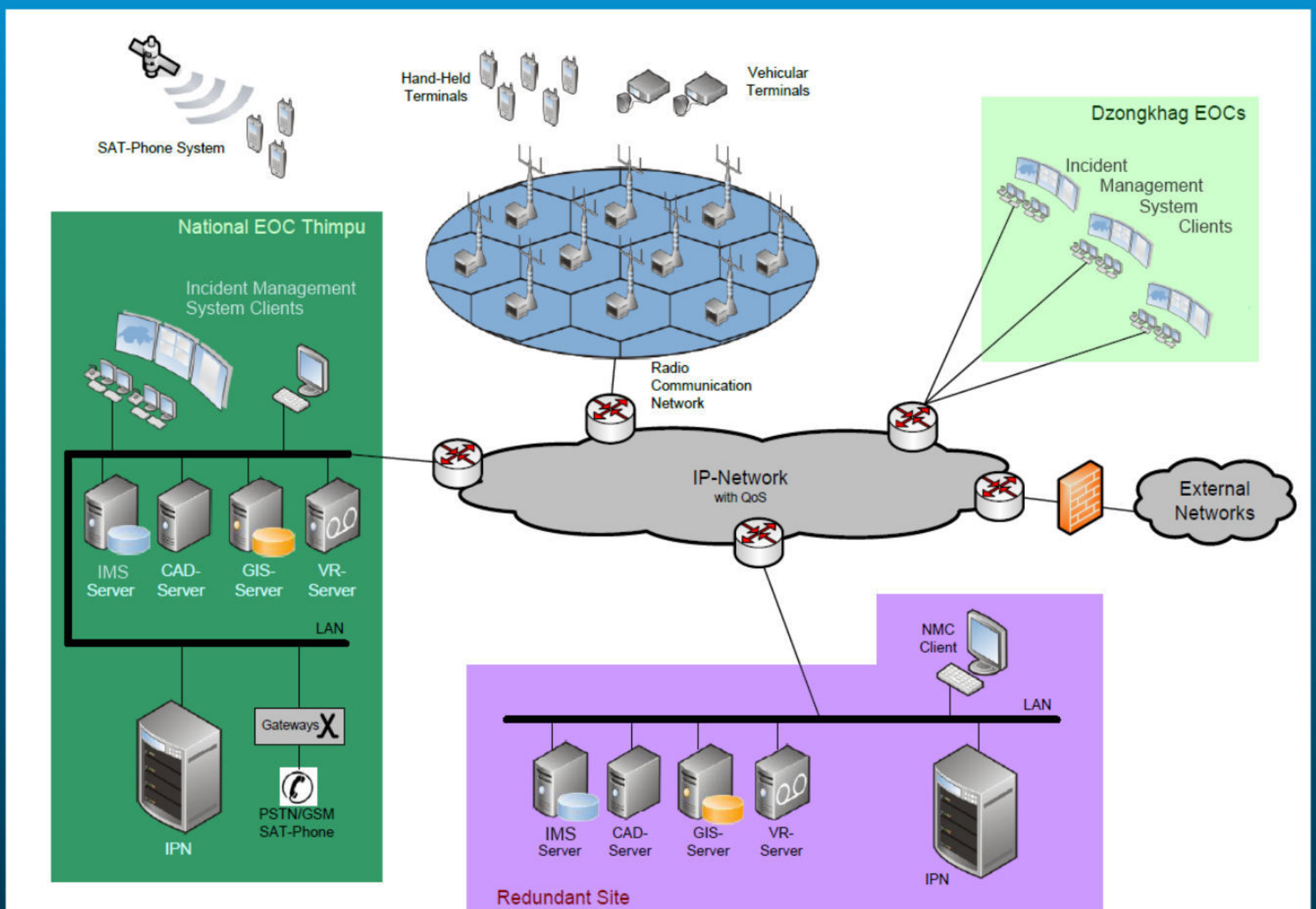
**Objective:** To develop capacities for communication with sufficient redundancy during the time of disaster.



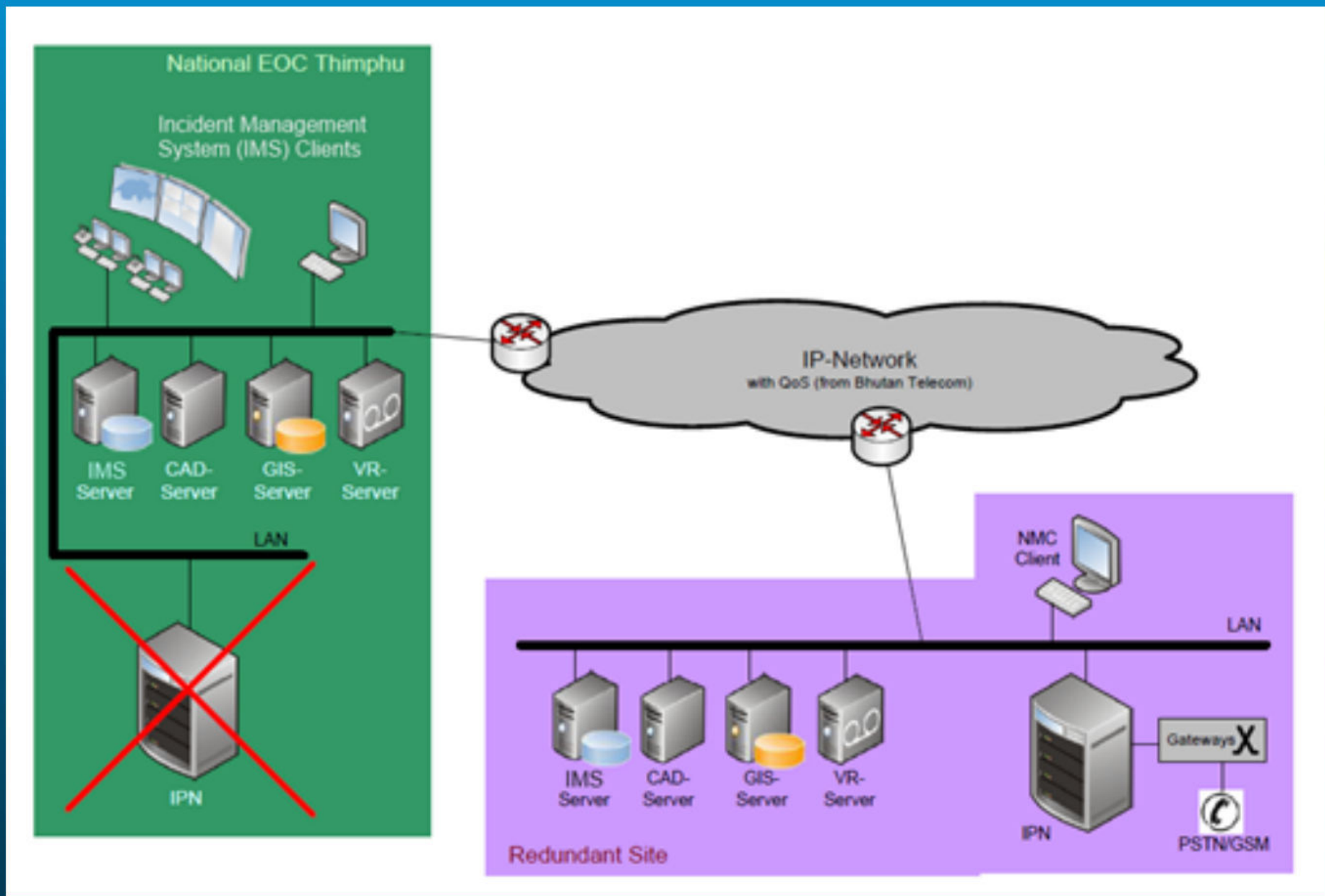




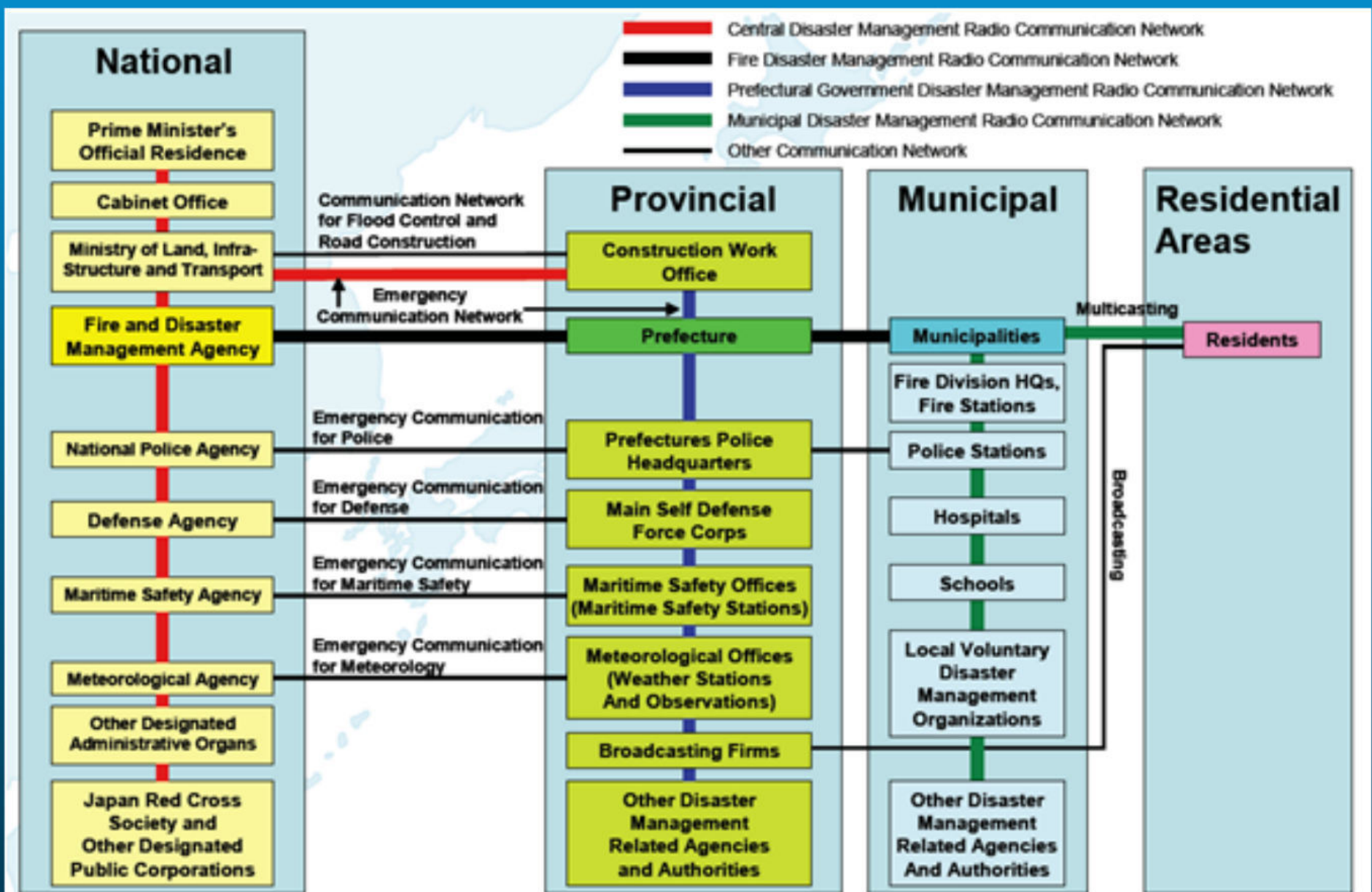
## General System Overview with TETRA solution



# Redundancy of the communication service with TETRA



# Disaster Management Communication System Network of Japan





# Early Warning System

## Early Warning System

According to the World Bank, one of the three key sectors where investment can be focused to help minimize the effects of, or even prevent, disasters is that of early warning systems

Early warning system is an integration of the following four elements:

1. Risk Knowledge
2. Monitoring and Predicting
3. Disseminating Information
4. Response

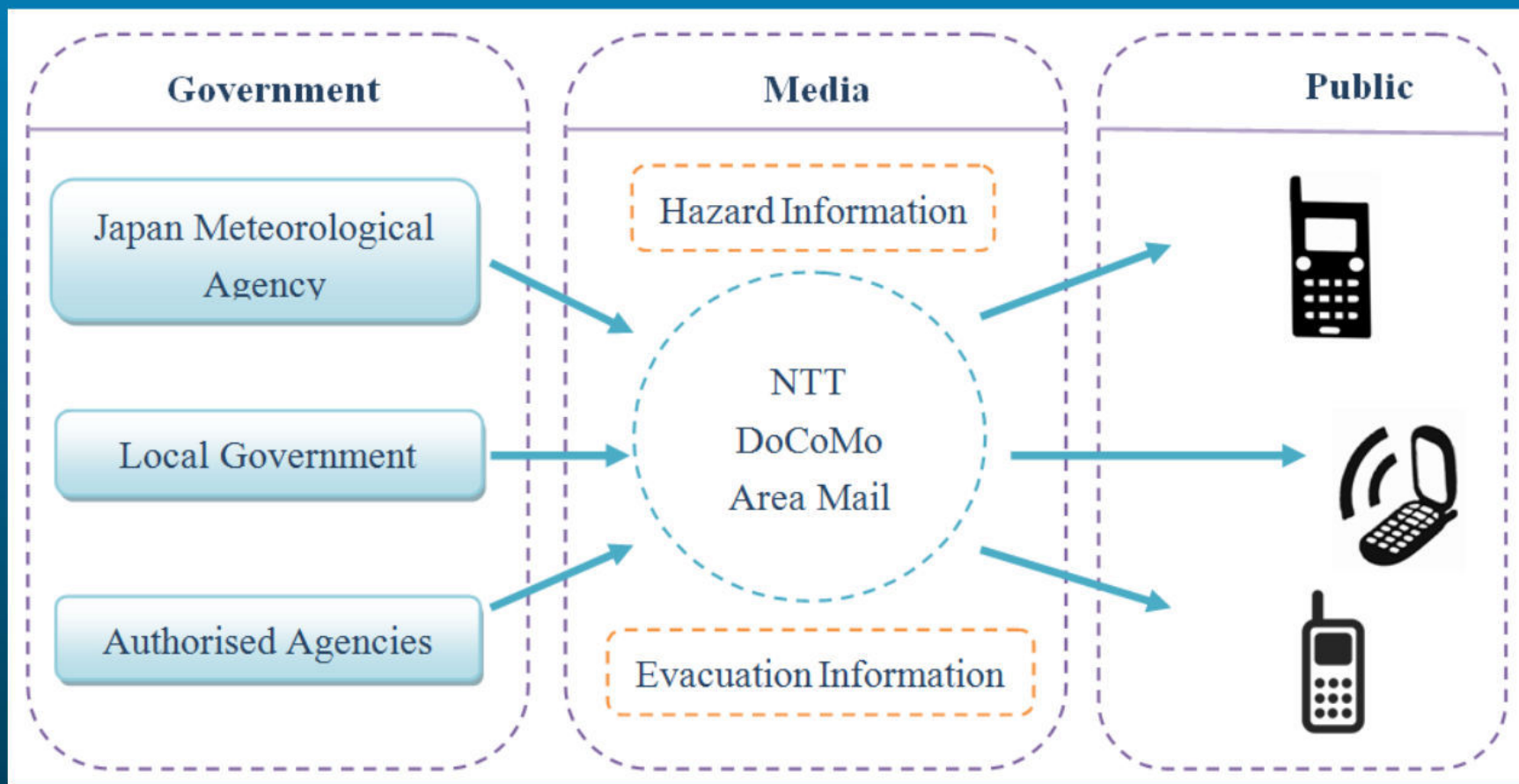
### Disseminating Information

#### *Short Messaging System vs Cell Broadcast*

SMS sends messages on a one-to-one basis while CB is a one-to-many broadcasts messaging service

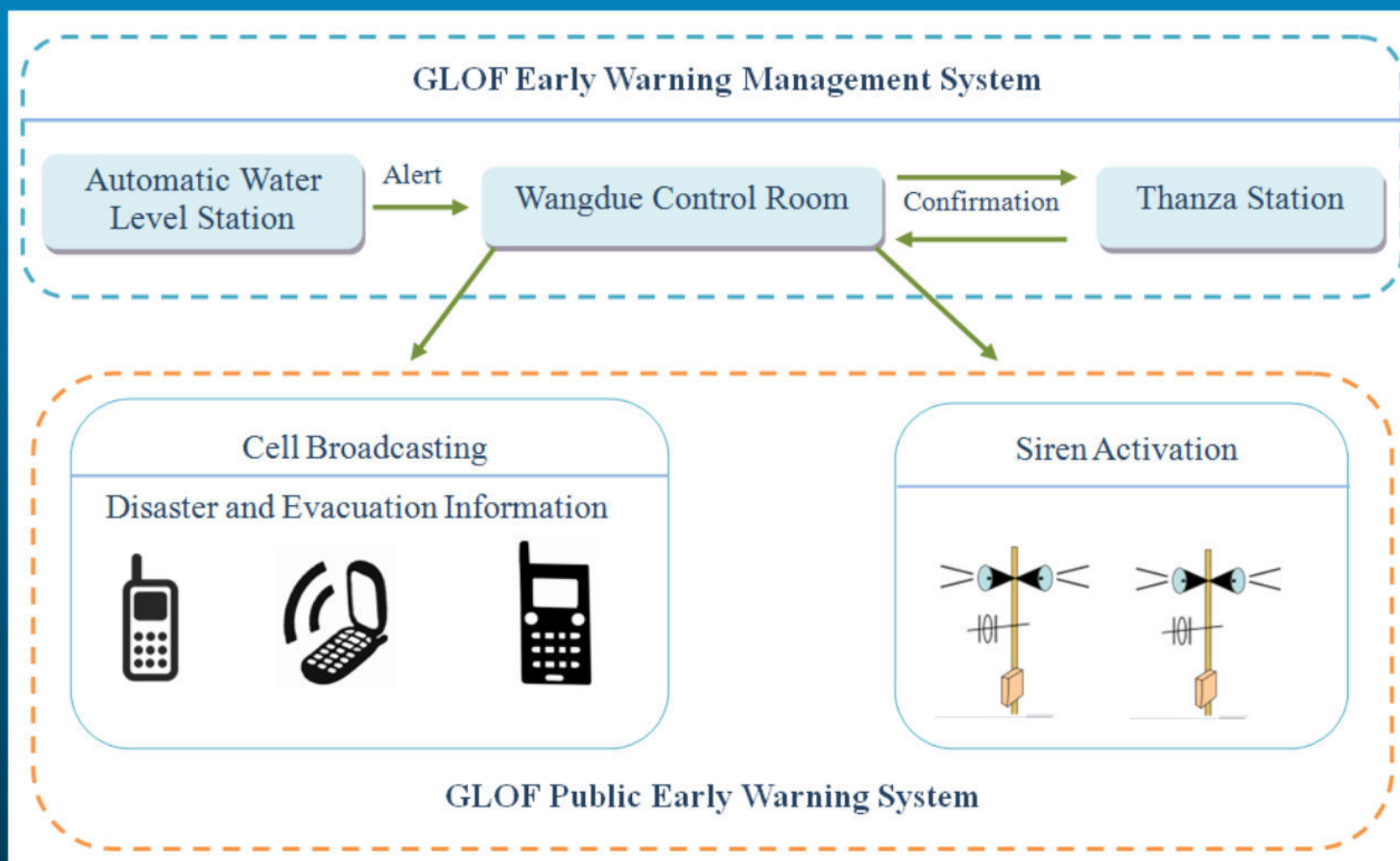
# Cell Broadcast based Public Early Warning System

A Case Study of Japan: NTT DoCoMo's "Area Mail" Earthquake Early Warning information dissemination system.



# Cell Broadcast based Public Early Warning System in Bhutan

## The GLOF Early Warning System



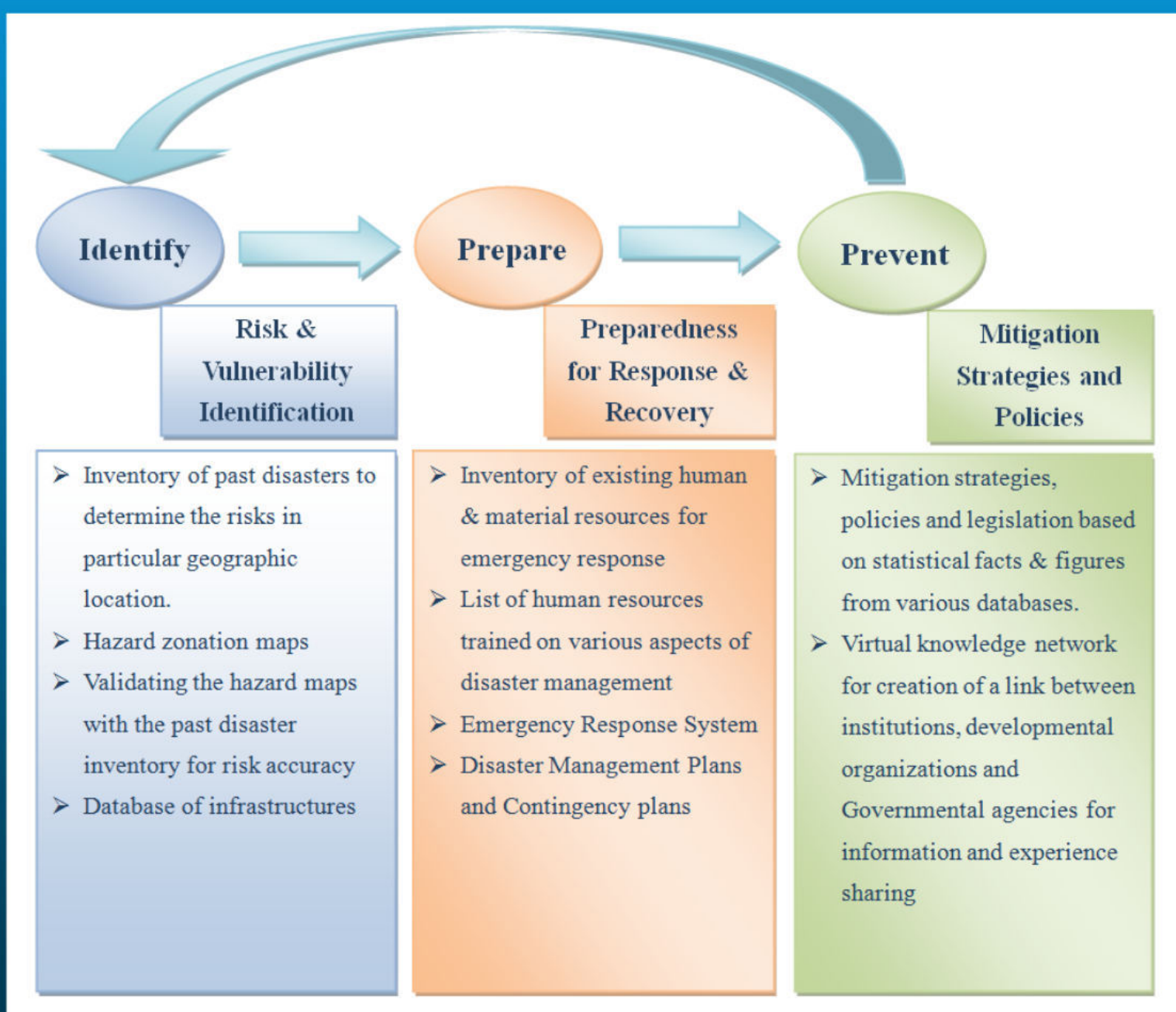


# Disaster Management Information System

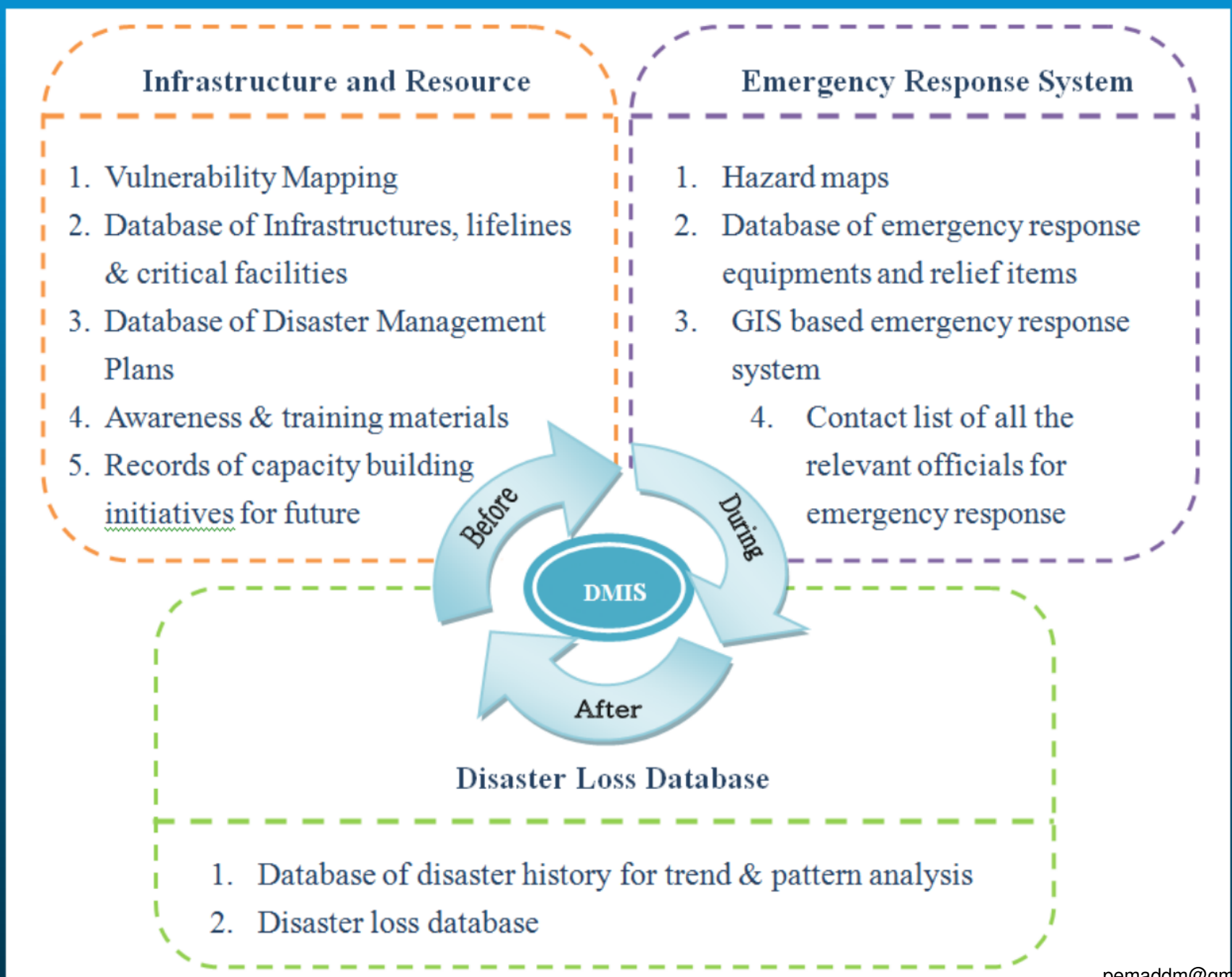


# Role

## The Role of Disaster Management Information System







pemaddm@gmail.com

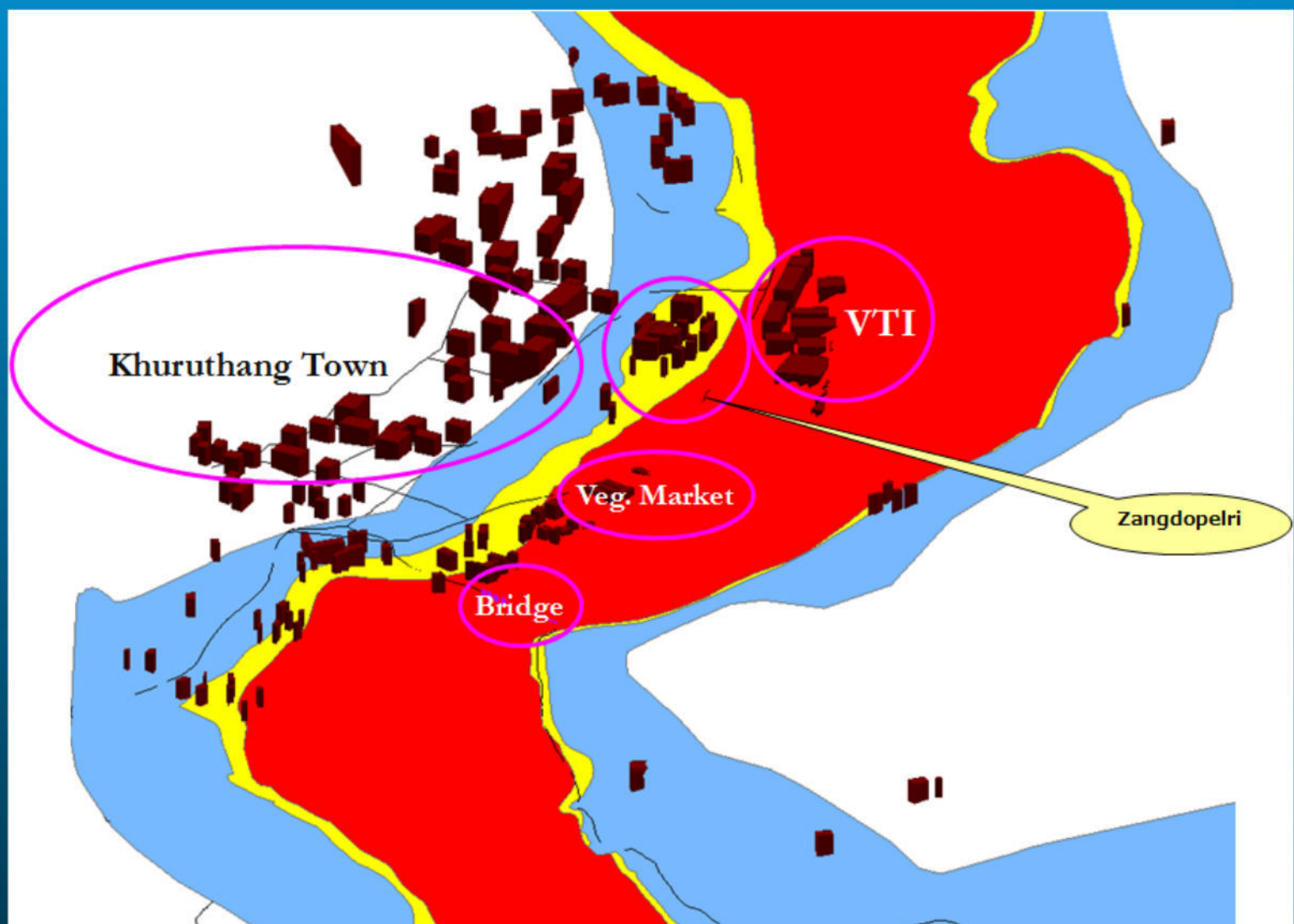
# Infrastructure Database

pemaddm@gmail.com

"The risk managers and the communities can make effective decisions to reduce disaster risks only if they have the knowledge of the assets that are at risk"



## The Application of Infrastructure Database














# Resource Database

## Resource Database

"Responding to an emergency involves such intensive activities as arranging available resources and materials, mobilizing and coordinating sufficient skilled responders, deploying them with proper equipments to where they are needed"

Relief Item											
No.	Operation	Dzongkhag	Description	Quantity	Year	Condition	Incharge	Designation	Issued on	Remark	
1	 	Bumthang	Family Kit	70	2014	Good	Pema Tshering	Chief Accountant	2009-06-08		
2	 	Bumthang	Family Kit	100	2014	Good	Chimi Wangchuk	Environment Officer	2010-01-04		
3	 	Bumthang	Family Kit	100	2014	Good	Sonam Wangdi		2011-11-10		

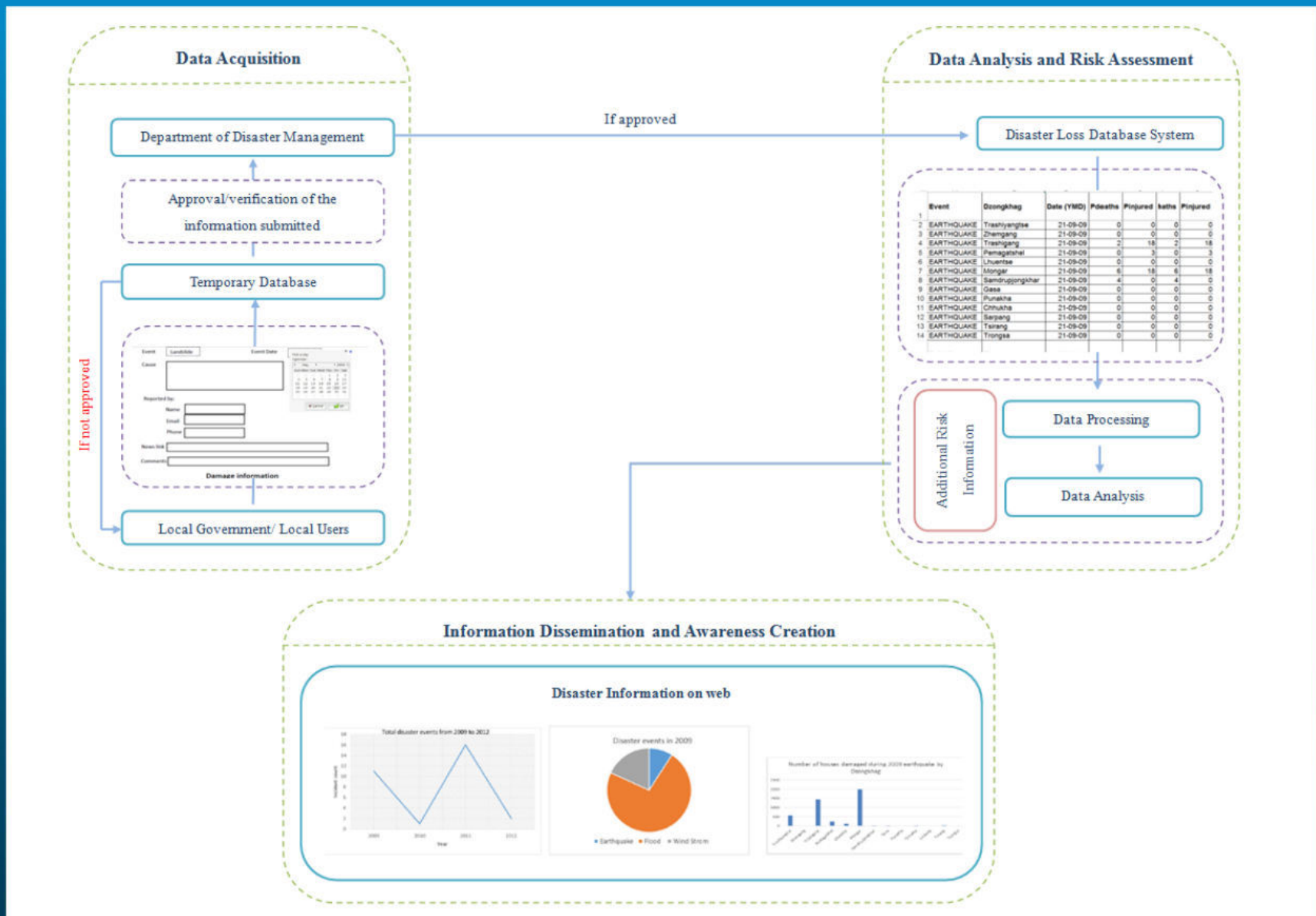
Search & Rescue Item											
No.	Operation	Dzongkhag	Description	Quantity	Year	Condition	Incharge	Designation	Issued on	Remark	
1	 	Bumthang	10ft. Foldable ladder	2	2014	Good	Chimi Wangchuk	Dzongkhag Environment Off	2010-01-01		
2	 	Bumthang	Life Vest	4	2014	Damaged	Chimi Wangchuk	Dzongkhag Environment Off	2010-01-01		

# Disaster Loss Database System

## Post Disaster Reporting System and Disaster Loss Database

- Create an inventory database of disasters that facilitates understanding of disaster patterns to improve disaster management.
- Create a database of losses, damages and effects caused by disasters
- Analysis of a systematic geo-referenced inventory of small, medium and large-scale disasters
- Creating political and bureaucratic will to manage disaster risk before the occurrence with the analysis of past disaster records
- To rationalize decision making for disaster preparedness, as well as providing an objective base for vulnerability assessment and priority setting
- To support planning & policy decisions for disaster preparedness and mitigation.
- To test the accuracy of different risk assessment models against the real events, post-disaster data collection is necessity





# Emergency Response System

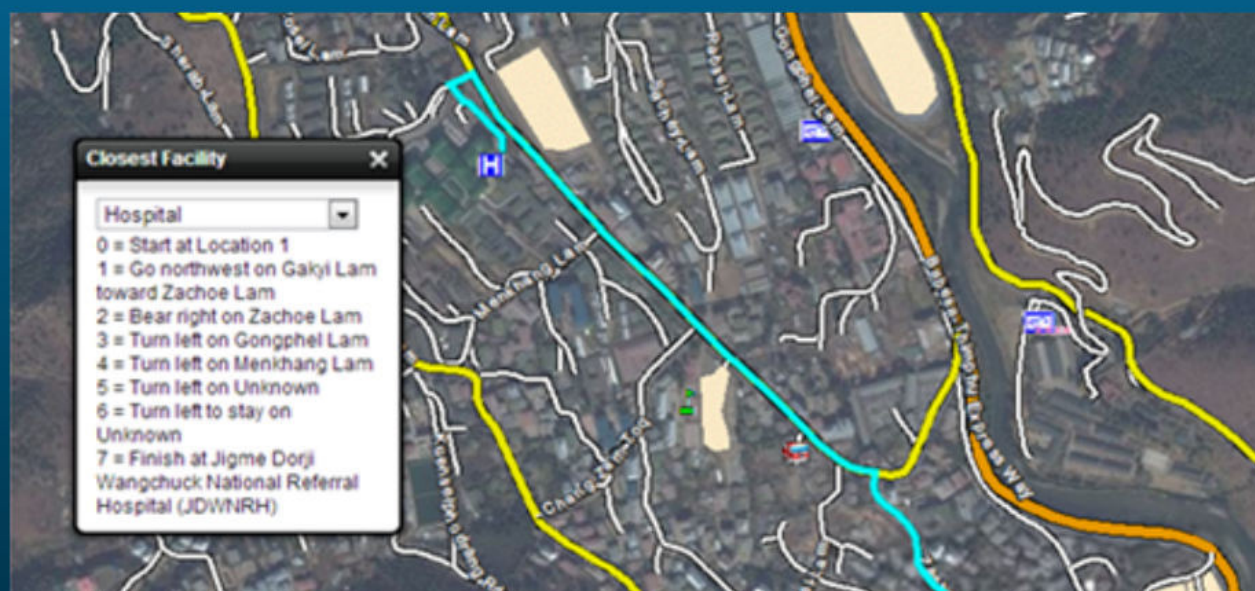
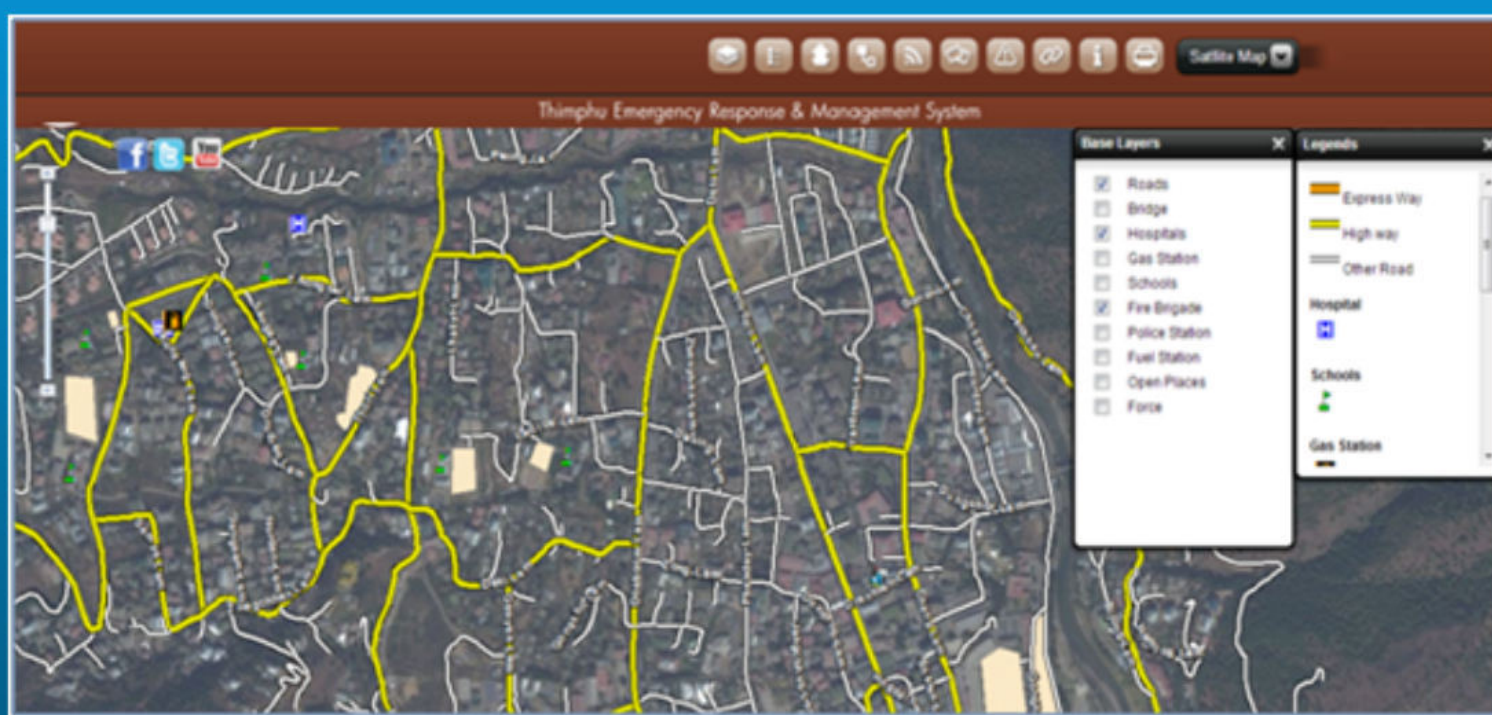
# Emergency Response System

"During the response phase of an emergency, the information systems designed for emergency response operations can enormously support the responders and decision makers for better planning and coordination"

## The objective of this system would be:

- To develop a standalone software called Emergency Response System
- To locate the nearest emergency resource, such as an ambulance, hospital, fire, etc.
- To suggest shortest route for the responders during emergencies
- To provide alternatives routes to the emergency field for responding
- To provide all the available information about the target area (eg. safe evacuation places, etc.)
- To assist the decision makers in better planning and coordination during emergencies

# Thimphu Emergency Response System





# Application of Geographic Information System (GIS), Remote Sensing, and Information & Communication Technology for Disaster Risk Reduction in Bhutan

Final Report

Application of Geographic Information System (GIS), Remote Sensing, and Information & Communication Technology for Disaster Risk Reduction in Bhutan

System Overview of Post-Disaster Reporting System and Disaster Loss Database

Threats and Hazard Identification

Disaster Risk Assessment

Disaster Risk Reduction

Application of Geographic Information System (GIS), Remote Sensing, and Information & Communication Technology for Disaster Risk Reduction in Bhutan

pemaddm@gmail.com

# Thank You

pemaddm@gmail.com