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ASIAN DISASTER REDUCTION CENTER (ADRC)

YEMEN
COUNTRY REPORT

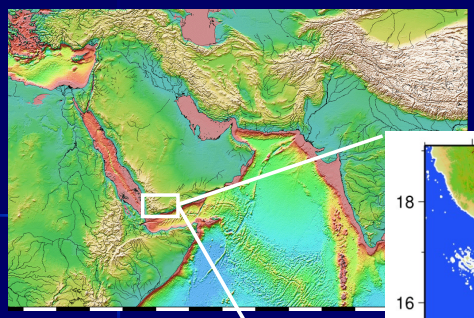
MONEER ABDULLAH AL-MASNI
SEISMOLOGICAL AND VOLCANOLOGICAL
OBSERVATORY CENTER (SVOC)

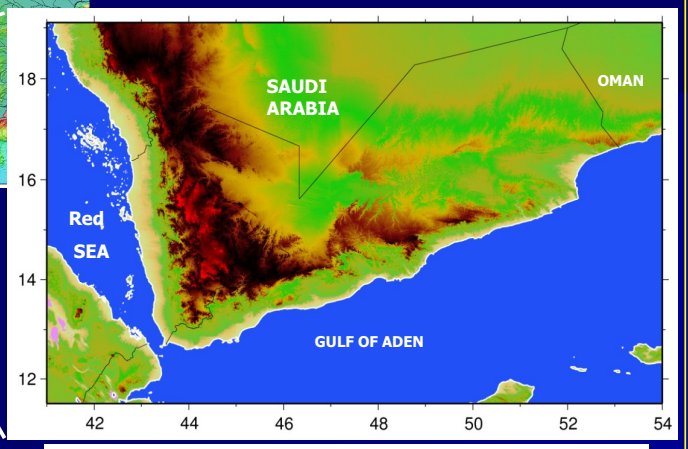
NSOC

OUTLINE OF PRESENTATION

- General Information
- Brief description of National Seismic Network.
- Disaster Profile in Yemen.
- Yemen Disaster Management System.
- Research Action Plan

GENERAL INFORMATION





- **Location:**

Yemen is located in the southern west of the Arabian peninsula.

- **AREA :**
528,000 km², 21 Governorate

- **POPULATION:**
22 million.

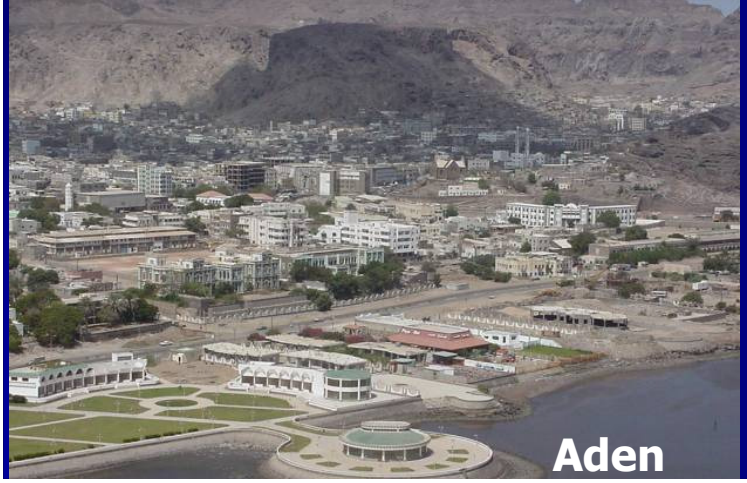
- **Topography**
The country's topography of Rugged Mountains, Volcanic Highlands, Deserts, and Coastal plains.

- **Geo-Tectonic setting**
(Arabian plate) is bordered by active seismic zone : the Red Sea from the west and Gulf of Aden from the south..

GENERAL INFORMATION

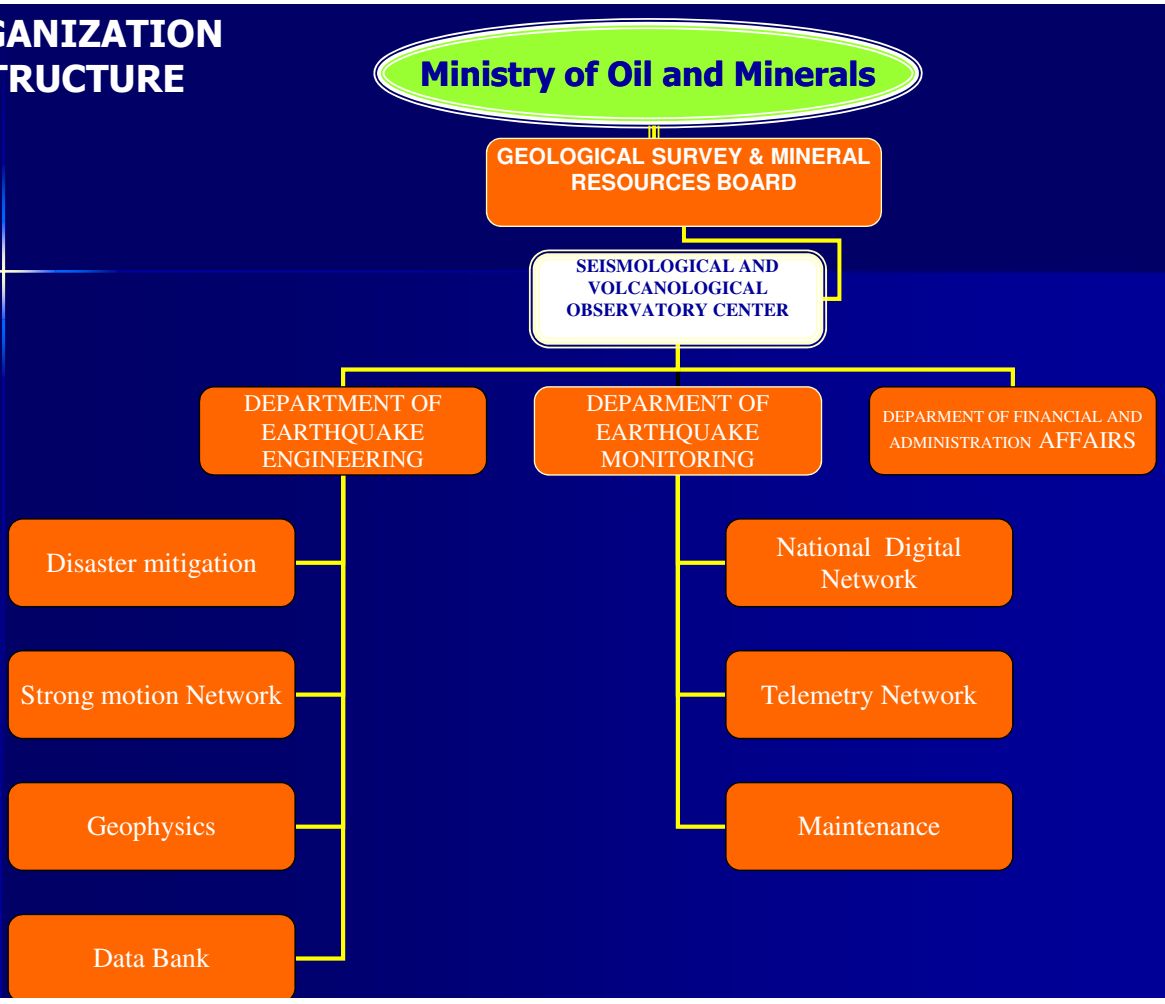

Sana'a city


Bottle Trees، Socotra Island

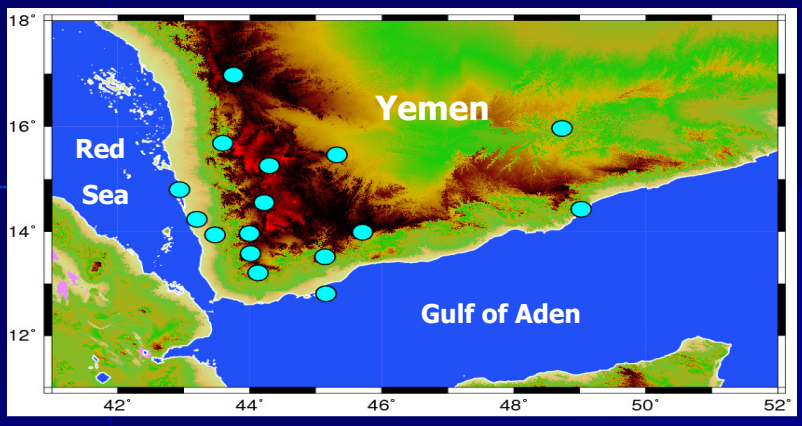

Aden

Brother Blood Trees ، Socotra Island

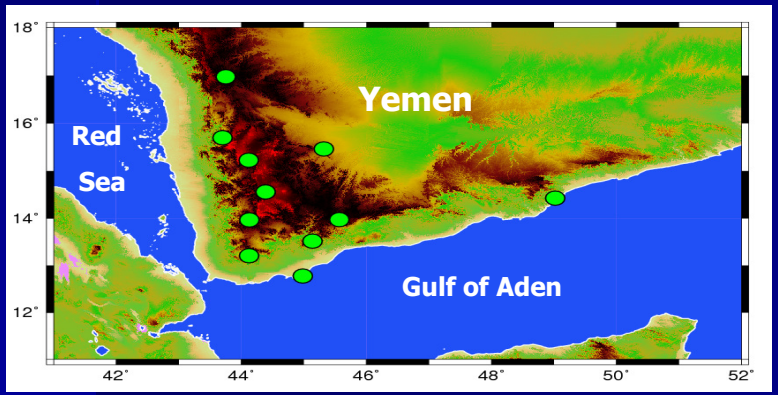
ORGANIZATION STRUCTURE



Yemen Seismic Network



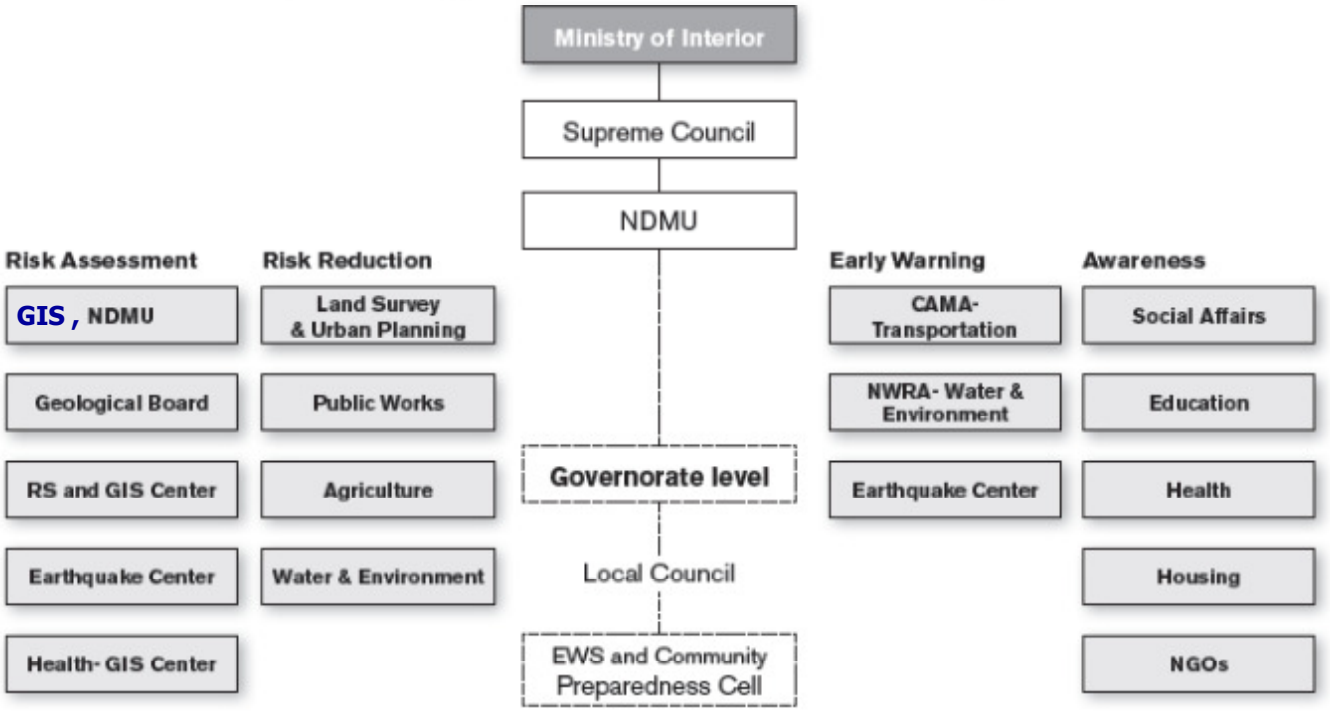
Strong motion stations



Short period stations

Broad band stations

Figure 7. Organizational Map of Government agencies for disaster risk management in Yemen



SPATIAL DISTRIBUTION OF DISASTERS IN YEMEN

Figure 3. Population Density

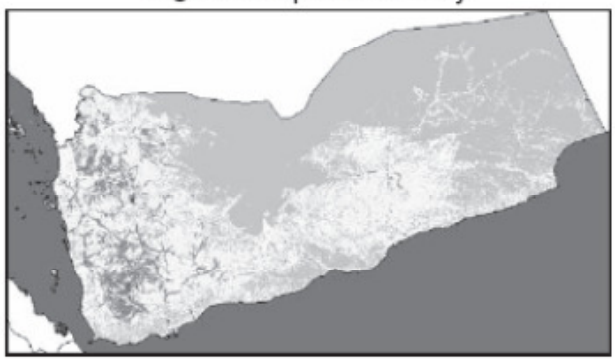
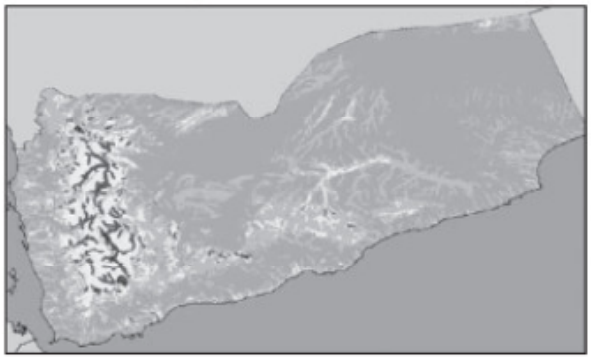


Figure 4. Flood Hazard



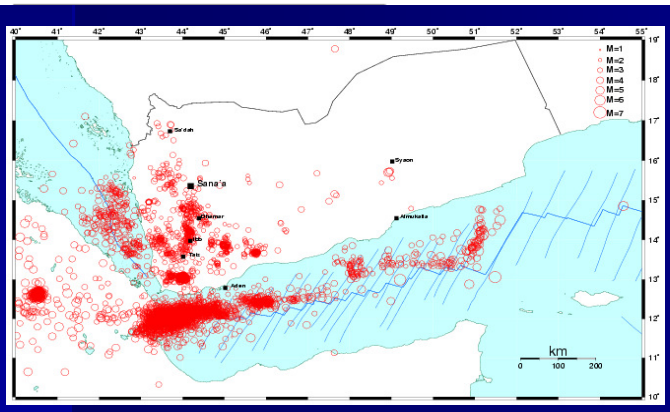
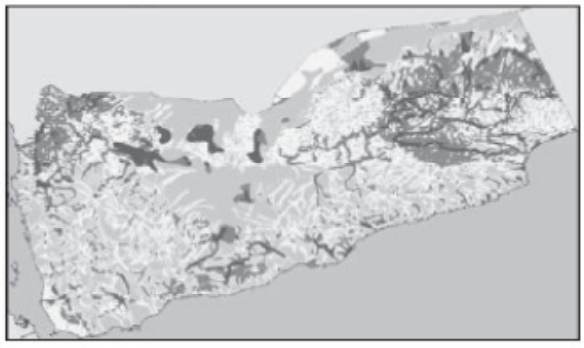


Figure 6. Landslide Hazard



EXAMPLES OF MAJOR DISASTERS IN YEMEN

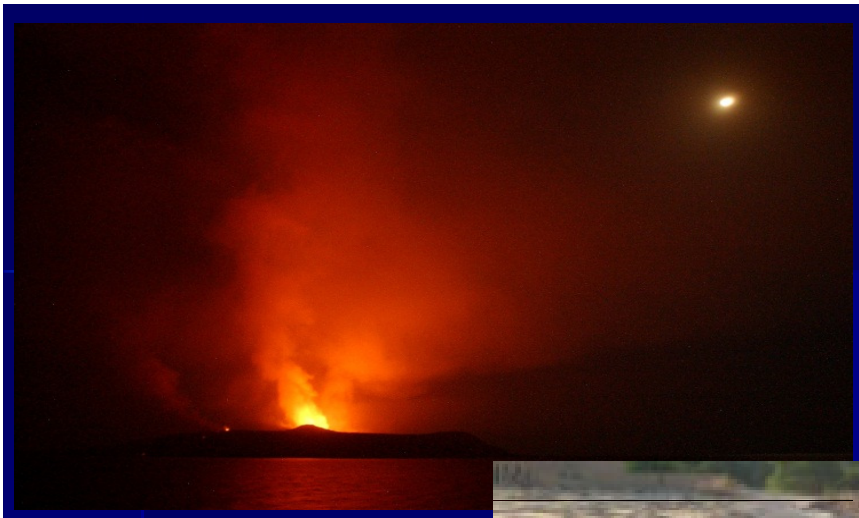
Dhamar Earthquake

December 13,1982

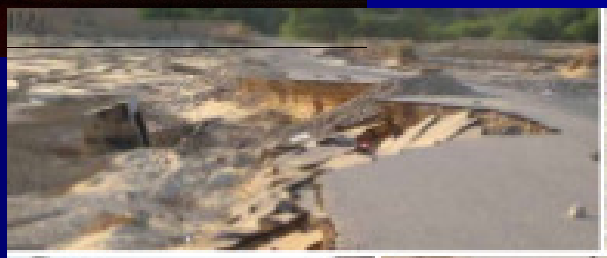
- **Magnitude: 6.0**
- **Depth: 7km**
- **Economic losses: 2 $ billion**
- **Homeless: 250,000**
- **Deaths: 2800**
- **Injured : 15000**

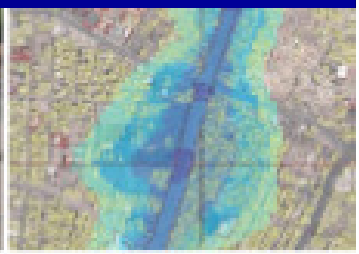
Landslides at Al-Dafir 2005 (killed 65 person)

Earth fissures , Jahran Basin,2006

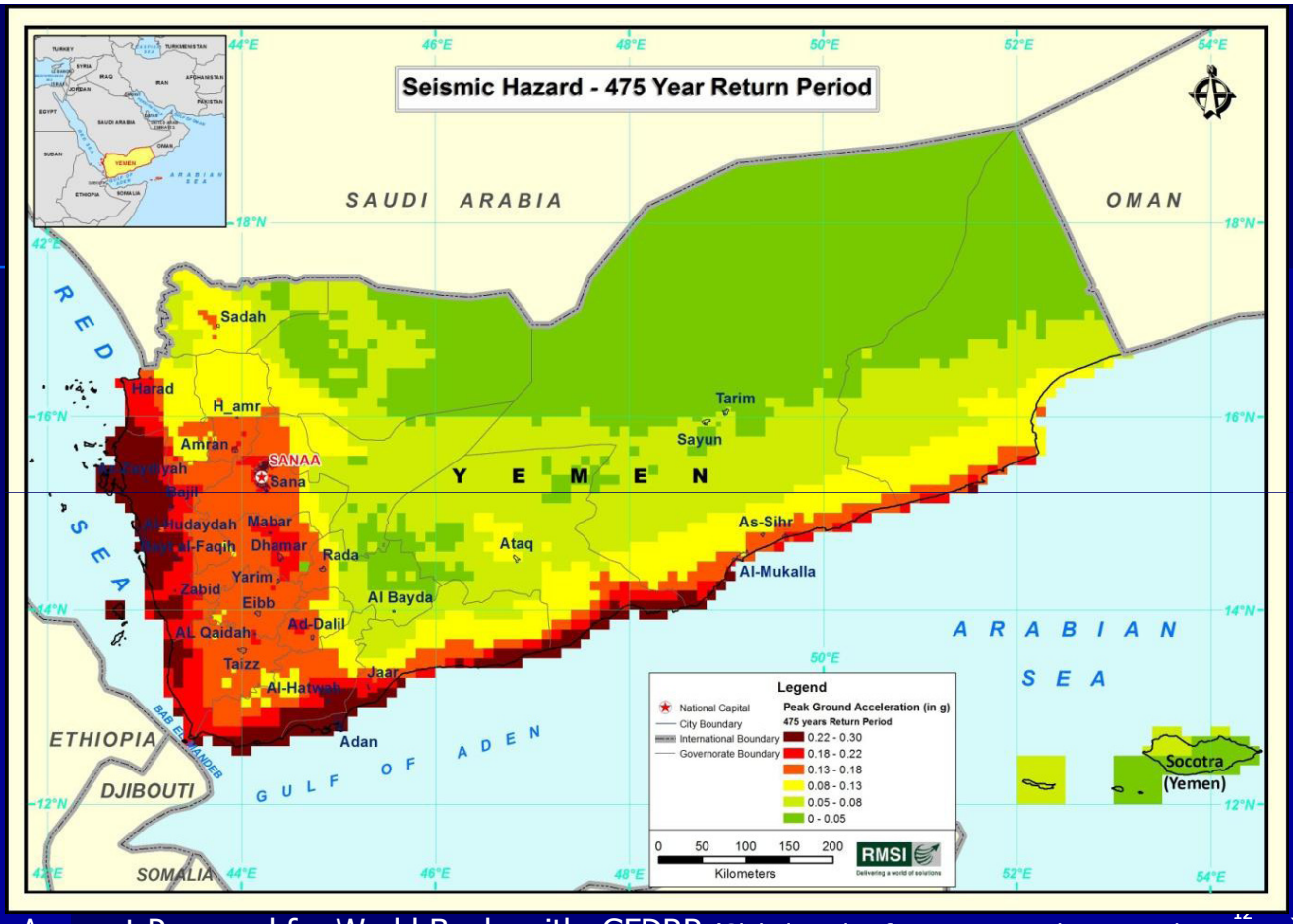


Volcanic Eruption at Al-Tair Island,2007 (Killed 6 persons)





Hadramut Flood ,2008 (Killed 73 persons)



A report Prepared for World Bank with GFDRR (Global Facility for Disaster Reduction and Recovery) Oct,2010

Research Action Plan For

Earthquake Risk Assessment In Sana'a City

Seismic Mitigation is a Cycle

Immediately after an earthquake

Risk Reduction:

Activities to reduce the impact of an earthquake before strikes

- Strengthening existing structures
- Implementing seismic building code
- Retrofit of buildings
- Planning and training for emergency response activities
- Public awareness raising
- Research on earthquakes
- establishment of Early warning System

Preparedness:

Emergency Response and Relief Actions immediately after an earthquake

- Search and rescue of buried victims
- Emergency medical care
- Fire suppression
- Shelter for homeless victims
- Supplies of food, water, and necessary materials

Before an earthquake

Rehabilitation and Reconstruction:

The long-term process of rebuilding a whole community after an earthquake

- Rebuilding houses and buildings
- Financing for retrofitting & rebuilding
- Repair of roads, bridges, water system, etc.
- Psychological counseling

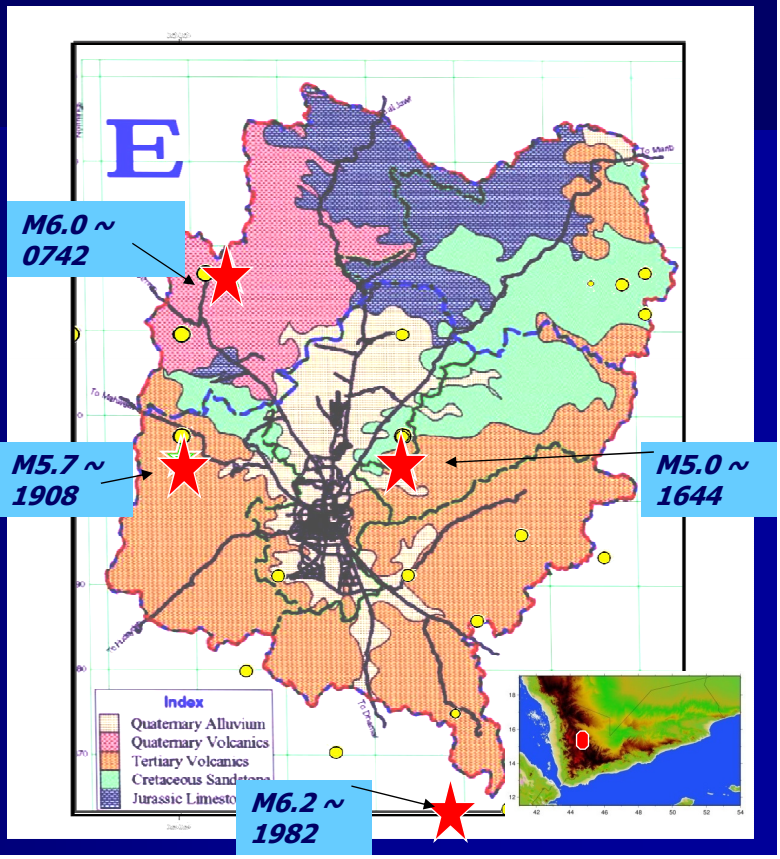
Long-term after an earthquake

Background

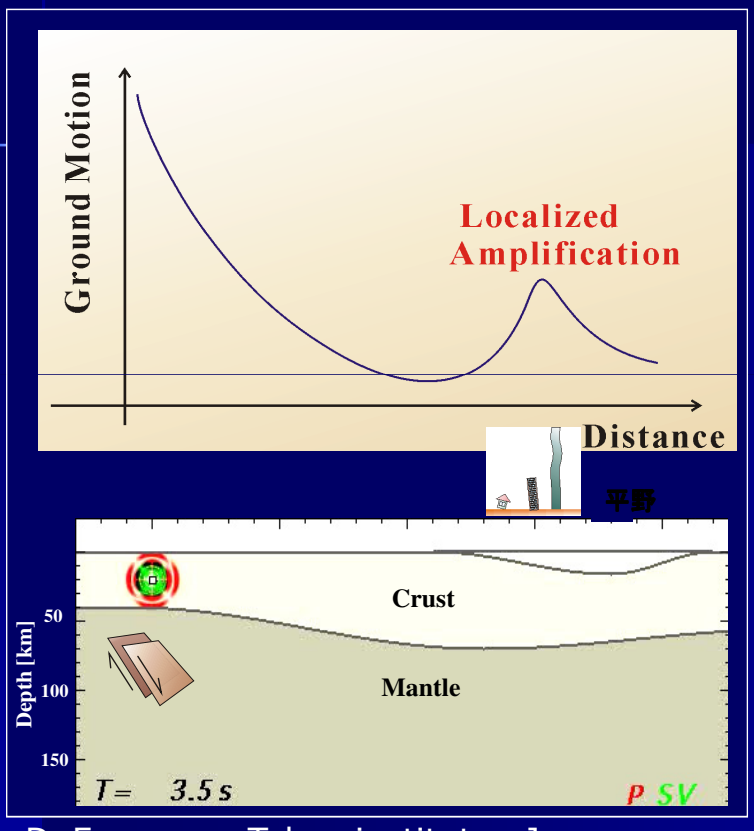
Important of Sana'a City

- **Sana'a basin area : ~ 160** km²
- **POPULATION: ~ 2 million**
- ***Sana'a city is subjected by several strong earthquakes occurred in the past periods.***
- ***Recently, peoples in this area feeling by a large shaking ,although , it is small earthquakes. Due to the effect of the sedimentary basin layers which acting to* amplify the seismic waves.**
- ***Generally , Earthquake Damage, is larger over soft sediments than on firm bedrock outcrops.***

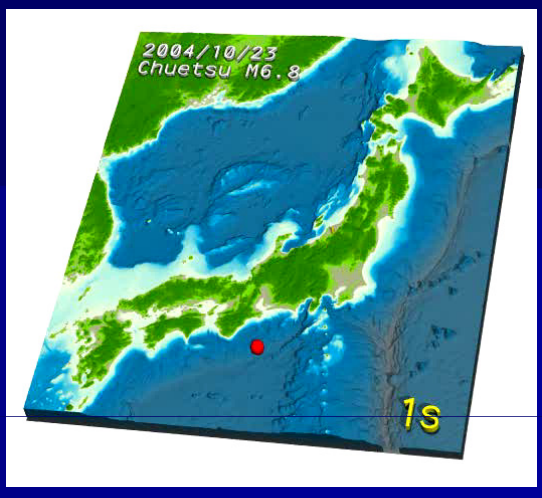
Therefore, Earthquake Risk Reduction *on Sana'a sedimentary basin is necessary.*



Effects of sedimentary basins



Dr.Furmura , Tokyo institute , Japan



at Sedimentary Basins

-Amplification in Low-Vs (Soft) sediment

-Basin Induced Surface Waves

-Energy Trapping

Objective of the Project

Earthquake Loss Estimation and Risk Assessment in Sana'a City

METHODOLOGY OF EARTHQUAKE RISK ASSESSMENT

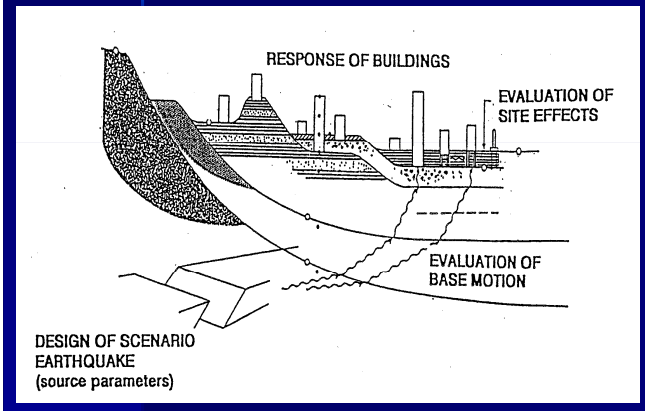
- Assessment of the Seismic Risk using the relation:

  Seismic Risk = Hazard * Vulnerability

- Develop an Earthquake Scenario to estimate and describe the (damage) of a probable earthquake on the city.

METHODOLOGY OF EARTHQUAKE RISK ASSESSMENT
(Main Process)

Ground Motion =
Source+ Path + Site effects



Hazard Assessment (~ Soil Effect Study) (1)

↓

Vulnerability Assessment (2)

↓

Development of Earthquake Scenario for Damage Assessment (3)

↓

Urban Disaster Prevention Planning (4)

↓

Safety & Strengthened City

Activity (1): Hazard Assessment (~ Soil Effect Study)

Required information :

- Estimation of Local Site effects (soil Response)
  - Soil Amplification.
  - Predominant period.
  - PGA/MMI.
  - S- wave velocity of subsurface structure.

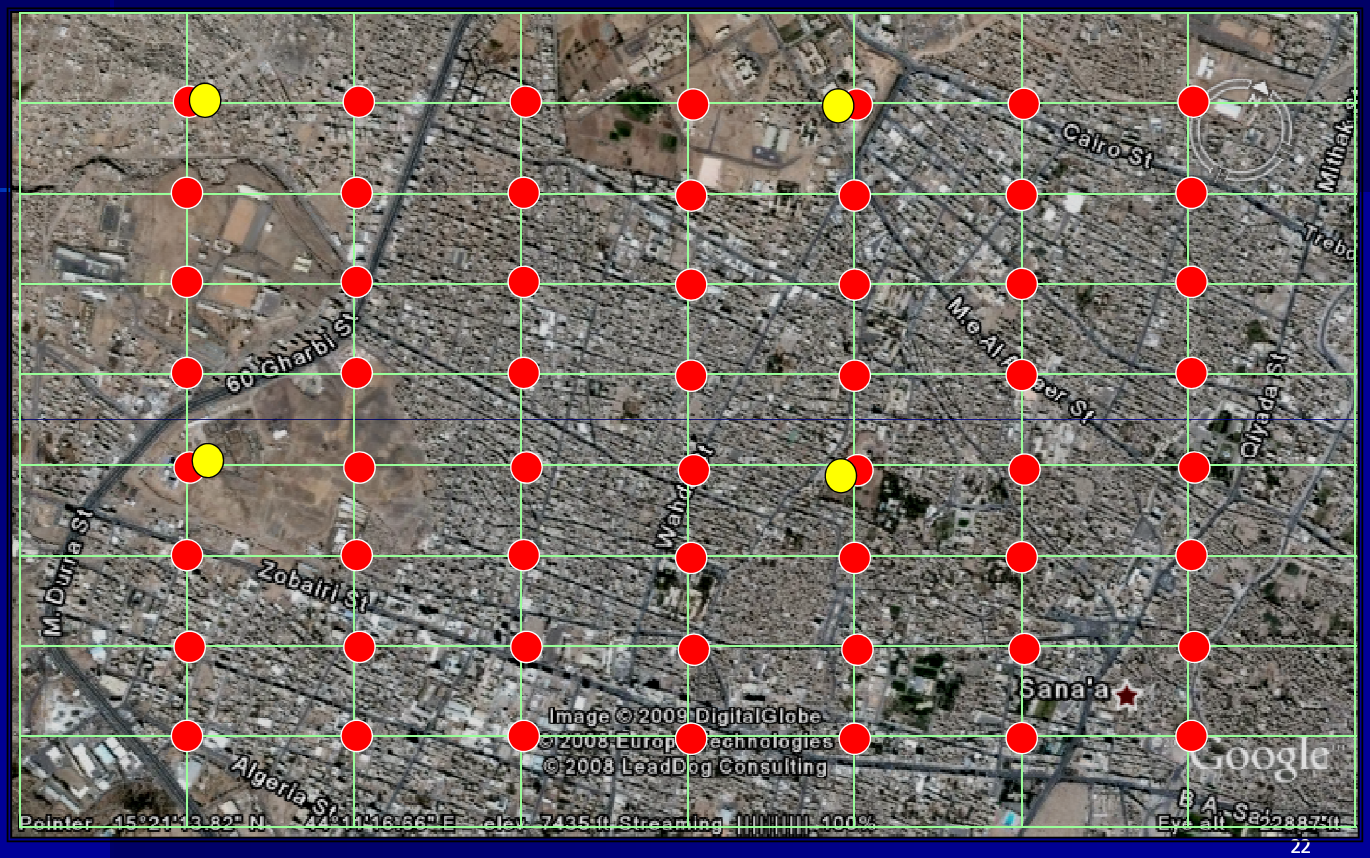
Methods of Estimation Site effect

(1) H/V spectral ratio

(2) Ground Response analysis

- Information of underground structure
  - S-wave velocity , Density, Thickness,
  - Microtremor Survey
- Numerical Analysis
  1D-SHAKE Model
  - Amplification, Stress and strain
  - Equivalent linear method

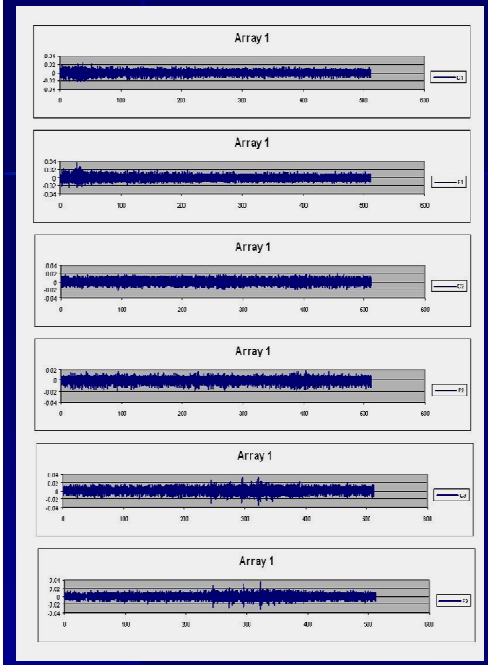
Example of grid Points

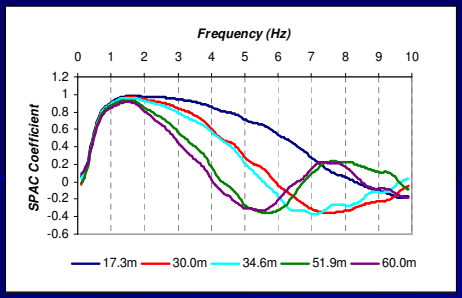


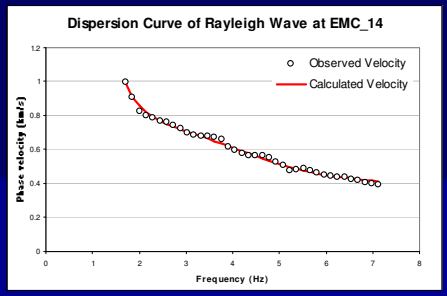
Points of H/V method

Points of Array method

(SPAC) Analysis

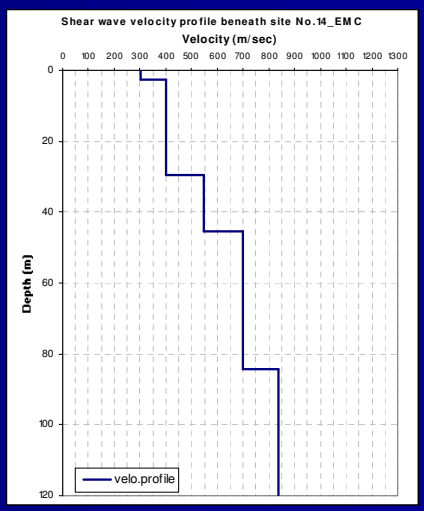




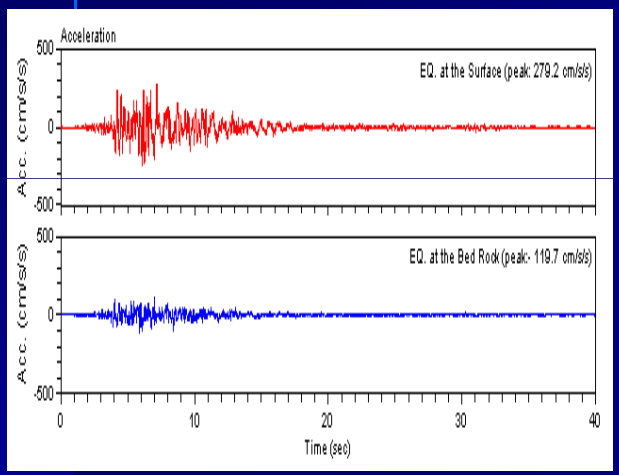


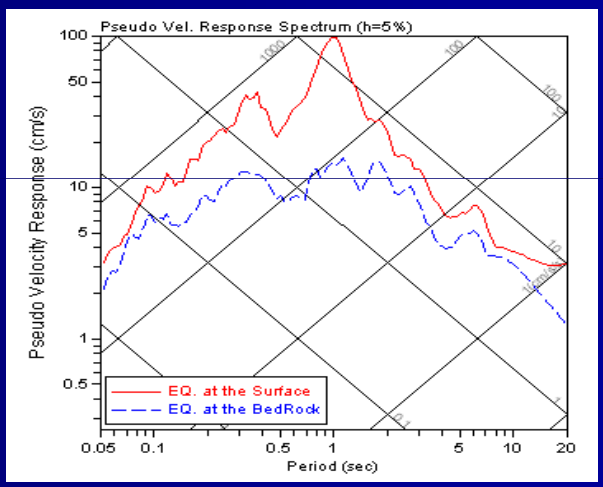
$$\rho(\omega,r)=\frac{1}{2\pi}\int_0^{2\pi}\frac{re[S_{CX}(\omega,r,\theta)]}{\sqrt{S_C(\omega,0,0)S_X(\omega,r,\theta)}}d\theta$$

$$\rho(r,\omega_0)=J_0(k_0 r)=J_0\left(\frac{\omega_0}{c(\omega_0)}r\right)$$



Ground Motion Modeling at surface of study site Using equivalent linear Method





Output of Hazard Assessment

- **Seismic Microzoning Maps:**

  - Soil Amplification zoning Map
  - Predominant Period zoning Map
  - PGA Acceleration zoning Map
  - Seismic Intensity zoning Map
  - Shear wave Velocity structure profiles
  - Soil classification Map
  - Engineering bedrock Map

Activity (2): Vulnerability Assessment using GIS

Required information

- Characteristics of local buildings (Type, Age, Height, etc.)
- Inventory of buildings (include location of buildings)

- Characteristics of local infrastructure.
- Inventory of infrastructure .

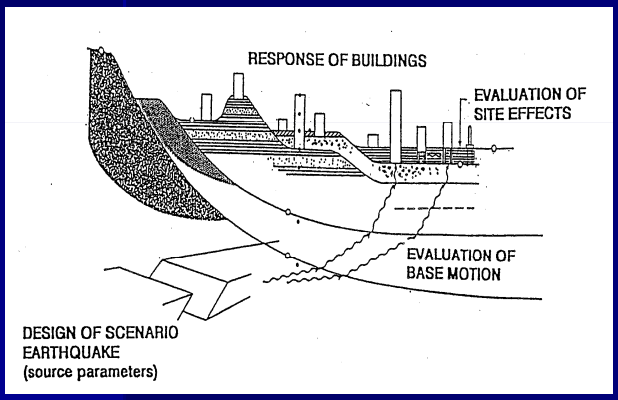
- Population information.

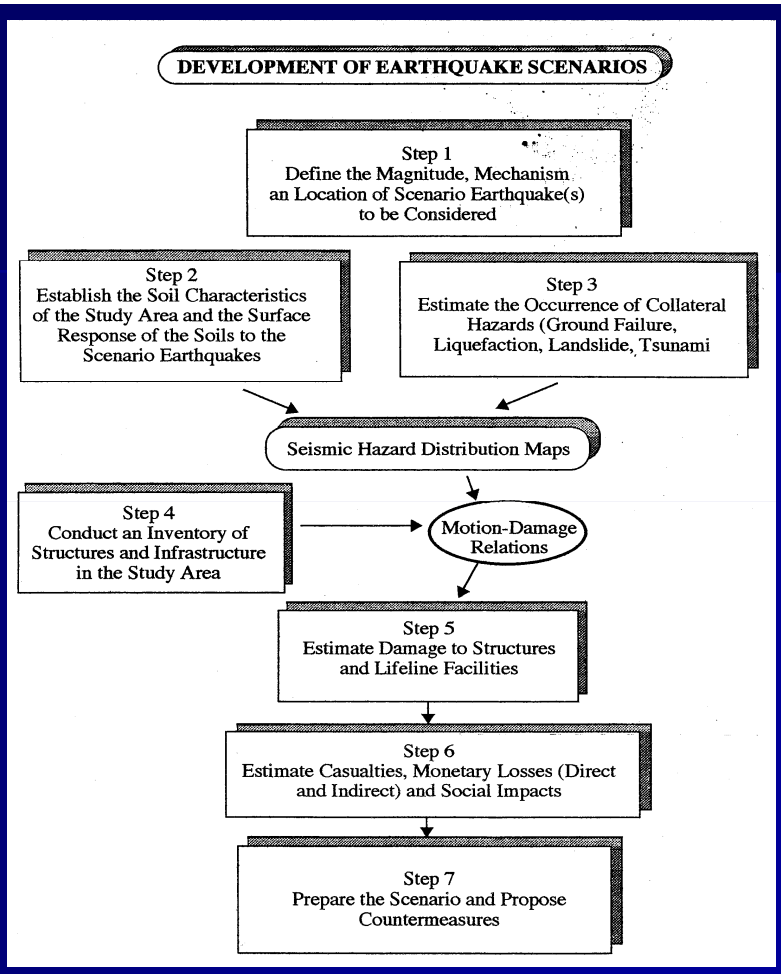
- Data on the human and economic impacts of past earthquakes.

Digital Maps:
Geological Map, Topography map ,Borders map , faults map
Satellite Base Map , seismicity map …. etc

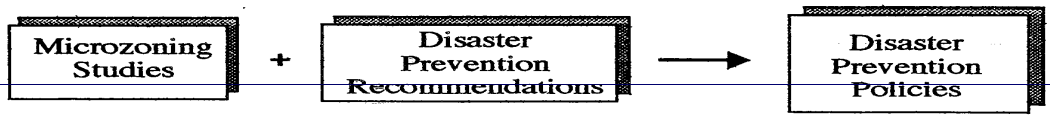
Activity (3):

Damage Assessment





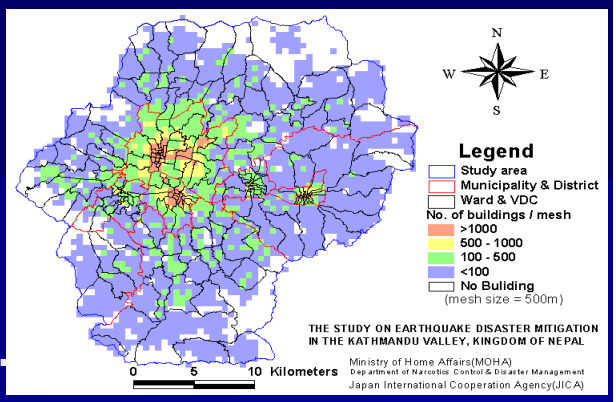
Activity (4): Urban Disaster Prevention Planning



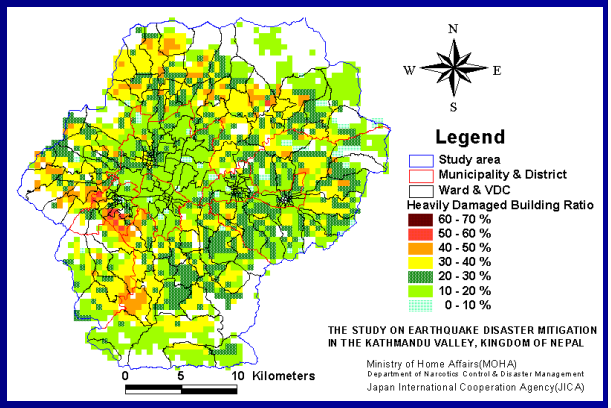
Output of Vulnerability and Damage Assessment

❑Seismic Risk Distrib. Maps:

- Building damage zoning Map.
- Infrastructure Damage zoning Map.
- Casualties zoning Map …etc.

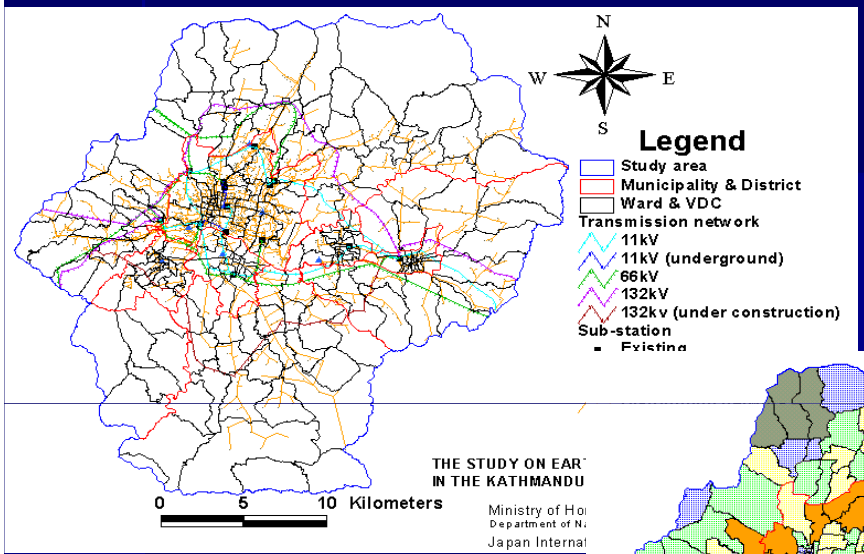


Example : Existing Building Distribution

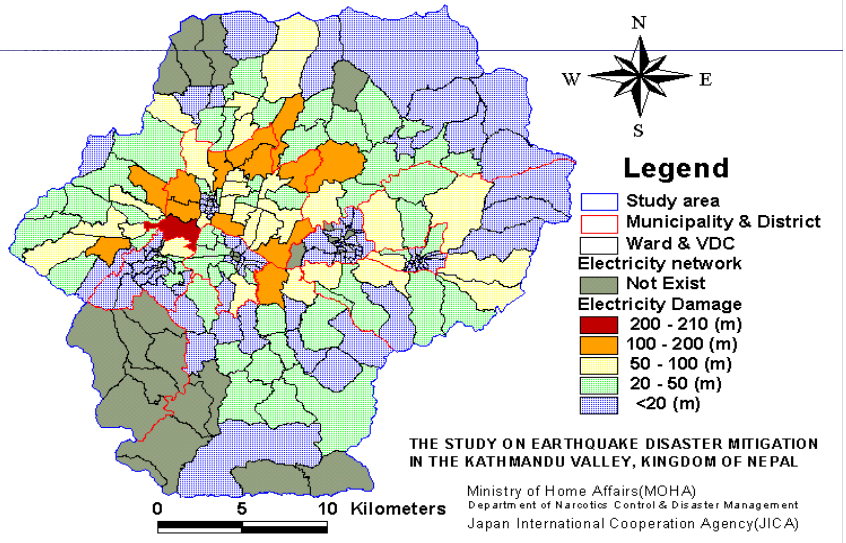


Building Damage Ms 8.0

Existing Electricity Network



Damage of Electricity



(Thank you!)

SANA'A