Government of Ulaanbaatar City,
Emergency Management Department of the Capital City
Japan International Cooperation Agency (JICA)

# Mongolia
# The Project for Strengthening the Capacity of Seismic Disaster Risk Management in Ulaanbaatar City
# Final Report

## Volume-2 Main Report

October 2013

Asian Disaster Reduction Center, Urban Disaster Research Institute
Tokyo Electric Power Services Co., Ltd.

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# Mongolia
# The Project for Strengthening the Capacity of Seismic Disaster Risk Management in Ulaanbaatar City

# Final Report
# Volume-2 Main Report

## Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| ADRC | Asian Disaster Reduction Center |
| ALACGaC | Agency of Land Affairs, Construction, Geodesy and Cartography |
| ASTER | Advanced Spaceborne Thermal Emission and Reflection Radiometer, Global Digital Elevation Model |
| CA | Capacity Assessment |
| CBS | Cellphone Broadcast System |
| CP | Counterpart |
| DF/R | Draft Final Report |
| EEWS | Earthquake Early Warning System |
| EMDC | The Emergency Management Department of the Capital City |
| EOST | la Ecole et Observatoire des Sciences de la Terre |
| EWS | Early Warning System |
| F/R | Final Report |
| GDP | Gross Domestic Product |
| GIS | Geographic Information System |
| GTZ | Deutsche Gesellschaft fur Technische Zusammenarbeit |
| HFA | Hyogo Framework for Action |
| HRW | Human Rights Watch |
| IC/R | Inception Report |
| ISC | International Seismological Centre |
| JCC | Joint Coordination Committee |
| JICA | Japan International Cooperation Agency |
| M | Japan Meteorological Agency (JMA) magnitudes |
| Ml | Richter magnitudes |
| Ms | Surface magnitudes |
| Mw | Moment magnitudes |
| M/M | Minutes of Meetings |
| MHFC | Mongolian Housing Finance Corporation |
| MRTCUD | Ministry of Roads, Transport, Construction and Urban Development |
| MSK | Medvedev-Sponheuer-Karnik intensity scale |
| MUST | Mongolian University of Science and Technology |
| NEMA | National Emergency Management Agency |
| NGIC | Mongolian National Geo-information Center |
| NGO | Non-Governmental Organization |
| PGA | Peak Ground Acceleration |
| PR/R | Progress Report |
| R/D | Record of Discussions |
| RC | Reinforced Concrete |

| | |
|---|---|
| RCAG | Research Center of Astronomy and Geophysics of Mongolian Academy of Sciences |
| SC | Steering Committee |
| UB | Ulaanbaatar |
| UBMPS | The Study on City Master Plan and Urban Development Program of Ulaanbaatar City |
| UN | United Nations |
| UNDP | United Nations Development Programme |
| UNESCAP | United Nations Economic and Social Commission for Asia and the Pacific |
| UN-HABITAT | United Nations Human Settlements Programme |
| USD | United States Dollar |
| USGS | United States Geological Survey |
| WB | World Bank |
| WG | Working Group |
| WS | Workshop |
| WMO | World Meteorological Organization |

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# Chapter 1 Summary

## 1.1 Outline of the Project

Project title: The Project for Strengthening the Capacity of Seismic Disaster Risk Management in Ulaanbaatar City, Mongolia (hereinafter referred as “the Project”)
Counterpart (hereinafter referred as “CP”): Ulaanbaatar City, Emergency Management Department of Ulaanbaatar (hereinafter referred as “EMDC”)
Implementation period: February 2012 – July 2013

The objective of the project is to strengthen the capacity for seismic disaster risk management in UB City and to transfer relevant skills and technologies to personnel concerned with the Project. And remarkable outcomes of the project are as follows;

1) Formulation of integrated seismic risk map for UB,
2) Revision of regional seismic disaster risk management plan,
3) Preparation of the draft construction guideline for middle-high storied building considering seismic disaster risk resilient urban development and
4) Capacity development of the relevant authorities and citizens in seismic disaster risk management

## 1.2 Earthquake Risk Assessment of Ulaanbaatar

### 1.2.1 Ground Survey

The ground is mainly composed of sand and gravel in the central city of UB.

1) Boring Survey (depth 30 m, 10 holes, including SPT on per m)
2) PS Logging (depth 30 m, 10 sites)
3) Surface Wave Exploration (50 sites)
4) Microtremor Measurement (50 sites)
5) Surface geological map (scale 1:10,000)

### 1.2.2 Active Fault Survey

To set scenario earthquakes, existing material survey and field survey were conducted the active faults around UB city.

1) The Hustai fault is an active fault which extending to southwest direction from the location of about 30 km southwest of central UB city. The RCAG had conducted trench surveys on the fault in 2008 and 2010. The RCAG orally reported to the *Mongolia National Safety Council* that the recent activity of the fault was in 1250 and its next activity probably to be after 2000-3000 years.

2) The Emeelt fault is an active fault which extending NW-SE direction located southwest 15 km from UB city. Based on seismometers records, the seismicity being active along the fault since 2005, and a clear active fault surface traces were confirmed by field survey conducted by RCAG and France universities (Université Montpellier 2; Université de Strasbourg). According to RCAG’s oral report to the *Mongolia National Safety Council*, the recent activity of the fault was 5500 years ago, and the next activity is considered to be approaching.

3) The Gunjiin fault is extending to northeast from 5km northeast distance from UB city. Trench survey conducted by the RCAG revealed at least 2 events occurred on the fault. However about the recent activity and recurrence interval is under study.

### 1.2.3 Seismic Hazard Assessment

Among the active faults in and around the UB city, two earthquake scenarios were set targeting the Hustai fault, Emeelt fault and Gunjiin fault. A deterministic method for ground motion evaluation was conducted under the maximum earthquake estimated on the target fault. The attenuation law of Kanno et al., (2006) was used in the ground motion calculation, and the AVS30 in the attenuation law was based on the results from ground survey.

1) Scenario 1: The case of the Hustai fault generates its maximum earthquake (Mw7.6)
About the length of Hustai fault, RCAG report indicated 70-80 km, Demberel (2011) showed 92 km, and Ferry et al. (2012) suggested 112 km. But based on active fault topography, RCAG report and Demberel (2011), the length of the Hustai fault should be about 80 km.

2) Scenario 2: Integrated maximum value of maximum earthquakes occurs on Emeelt fault (Mw7.0) and Gunjiin fault (Mw6.6)
In the Scenario 2, considering the comments given on WG1, say the Gunjiin fault has much more influence in the city area when it generates earthquakes, and take into consideration of result of the 2nd Domestic Supporting Committee of JICA, the larger value of the intensity of the two earthquakes will be selected. Note that this scenario does not mean the two earthquakes will occur simultaneously, but it is only an estimation of the maximum hazard potential. The length of the Emeelt fault is about 30 km, while the Gunjiin fault is about 18 km.

Both in the cases of Scenario 1 and Scenario 2, in the city area of UB, the calculated MSK scale seismic intensity are VIII-IV.

The ground was estimated as low liquefaction possibility or no liquefaction based on the results of microtopography classification, boring survey and soil test. However, it is cannot be completely denied that there is no liquefaction possibility in possible higher groundwater level area along the Tuul River under strong earthquake.

In the case of Scenario 1, high susceptibility ranked meshes distributed in the Songino mountains, which located on the western side of the city. The northwest faced slope meshes in the northern slopes of the southern mountain areas of the city shows relatively higher susceptibility. In Scenario 2, the high ranked susceptibility meshes are concentrated in western mountainous and the mountainous area along the Gunjiin fault in eastern side of UB city, and in the mountainous area along the Emeelt fault, high and relatively high meshes are observed.

### 1.2.4 Results of Disaster Risk Assessment

In order to conduct a risk assessment for buildings, inventory data of buildings was established by combining the UB city's database and UBMPS's one after conducting the followings; material survey of capacity assessment of the existing buildings by UB city, hearing survey to construction companies, additional capacity assessment of buildings and building material testing.

Inventory data for bridges was also established based on the JICA report on Ajilchin flyover, design documents and drawings collected, results of concrete material testing and report on seismic capacity evaluation. According to the discussion with road agency in UB city, field survey to eight bridges whose design drawings were available, was conducted.

For roads and lifeline structures, the inventory data was established by the GIS data supplied by UB city. Based on the risk evaluation by Central Disaster Prevention Council Vulnerability in Japan, vulnerability functions for each structures were selected.

For fire following earthquakes, after overviewing the ignition situation using fire accident census supplied by EMDS, field surveys to apartment houses and to Ger areas were conducted to grasp the situation of usage of fire and electrical equipment in residence and hazard of fire spreading. The method by Tokyo Metropolitan Fire Department was modified to reflect the conditions of UB city and applied for fire risk assessment. Fire spreading in Ger area was estimated using the parameters such as a density of wooden houses, season and wind speed.

From the inventory data, vulnerability functions for each structure and ground motion intensities for scenario earthquakes, following damage situation will be estimated;
Since damage to buildings is correlated with the ground motion velocity, scenario I earthquake gives greater damage to buildings, particularly to those in Ger area. On the other hand, damage to lifeline

structure is affected by the ground condition, so that the difference in damage is not large comparing to the case of buildings. It is noted that liquefaction risk is negligible. Fire spreading risk in Chingeltei district, Bayanzurkh district, Songinokhairkhan district and Bayangol district is large comparing to that in other district.

Table 1.2.1 Result of Damage Estimation for Buildings

| | Scenario I | | Scenario II | |
|---|---|---|---|---|
| | Urban Area | Ger Area | Urban Area | Ger Area |
| collapse rate | 48% | 81% | 22% | 29% |

Table 1.2.2 Result of Damage Estimation for Lifeline Structures

| | Scenario I | Scenario II |
|---|---|---|
| Damage to Roads [points] | 66 | 60 |
| Damage to Bridges (Impassable) [points from 67 bridges] | 28 | 22 |
| Damage to Water Supply [points] | 68 | 44 |
| Damage to Sewage [km] | 191 | 176 |
| Damage to Underground Heating Water Supply [points] | 97 | 59 |
| Damage to Electric Poles [points(rate)] | 845(2.8%) | 352(1.2%) |

Table 1.2.3 Result of Fire Risk Estimation

| | Scenario I | | Scenario II | |
|---|---|---|---|---|
| | Winter, 18:00 | Summer, 12:00 | Winter, 18:00 | Summer, 12:00 |
| Fire Outbreak [buildings] | 114 | 107 | 91 | 46 |
| Fire Spreading [buildings] | 7,601 | 4,334 | 6,341 | 1,711 |
| Casualties by Fire | 48 | 27 | 40 | 6 |

## 1.3 Seismic Disaster Risk Management Plan

### 1.3.1 Earthquake Disaster Scenario

Damage of earthquake disaster become different depends on the condition of earthquake occurrence. Also it is needed to understand the situation of not only damage of structures but also situation of social problems happen after earthquake occurs to prepare for earthquake disaster. For this purpose, Earthquake Scenario is analyzed to understand what may happen and how to take actions or implement countermeasures assuming earthquake occurs evening of winter considering timing of using fire for cooking and difficulty of emergency response. Scenario for Emergency Management Headquarter, Search and Rescue, Medical Care, Evacuation, Food and Drinking Water supply, Electricity Supply, Heating Water Supply, School Education, Temporally and Permanent Housing Supply, Debris Treatment and Life Rehabilitation. Example of the Scenario for UB city Disaster Management Headquarter is shown in Table 1.3.1.

Table1.3.1 Earthquake Scenario for UB city Disaster Management Headquarter

| | | |
|---|---|---|
| Building Damage | ・UB City Hall does not collapse.・Bookshelves are scattered・PC fall down from desks・Window grass are broken and scattered・Elevators stop | |
| Lifeline Damage | ・Electricity cut off （At least Day1）・Water suspended(Toilet cannot use for some time )・Telephones are congested・Mobile phones are also congested | |
| Casualty | ・Officers in city hall are few because of off of office hour. Few officers injured・Officers may suffer human damage in their home. | |
| Day1-Day3 | Disaster Response Activity | Improvement |
| | ・There are some officers still working at 6 o'clock even office hour is until 5 o'clock. City Hall suddenly began shaking. .It was big shaking such as Hall may collapse. But Hall is not collapse fortunately. Bookshelves are fall down; | |

| | | |
|---|---|---|
| | PC is also fall down from desks. Many apartment houses are collapsed and raising cloud of dust. It was twilight when the earthquake occurred, but was in the dark gradually.There are no light in city and only the head lights of congested cars, but lights are not moving at all.<br>・Disaster countermeasures headquarter is established and also UB city headquarter is established when national wide disaster occurs according the Disaster Countermeasures Act issued 10th of July, 2009. Disaster countermeasure headquarter is not located in city hall and it is established in EMDC office. I am not in charge of disaster management but consider that I should take action as senior officer. City mayor is not in city hall and not able to contact to mayor. I think Disaster Countermeasure Headquarter should be started by the senior officers in city hall and dispatch my staff to other senior officers to gather in front of city hall.<br>Following indicated the situation that will come up after and comments for improvement | |
| | Set up of Disaster Countermeasures Headquarter<br>・Manual of operations and list of contact persons are not prepared.<br>・Emergency contact list and tools are not equipped. How to calling together.<br>・Is it permitted to set up UB city disaster countermeasures headquarter? Who decide to set up HQ? | ・Manual of Operation of HQ.<br>・Convened drills of HQ<br>・Convocation standard and its well-known<br>・Prepare of Information collection tool |
| | Set up of Disaster Countermeasures Headquarter<br>・There is no branch of EMDC in UB City Hall. Who will be secretariat of HQ?<br>・Where is HQ place? City Hall is not collapsed but certain damage occurs and need to check its safety.<br>・Telephones are congested ・Mobile phones are also congested<br>・Put desks and chairs in parking space in front of City Hall with Tent.<br>・Dark, cold<br>・Light up only Headquarter by Car light.<br>・Documents are scattered on the floor and difficult to find documents needed. | ・Emergency Assessment of Damage Buildings<br>・Need of stock Emergency Generator, Tent, Heating , Food<br>・City Hall building must be construct strong enough against expected earthquake and fixing of furniture |
| | Operation of Headquarter<br>・Requests and complaints comes from peoples. Officers have to correspond and cannot operate other issues.<br>・National level organizations frequently request the situation reports. It makes difficulty to implement necessary operation. | |

### 1.3.2 Comprehensive Risk Map

Earthquake information database consists of ground motion intensity and ground damage risk as well as of building inventory data, lifeline structure inventory data and so on. Results of building damage estimation, infra- and lifeline structure damage estimation, fire spreading estimation and so on will be included in the database, so that they can be shown in the comprehensive risk map.

Risk map is constructed on the ArcGIS system that can gives user friendly operation. Outline of establishing and operation of the system is shown in Figure 1.3.1

.

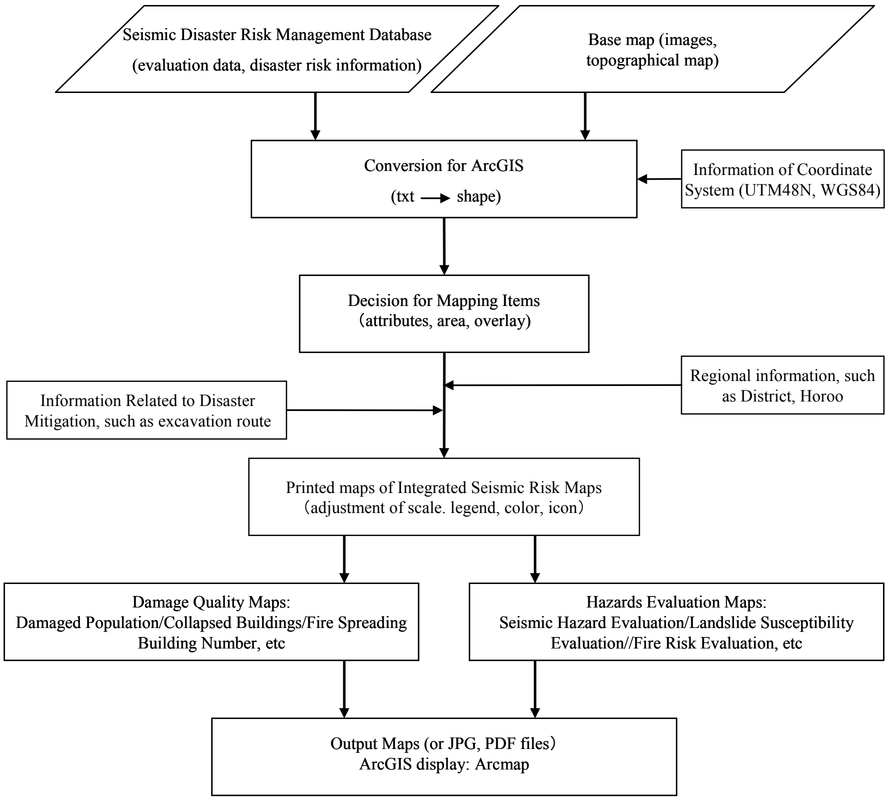


Figure 1.3.1 Flow for drawing integrated seismic risk map

### 1.3.3 Review and proposal of the Earthquake Disaster Prevention Plan of UB city

(1) The analysis of the Earthquake Disaster Prevention Plan of UB city

There are the Earthquake Disaster National Capacity Strengthening Plan in National level and the Disaster Prevention Plan of UB city. The Earthquake Disaster Prevention Plan is one of 27 separated plans among the Disaster Prevention Plan of UB city.

The analysis of the Earthquake Disaster Prevention Plan of UB city is implemented from the state of the Plan, disaster awareness survey, risk evaluation and earthquake scenario.

- Wide-ranging countermeasures are covered in the Plan. These are mainly the countermeasures which are responsible to implement by Emergency response section of UB city.
- The target of disaster reduction (how much damage will be reduced by implement the plan), the role of stakeholder, issued to be taken and its action plan are not clearly described。
- Earthquake is very uncommon for UB Citizens and most peoples have not experienced big earthquake. Evacuation, firefighting, living after disaster is all out of expectation. Therefore Proper action can not to be expected to be taken by citizens. Education and Awareness of fundamental earthquake disaster are needed to be done not only for citizens but also private sectors and governmental staff.
- Considerable building damage may occur. Emergency response capacity may deteriorate by suffering damage on important facilities such as governments, schools, hospitals
- There is risk of fire damage in Ger area
- Break of roads which are especially important for emergency response activities because of bridge damage by earthquake.

(2) Items needed to be reviewed

Following items are the items to be reviewed and indicated detail proposal are presented.

- The object and role of stakeholders should be clearly described.
- The plan is recommended to reconstruct as several separate chapters that individual countermeasures are categorized by implementing organizations.

- Countermeasures directly reduce earthquake damage such as strengthening of buildings especially school buildings, buildings of emergency response organizations such as Fire fighting stations, hospitals.
- Countermeasures of fire protection in Ger area

・ Countermeasures to reduce obstruct factors of disaster response activities
- Education and Awareness for Citizens
- Role of evacuation places and necessary condition such as scale of open space, evacuation buildings and function to be requested as evacuation place
- Plan of Important Road Network which are used for emergency and recovery activities

・ Countermeasures to promote disaster activities
- Manual of operation of disaster related organization
- Disaster damage information network
- Professional experts network

(3) Review and Modification of the Plan

Reviewing is periodically done every March. On March of this year revise procedure is done. This revised plan 2013 is in data book of this report. Lessons learned from the training in Japan and project team proposal to UB counterpart are reflected in the new plan 2013.
- Target of damage reduction, role of stakeholder (Government, Residents and Private Sectors)
- Emergency assessment of damaged buildings
- Emergency medical care such as triage of injured persons

1.4 Aseismic Guideline for Mid- and High-rise Buildings to Mitigate Earthquake Disaster

The guideline was established by collaboration of PT and CP. For example, CP described the status of the buildings in UB and outline of seismic capacity assessment of existing buildings. On the contrary, examination of the risk assessment, illustration of Ultimate Capacity Method and overview of capacity upgrading in Japan were described by PT. It is noted that categorization of building importance and determination of importance factor was conducted based on the discussion between both parties. Technical transfer of Ultimate Capacity Method was also done through workshop activity.

Contents of the guideline are summarized below;

| | |
|---|---|
| Chap. 1 | **Preface**: Role of the guideline, target buildings and contents are overviewed. |
| Chap. 2 | **Current issues**: Status of the buildings and the results of risk assessment are explained, followed by the arrangement of issues for capacity upgrading. The reflection of the issues to the guideline is also described. |
| Chap. 3 | **Target performance of buildings**: Importance of the buildings is determined from the viewpoint of disaster risk reduction. Target performance is given according to the importance. |
| Chap.4 | **Capacity evaluation of existing buildings**: The procedure to evaluate seismic capacity is illustrated, followed by the modeling method and application of the existing assessment by UB city to this evaluation. |
| Chap. 5 | **Upgrading measures**: Three methods such as strengthening, relocation and rebuilding are selected with technical guidance of each measure. |
| Chap 6. | **Promotion policy for upgrading**: After investigating the existing promotion measures, promotion policy is proposed for future upgrading. |
| Chap 7. | **Suggestions**: Suggestions for the items that are out of the scope but useful for future upgrading are summarized. |

1.5 Environmental and Social Consideration

The environmental and social challenges should be considered in case of reconstruction and rehabilitation activities after earthquake disaster are as follows;

(1) Issues on Disposal of Rubbles after Earthquake

The estimated volume of rubbles due to Scenario I Earthquake is 12.14 million m3. Dominant source of the rubbles are structures built of stone-masonry, reinforced concrete and bricks. 2.43 million 10ton-dumptrucks are required to transport the total rubbles.

For this reason, it is required to select temporary and final disposal site, and to make cooperation arrangement and roles in advance.

(2) Human-waste Treatment

Most toilets in the affected apartment area would be disabling after earthquake. Evacuated people and residents of undamaged area are supposed to use toilets nearby ger area or install simple pit latrine in yard to use. Envisaged issue would be difficulties in excavating ground due to frozen top soil in winter. In summer, residual urine in the damaged apartments would cause serious offensive odor as well as health problem. UB City should in advance grasp the number of potential portable toilets which normally are used for event and conclude corporative agreement with other owners. UB City also promotes utilization of practice bags as portable toilet.

(3) Dangerous Facilities and Hazardous Substance Disposal

Due to insufficient seismicity of dangerous facilities, there is fear that fire and environmental pollution caused by leakage of hazardous substance. Post-earthquake confusion would complicate issues on hazardous waste disposal, i.e. dumping into illegal area, temporal rubble storage area and waste disposal plant. Therefore it is necessary to promote the seismic measures of dangerous facility as well as to promote the strengthening supervision of hazardous materials processing.

(4) Issues on Resettlement in Recovery Stage

There is possibility of resettlement in case of implementation antiearthquake urban planning or reconstruction phase after massive earthquake. In these cases, UB City should implement proper information disclosure on resettlement program to residents, and sufficient consultation with stakeholders such as affected residents and communities. consideration of the following items.

## 1.6 Capacity Development Plan

The following activities were carried out in this project.

- Study meetings of hazard and risk assessment methods
- Training course in Japan
- Study meetings of earthquake disaster management for EMDC staffs
- Earthquake Disaster Management awareness activities WS
- Earthquake Disaster Management awareness campaign
- 

The program and use manual or materials used in the above activities, taking into account that you use to human resource development plan in relation to institutions, was developed in the electronic file. Further, to consider adding techniques and other knowledge, each document has components as much as possible.

## 1.7 Recommendations

### 1.7.1 Disaster reduction related Laws, System and organizations

- Mass Media, Red Cross, Academia Society and also Economic become member of the Disaster Prevention Standing Committee or its sub-committee.
- To establish sub committees to make advice disaster policy making under the Disaster Prevention Standing Committee such as "Earthquake Disaster Research Council" or "Academic Research Sub Committee".
- Member of the Council or Sub Committee, not only seismologist but also experts from Geology, Civil Engineering, Architecture, Mechanical Engineering in Engineering field, Sociology, Economics, Law in field of Arts, Disaster Medical and Education are recommended to participate to cover the fields which may suffer earthquake damage to promote holistic countermeasures in disaster management.

### 1.7.2 Proposal for Earthquake Disaster Management Plan

- To show the target of damage reduction
- To describe as government, residents and private sectors are the stakeholders and they shoulder their responsibility implement for target of disaster reduction.
- Representative of citizens and private sectors to the process of reviewing the plan as the stakeholders of disaster management of UB city.
- To open the plan for public to have common understanding to implement the issues indicated in the plan.
- To examine the schedule and priority of implementation of the plan. By showing the schedule and priority, it becomes understanding of stakeholders.
- To set up the checking procedures of progress of the plan.

### 1.7.3 Financial actions, enactment of disaster related laws and regulations for implementation of the plan

- Considering necessity of projects for disaster mitigation, priority of the projects and schedule of projects plan should be made to obtain the project budget allocation.
- Disaster related laws should be enacting as soon as possible according to the order by National Security Council.
- Regulations and standards need for implementation of project should be enacted.
- The Earthquake Disaster Management Plan is opened as much as possible to let stakeholders to understand and have common recognition to play the role of stakeholders for disaster reduction.
- Publication of the plan is needed to citizens to understand the limitation of assistance from government that what assistants will be able to get or may difficult to get when disaster occurs and to understand that citizens have own role against disaster without having over expectation to government.
- Publication of the plan is needed to citizens to understand the role of community and importance of preparedness for disaster.

### 1.7.4 The communication and reporting system during disasters

- Implementation of the external evaluation of the BCP and quake resistance for the system under development.
- Creation of educational materials such as brochures and videos about the early warning system.
- Development of a highly effective system by the modulation mechanism of voice transmission.
- System construction proposal to install early warning systems on local cities in Mongolia.

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### 1.7.5 Establishment of seismograph network system

- Installing various devices for quickly estimation of seismic scale

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### 1.7.6 Emergency response system

#### (1) Result of damage estimation

- To promote the earthquake resistance of important facilities
- To strengthen the earthquake resistance of the bridges across the main roads
- For prevention of road blockage, quakeproof strengthening of roadside building, prevention of falling objects, and the road facility straddle.
- To set up seismic storage tank as fire protection.
- To develop the operating rules and specification of important road disaster.

#### (2) Establishment of the experts network in charge of emergency response

- To develop information network and helicopter transportation system for wide area disaster medical system
- To develop emergency medical expert including triage skill

#### (3) Safety check of buildings

- To develop the emergency safety check system for safety check of the affected buildings, and to train experts.

(4) Network of lifeline construction officials for emergency res recovery

- To set up a committee by lifeline and related industries, and to develop a national support system for disaster.

(5) School

- To make and train disaster response manual of on/off time, and operation manual of evacuation center

### 1.7.7 Land use and development regulations

- To promote a development of new town, rebuilding of aging housing complex, permanent housing of the gel region, land readjustment to make the development of the city district road, etc., as planed "City Planning".
- To formulate a disaster urban planning from the point of view of enhancement disaster prevention in urban, and be consistent with the city master plan.

### 1.7.8 Earthquake resistance of buildings and infrastructure

- Review of the aseismic design standards
- Improvement of construction quality by training of skilled workers
- The promotion of public awareness to the building earthquake resistance at residents level
- Creation of mechanisms for residents to wish funded for earthquake resistance by themselves
- Earthquake resistance for preferential important buildings

### 1.7.9 Community Based Disaster Management

- Acquisition of knowledge of earthquake and disaster management in disaster related organizations
- Promotion of disaster management awareness activities at residents level
- Sharing contents of training course in Japan
- Promotion of school disaster education at school level
- Promotion of disaster management educational activities via mass media
- Promotion of disaster management awareness activities in cooperation with private companies
- Development and maintenance of earthquake experience facilities
- Compilation of past earthquake experiences of Mongolia

# Chapter 2 Fundamental Survey

## 2.1 Disaster reduction related policies, plans, laws, development regulations, anti-earthquake (seismic) standards, organizations, communities in Mongolia and UB City

### 2.1.1 Disaster Prevention Policy

Central government and local governments in Mongolia have disaster management sections according article 13.to article 26. of Parliament Law of Mongolia on Disaster Protection. In addition, there are two council and committee related to policy making of Earthquake Disaster Prevention. One is the National Security Council which members are only President of Mongolia, Prime Minister of Mongolia and Chairman of Parliament and this council has big role to push forward the disaster prevention and management in Mongolia. The other is the Disaster Prevention Standing Committee. This committee is in the Cabinet which chairman is the 1st vice minister and other members are from related ministries and organizations. The secretariat is in National Emergency Management Agency (NEMA).

### 2.1.2 Earthquake Disaster Prevention Plan

(1) National Earthquake Disaster Prevention Plan

National Earthquake Disaster Prevention Plan authorized on 30th of March, 2011 is shown below. As the earthquake disaster risk management project has started soon in Mongolia, many of items in this plan are urgent and targeted period for completion are set in 2 or 3 years.

(2) Earthquake Disaster Prevention Plan in UB city

Earthquake Disaster Prevention Plan of UB city is made based on Earthquake Disaster National Capacity Strengthening Plan. Plan has made to responding 3 phases. The Earthquake Disaster Prevention Plan was revised on March 2013. In revised version of the plan, in this review procedure, new information and knowledge learned from the training Course in Japan and proposed ideas from our project team are introduced into reviewed. This new plan is not authorized by City Council.

### 2.1.3 Earthquake disaster related laws

Basic law related earthquake disaster countermeasures in Mongolia are Parliament Law of Mongolia on Disaster Protection issued on 20th of June 2001. Disaster Management is independent from other Ministries and responsibilities and duties of disaster management staff are clearly defined.

### 2.1.4 Disaster related organizations and communities in Mongolia

(1) Disaster management organizations in Mongolia and National Emergency Management Agency(NEMA）

National Emergency Management Authority which National Defense Committee, Fire Agency and National Storage Agency were unified was established according National Resolution No 1. (issued on 7th of January 2002). NEMA is in charge of Disaster Prevention, Search and Rescue, Emergency Response and Recovery and also in charge of disaster related legal and policy making organization. There are branch office in 21 prefectures and UB city to draw and implement plan and project in field.

(2) Disaster management organizations in UB city and Emergency Management Department of Capital City ( EMDC）

EMDC is in charge to make plan and to implement corresponding to NEMA. Disaster Prevention Plan (annual revise of the plan in every January) and risk management and its implementation.

(3) Other organizations related earthquake disaster management

- Ministry of Roads, Transport, Construction and Urban Development (MRTCUD), Department of Policy for Buildings, houses and public utilities
- MRTCUD, Agency of Land Affairs, Construction, Geodesy and Cartography ( ALACGaC)
- General Agency for Specialized Inspection
- Construction Urban Development and Planning Agency of UB city

- Road Department of UB city
- UB Railroad
- Mongolia Academy of Sciences

### 2.1.5 Community Based Disaster Prevention Organizations

Most close administrative unit is Kholoo, which is lower lever of District. There is no community based disaster prevention organization. Only UN HABITAT organized community organization in Pilot Project Area. It may work as similar organization as Community Based Disaster Prevention Organizations.

## 2.2 History and state of measures against seismic disasters, disaster reduction related educations and publicity activities in UB City

### 2.2.1 Measures against Earthquake Disaster in UB city

Earthquake Disaster National Capacity Strengthening Plan is the starting line of Earthquake Disaster in 2009. Therefore earthquake disaster measures are now incunabulum and just started.

(1) National Measures of Earthquake Disaster Prevention

Earthquake Disaster Prevention Measures is as follow.

- Earthquake Hazard Map
- Imprementation of seismic-capacity evalunation
- Reconstruction plan of old buildings
- Select new town area, government office area, buckup base in case of disaster occures
- Revision of Building Code
- stock of food and its storege buildinds
- Extention work of Military Hospital and Formation of Portable Hospital
- Early Warning System

(2) UB city Earthquake Disaster Measures

Following measures also started in UB city to responding National Plan.

- Earthquake Disaster Evalucation, Intensity Map
- Earthquake Risk Evaluation
- Disaster Prevention, Emergency Response, Recovery

### 2.2.2 Disaster Reduction related Educations and Publicity Activities in UB city

Disaster Education and Training Program is promoted based on the article 7. of Parliament Law of Mongolia on Disaster Protection. Also various activities started since 2011 according to the order that "Implement evacuation exercise on $4^{th}$ Wednesday of every March and holding events on United Nations disaster reduction day" from Earthquake Disaster Prevention Standing Committee.

### 2.2.3 Collected Documents related History and State of Measures against Earthquake Disasters, Disaster Reduction related Educations and Publicity Activities in UB City

ADRC country report 2006 and 2010 (Asian Disaster Reduction Center)

## 2.3 The state and plan of land use and urban development plan of UB City

### 2.3.1 Legal system of land use planning and urban development planning

Following are the legal system land use and urban development plan of UB City, Please refer Supporting Report in detail.

- Law of Mongolia on Land
- Urban Development Law
- Law on Allocation of Land to Mongolian Citizens for Ownership
- Housing Law
- Law on the Property of Shared-ownership of Residential Buildings and Legal Status of the

Condominium Association
- Urban and Village Planning and Construction Standard
- Zoning of law of Mongolia on land and Urban Development law

### 2.3.2 The state and plan of land use

(1) The state of land use
Present land use of whole city of UB is on Supporting Report.

(2) The Problem of Land Use
Apartment houses that major buildings in built-up area of UB city were mostly constructed during era of socialism from 1921 to 1992 and these buildings are getting old.
Major road network in central area of UB city was constructed with sufficient width but sub road network is not sufficient in central area. For street level road network, it seems not designed based on urban planning. Especially in Ger area, there is no road in side of Ger area and only between wooden fences of houses used as road without any pavement.

Based on this observation, it is very important and urgent to implement the planned improvement. Newtown planning, reconstruction of old apartment houses, land readjustment of Ger area with promoting to rebuild Ger to permanent houses and road network plan. These problems are also important as Disaster Prevention Urban Planning to promote anti-seismic retrofitting of buildings, ensuring of evacuation place an evacuation road, earthquake fire countermeasures and earthquake countermeasures.

(3) Land Use Plan
UB city urban planning master plan started in 2001 targeting year 2020. This plan is physical special plan responding to UB city urbanization and rapid mobilization and also proper vision for environmental countermeasures for water resources conservation. But on the other hand, there are some scope of consideration related urban planning topics related comprehensive urban growth management and proper land use based on privatization.

From this view points, The Study on City Master Plan and Urban Development Program of Ulaanbaatar City (UBMPS) was implemented from March 2007 to February 2009 by JICA.

### 2.3.3 Urban development Plan

Ongoing project related urban development plans are introduced in Urban development Plan. Please refer Supporting Report for detail plan.
- Hundred Thousand Housing Construction Project
- Redevelopment of Central Area
- Construction of apartments in Ger redevelopment Area

### 2.3.4 The documents related the state and plan of land use and urban development plan of UB City

The documents related the state and plan of land use and urban development plan of UB City are collected.

## 2.4 Geography, geology, meteorology, soil condition and underground water of UB City

Mongolia is an inland nation located in eastern part of Eurasian continent. The topographical feature of Mongolia is higher in its west and lower in its east. Mongolia is mainly composed of three types of landscapes, mountains in the north and western region, basin area among them and plateau in the south and eastern region. In the southwestern part and western part of Mongolia is occupied by the Altay Mountains and Hangai mountains, respectively, both are reached 4,000 m above sea level. On the other hand, the elevation being lower to 500-1,000 m in the central to eastern step land. In the southern part of the nation is Gobi desert region. The capital city Ulaanbaatar is located in central northern part of the country.

### 2.4.1 Topography and Geology

The capital city Ulaanbaatar is comprised of 9 administrative districts, occupying a total area of 4,704.4 $km^2$ (Statistics Department of Ulaanbaatar). In which, the Bagahangai and Baganuur districts are located far from the city area, being as satellite districts of the capital.

The capital city Ulaanbaatar and its surroundings are as the southern end of the Hentei ranges, composed of mountains and hills and basins among them. The city area of Ulaanbaatar is mostly distributed along bank of the Tuul river, which rises in the Hentei ranges and flows west through the Ulaanbaatar city, most of the settlement located on the right bank of the river.

The city area is a basin surrounded by 4 mountains. The satellite district, Baganuur district is located on the right bank of upper stream of the Herlen River that raises from the Hentei ranges. In this district, the elevation along the river is about 1,330 m but rise high to 1,750 m in the northern mountain areas. Another satellite district, the Bagahangai district is a gentle slope hilly area with small scale channels. The elevation is about 1,500-1,600 m in this district.

The geology of Mongolia is divided northern domain and southern domain by the Main Mongolian lineament. In the northern domain, it is mainly composed of pre-Cambrian and lower Paleozoic rocks, while the southern domain is composed of Lower to upper Paleozoic rocks. The capital city Ulaanbaatar belongs to the northern domain of the geological unit. The geology of Ulaanbaatar city and its surroundings, from older order, is composed of lower Paleozoic Hara Formation, middle-upper Paleozoic Hentei Formation, Mesozoic granite, Cretaceous Zuunbayan Formation and Cenozoic sediments (Takahashi *et al.*, 2004). Along the Tuul River and its tributaries, it was covered by sediments of sands, gravels and mud that transported by the rivers. Moreover, sands and gravels deposited on terraces and on small scale alluvial fans.

As above description, the geology of city area of Ulaanbaatar is characterized by sands and gravels that mainly transported by the Tuul River, while the mountain and hilly areas are composed of older rocks.

### 2.4.2 Climate

Almost all of the Mongolian territory belongs to same climate classification, say typical continental subarctic climate or steppe climate. The climate of Ulaanbaatar city has distinctive four seasons, characterized by dry and short summer (from June to August), cold and long winter (from November to April) and sharp fluctuation of spring and autumn.

The annual temperature of Ulaanbaatar city is about 0℃. However, the temperature varies very violent, such as the average maximum temperature is 35℃ while the average minimum temperature is -34℃. According to WMO, the monthly average temperature and precipitation within 30 years (from 1971 to 2001), the highest value of average maximum temperature is in July, and the next is in June. The average minimum temperature is in January and the next is in December. About the precipitation, annual amount is about 270 mm. The monthly average of precipitation is highest in August, 76.3 mm and the next is in July, 65.7 mm. However, in December, January and February, the precipitation is very low, only 2-3 mm.

However, considerable abnormal climate has been observed recent years. For example, according to the climate situation of 2011, it recorded 31.8℃ on August 10, and recorded -39℃ on January 26 and 27, and the severe cold continued from December to February (Weather, Environment institute of Mongolia).

### 2.4.3 Ground condition and groundwater

According to topography and geology, most of the area of Ulaanbaatar city is occupied by hard rock except younger sediments like sands and gravels along the floodplain and on the terraces of the Tuul

River.

According to the soil classification of Mongolia by NGIC, the Ulaanbaatar city and its surroundings are can be classified to mountain, low mountains and rolling hill soil, soil of humid areas and riparian soil. In the mountainous area, the ground can be estimated hard rock based on geological map. However, along the rivers and channels, the ground estimated to be sand, gravel and mud.

Within the Ulaanbaatar city area, we collected an engineering geological map the RCAG. According to this map, mud deposits distributed intermittently along the main stream of the Tuul River, alluvial deposits distributed along the main stream and tributaries. Except these deposits, and part area that are not classified, the remains are composed of base rock ground.

About the groundwater data sets of Ulaanbaatar city, there are two data sets has been collected, one is Above two date sets are both old. The data set of JICA (1995) was collected in 1993 and 1994, while the groundwater flow map of NGIC was compiled from the 1981 report of Mongolian-Russian scientist, so the date was considered to be collected before 1981.

To confirm the groundwater level of Ulaanbaatar, especially in the city area, we used the 1,500 boring which included groundwater level in 4,076 boring data provided from RCAG, ,created groundwater level map of the city area. According to this map, in the northern area of the city, the groundwater level is deep and lower in the southern part of the city.

## 2.5 Existing survey material and amendment field survey for the active faults in and around UB City

Several active faults, such as shown in Figure 2.5.1, recognized around Ulaanbaatar city. These active faults have been studied mainly by RCAG using geomorphological and geophysical methods. Below is description about main active faults in and around Ulaanbaatar city, Hustai, Emeelt, Avdar uul and Gunjin faults, based on related materials and additional field survey. The outline of the active faults survey is summarized in Supporting Report.

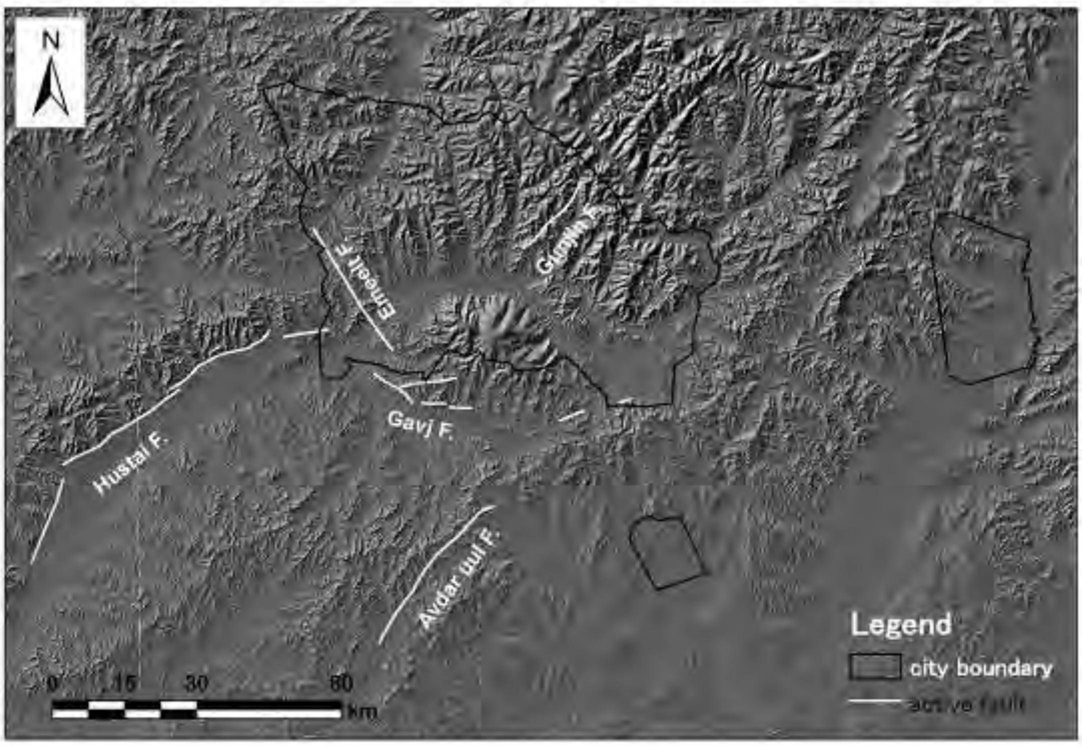



Figure 2.5.1 Active faults in and around Ulaanbaatar city
(background is shaded map created from Aster DEM, fault traces are based on RCAG)

## 2.6 Earthquake/Strong ground motion observation data, earthquake wave data, investigation material of historical earthquake including disaster damage data by past earthquakes

Although seismicity of Mongolia is not so active compare to regions of plate boundary, such like Circum-Pacific seismic belt, but it is a quiet active seismic region as an inland. In Mongolia, its west and western regions are very active in seismicity, in which huge earthquakes over Mw8.0 occurred in these regions, such as Bolnay earthquake in 1905, Gobi-Altay earthquake in 1957. These earthquakes were considered to be the largest scaled one ever occurred inland (Suzuki, 2009). This active seismicity was considered to be the stress transportation to Altay Mountains, due to collision of Indian plate and Eurasian plate. However, including Ulaanbaatar, the eastern part of Mongolia is not so activity in seismicity.

About Ulaanbaatar city and its surroundings, it has been attracting attention due to active seismicity from 2005, according to RCAG report (2012). Especially in the western part of the city, a northwest-southeastern directed swarm of micro earthquakes were observed, which was considered as the activity of Emeelt active fault.

However, about wave form data, we got only data from one seismic station of ULN. Moreover, there was no historical earthquake in Ulaanbaatar city has been reported, and no related materials have been found.

## 2.7 Population, residential buildings, public buildings, infrastructures, and others

### 2.7.1 Population

Population of UB city is assessed 1206.6 thousand at 2011. Structure of population in each district is almost identical, *i.e.* population under 16-years is a little under 30%, that of working age is a little under 70%, and aging population is a little under 10%.

Steep increments in population occurred in 1988 and 1999, and population increment rate has become high since 2002.

### 2.7.2 General buildings

Data related to general buildings are provided by UB master plan project and by UB city. The data includes 190,036 buildings, in which 57,848 buildings are relatively large with building area of 10 square meters or more, and the rests are small ones such as storage, garage and so on. It is noted that included in the database are not only apartment houses in the central area but also small houses in Ger area.

### 2.7.3 Public buildings

(1) School

Regarding to the number of rooms to the population of one thousand, the maximum of 7.25 in Sukhbaatar district is almost double of the minimum of 3.38 in Chingeltei district. Also, regarding to the number of gymnasia to the population of one thousand, the maximum of 0.54 in Bagakhangai district is almost eight times of the minimum of 0.07 in Songinokhairkhan district.

One of the important functions of school facilities in case of disaster is to receive the refugees, and it can be said that the capacity of function largely differs by districts.

(2) Hospital

Outline of hospitals is summarized. Some medical centers, such as an emergency medical center, a dental and neurological disorder institute, a blood transfusion center, an infectious disease institute and an occupational disease study center are established for special medical treatment.

Expert units, such as an emergency treatment unit, an ambulatory pharmacy, an ambulatory blood transfusion unit, an ambulatory infection prevention unit, an infectious prevention expert, expert treatment unit, are organized for the disaster response.

(3) Refuge
Location of refuges and pharmacies is put into database and shown on the maps. Moreover, refuges in suburbs and five evacuation routes from the central UB to suburbs are planned.

### 2.7.4 Infrastructures

(1) Road
The total length of the road is 842km with 110km road of more than four-lane, 308km road of two-lanes and the remaining 424km road of less than two-lane. The road in the urban area is paved and the damage and subsidence of road surface can be seen somewhere, may because of adequate maintenance. The road could be flooded when in heavy rain due to the insufficient drainage capacity.

The traffic jam occurred often on the main road, especially in the morning and evening rush hours. Ulaanbaatar City has 118,573 private cars in 2010 and the traffic jam can be partly attributed to the lack of parking area and the delayed establishment of traffic management system. The road in ger area is generally unpaved and the natural earthen road is narrow and rough, which may cause the problem for emergency vehicles in case of disaster.

(2) Bridge
It has been confirmed that there are 67 bridges in Ulaanbaatar City by the investigation from "The Project for Construction of Ajilchin Flyover in Ulaanbaatar City" project. Among the 67 bridges, there are 11 bridges constructed in 1960s, 7 in 1970s, 15 in 1980s, 7 in 1990s and 23 after 2000. Most of the bridges built before 1990 were constructed by the cooperation from former Soviet Union and China. The defects in construction and the deterioration are observed.

(3) Railway
The railway of Mongolia consists of a main north-south line, 7 branch lines from the main line and a freight line in the north-east connecting to Siberian railway. The total length of Mongolia railway is about 1800km with the north-south line, 1,118km, from the border of Russia to China. The railway is not electrified and almost all of them are single-track railways. The railway is operated by the Mongolian Railway, a State Owned Share Holding Company (Russia 50% and Mongolia 50%). The railway provides not only the domestic transportation but also the international transportation from Moscow to Beijing.

(4) Airport
The main international airport in Mongolia is Chinggis Khaan International Airport, located about 15km south-west of Ulaanbaatar. The airport was built in 1957 and had the name of Buyant Ukhaa Airport. The airport has its present name from 2005 as the commemoration of the 800 years anniversary of the foundation of the country.

Mongolia is planning to construct a new airport with 28.8 billion yen loan from Japanese government. The new airport, with a 3,600m runway, will be at a plain area and about 50km south of Ulaanbaatar. The airport has been started in May 2012 and expected to be completed in March 2016.

(5) River-structure
In 1966, the river flooded and caused 20 lives and affected 10 thousands households. After the flood, about 30km cobble river bank was constructed at the right side of the river. The bank is 2m high with the width of 1.5m at the top and 3-4m at the bottom. Another river, Selbe river, a tributary of the Tuul river and about 20m in width, flows through the center of the city and has a concrete bank at the two sides and concrete prevention works for river bed scour.

(6) Water supply and sewage

Water supply in Ulaanbaatar city has two types; one is piped water supply for apartment area, which provides water to each household, and another is bulk water supply for ger area, where the residents need to go to the water supply station to buy the water. The water supply and sewerage processing is operated by the Water Supply and Sewerage Authority of Ulaanbaatar City (USUG).

(7) Power Systems

The power system of Mongolia consists of four independent electric power systems: Central Energy System (CES), Western Energy System (WES), Eastern Energy System and Altai-Uliastai energy system in addition to Dalanzadgad combined heat and power plant (CHP) and other diesel fuel and renewable energy sources. The total power generation capacity is 897MW with 91.8% from thermal power, 5.1% from diesel, 3.0% from hydraulic power and 0.1% from renewal energy such as wind and solar.

(8) Gas

There is no piped gas supply system in Ulaanbaatar now. The Mongolia Government promotes the use of Liquefied Petroleum Gas (LPG) for both transportation and households. There are several private companies supply LPG to households and factories and the use of LPG for household will be increased in the future.

(9) Hot water supply

Hot water for central heating for apartment houses in Ulaanbaatar is supplied from three power stations and from more than one thousand heat boilers. Hot water is not supplied to the houses in Ger area, where stoves are heat sources in winter time.

(10) Fixed-line phone and mobile phone

There are two companies, Mongolia TeleCom (MT) and Mongolian Railways Communications (RailCom).

The mobile phone service is provided by four mobile network operators, i.e. Mobicom, Skytel, Unitel and G-Mobil. The Mobicom, a joint venture company of Sumitomo Corporation (44.4%), KDDI Corporation (44.4%) and NEWCOM (11.2%), has the top share now.

## 2.8 Transportation, logistics and regional economics in and around UB City

Mongolia is a landlocked country. There is no seaport and river water way is very limited because of the harsh weather. The domestic and international transportation means are road, railway and air flight. After the market economy started in 1990s, Mongolia has a rapid growth in economy in recent years, but the construction of transportation infrastructure is relatively behind the growth. The public transportation means of Ulaanbaatar is route bus, trolleybus and microbus.

The main industry of Mongolia before 1990s is stock farming, after 2005 mining became the major industry because of the exploitation of its rich reserves on gold, copper and coal, etc. The main export goods are mineral and stock products and the main export counterparts are China, Canada, USA, Russia and Italy. The main import goods are oil products, car, machinery equipment, medical products and daily goods and the main counterparts are Russia, China, Japan, Korea and USA.

Mongolia has a continuous growth of economy in recent years. The GDP growth rate of 2011 is 17.3%. The composition ratio of GDP is Mining and quarrying 23%, agriculture and fishing 16%, wholesale and retail 15%, manufacture 8%, transportation 8%, real estate 6%, communication 4% and the others 20%. The GDP of Ulaanbaatar contributes a big portion to the national GDP and it is about 65% in 2011.

## 2.9 Information on main road network connecting metropolis and other large cities in and around Mongolia

The total length of road of Mongolia is about 49,250km with state road of 11,219km and local road of 38,031km. The state road is mainly to link the capital city of Ulaanbaatar and Aimag center or among the Aimag centers. And the local road is mainly to connect the Aimag center and its surrounds. For state road, the paved road is 2,120km (19%), gravel road 1,440km (13%), improved earth road 1,400km (12%) and natural earth road 6,240km (56%). For local road, the paved road is 477km (1%), gravel road 521km (1%), improved earth road 499km (1%) and natural earth road 36,534km (97%).

## 2.10 Reports of the relevant donors

In Mongolia, a number of project conducted by UN and several countries. Here, we collected some reports of other team of JICA and other organization that related to this project.

### 2.10.1 UNDP

- Project title: Strengthen the disaster mitigation and management system in Mongolia, phase Ⅲ
- Program Period: 2007-2011
- Implementing partner: NEMA

Purpose: The principal objective of the phase Ⅲ project is to support implementation of the long-term strategy of Mongolia for disaster risk management to minimize vulnerability, improve preparedness; Enhance institutional capacity for disaster management and emergency response, and assist in adapting to climate change that adversely affects sustainable development of the country, especially those in the rural environments.

Main outcomes: The phase Ⅲ project has 3 outcomes as below.

- Enhanced the professional capacities of NEMA and its 30 departments at aimag/duureg levels;
- Increase of public awareness and education for disaster risk reduction;
- National capacity for climate resilience and adaption to reduce disaster risk strengthened.

In this project, it mainly focusing on natural disaster and emergency situation, but not including earthquake. Due to this reason, there are no items or data that directly related to our project.

### 2.10.2 ADB

- Project title: Mongolia: Cadastral survey and land registration project
- Program Period: 2002-2009
- Implementing agency: AlacGac

The project’s objective was to create an institutional environment

- for the efficient issuance and administration of property and land lease certificates and other land related documentation
- for collection of land fee payments and property taxes;
- to support urban and agricultural development
- to support the development and operation of a private land market

Project component:

A: supported carrying out of a systematic cadastral survey and mapping
B: supported the establishment of a National Land Information System (NLIS)

Project outputs:

Component A outputs include

- survey of up to 3 million ha of urban, settlement and agricultural land
- production of associated digital cadastral maps
- compilation of a database of basic textual attribute data
- creation of the national cadastral database

Component B outputs

- the design and operation of a fully NLIS, providing a centralized server-based land information system
- trained staff

### 2.10.3 GTZ

- Project title: Land Management and Fiscal Cadastre project
- Program Period:2005-2011
- Implementing agency: AlacGac

Main Objective: Improve general conditions for an active real estate market and for a communal land management

Contents:

- Implementation of modern and transparent valuation methods for real estate in compliance with international standards
- User orientated and efficient land management of communal and state land
- Supporting the development of a mortgage market
- Advice for amendments to the legal framework for land management
- Updating the cadastral database
- Strengthened human capacity in land administration

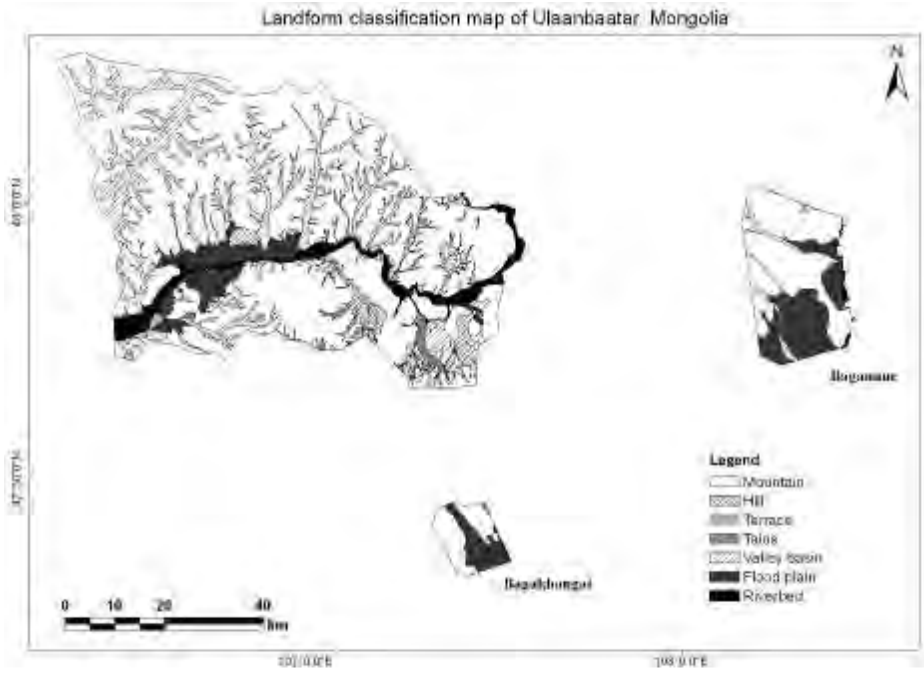
# Chapter 3 Results of Ground Survey

## 3.1 Formulation of Landform Classification Maps

In order to understand the micro topographical characteristics of the study area, a Red Relief Image Map (RRIM, developed by Asia Air Survey Co., Ltd.) was created using 30 m mesh ASTER GDEM digital elevation data. The geomorphology of the study area was interpreted using Google Earth satellite image and RRIM. The topographical classification map is shown in Figure 3.1.1.

In the study area, the microtopography can be mainly classified as:

- Mountains- including hills, generally composed of hard rock mass.
- Terrace- distributed along the Tuul River, developed lower to higher terraces.
- Mountain footslope- spread from footslope of mountains, distributed along the left bank of Tull River. Composed of talus deposits.
- Valley basin- lowland along valleys, including alluvial fans.
- Flood plain- lowlands developed along the Tuul River and the Herlen River.
- Riverbed- river beds of the Tuul River, the Herlen River. Including old river channels, natural levees, backswamps.




Ref: JICA Project Team

Figure 3.1.1 Result of topographical classification of the study area

## 3.2 Results of Ground Survey

### 3.2.1 Outline of Ground Survey

(1) Survey Items and Quantities

The ground surveys were conducted for confirming the ground composition of the study area as well as deriving the necessary parameters for ground modeling. The surveys were conducted from June 29 to September, 2012. The survey sites were shown as Figure 3.2.1.

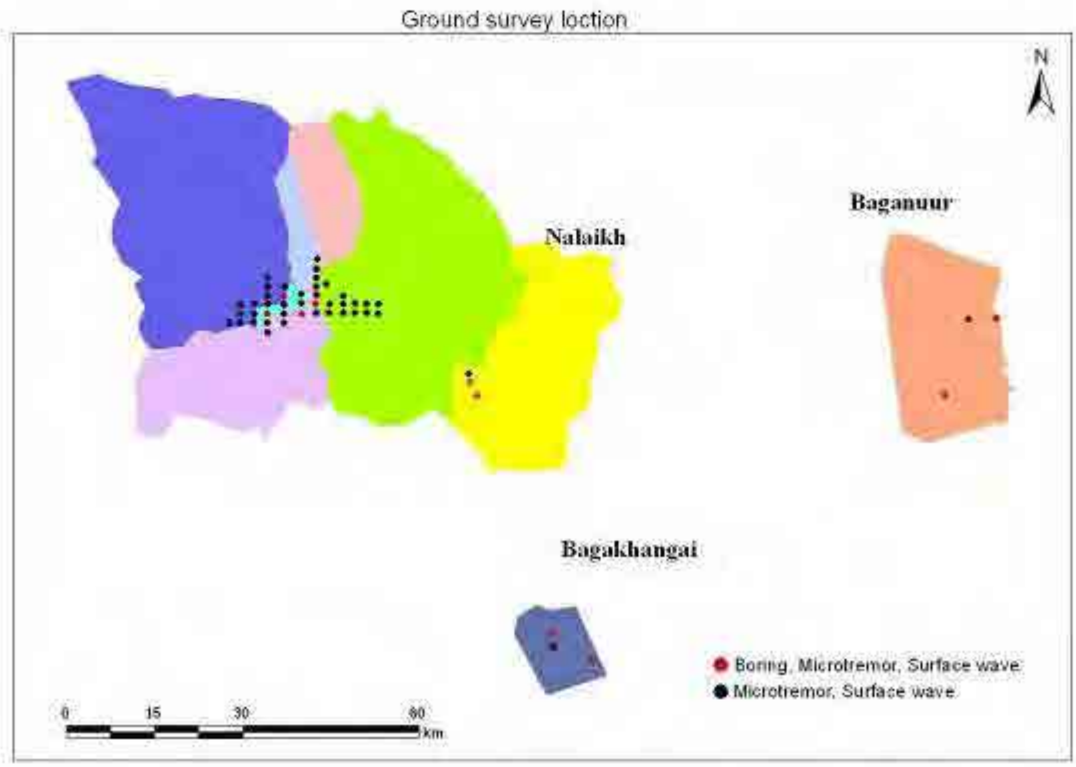
The items and quantities derived from the ground survey were shown in Table 3.2.1.

The detailed information of survey sites and the survey methods were summarized in Supporting Report.

Table 3.2.1 Ground survey items and quantities

| Items | Purpose | Quantity |
|---|---|---|
| Boring | Confirmation of ground composition | 10 holes（300m） |
| SPT | Get the N value of ground | 10 holes（298 times） |
| Soil test | Liquefaction evaluation | 10 holes（132 samples） |
| PS Logging | Get S-wave velocity | 10 holes |
| Surface Wave Exploration | Get S-wave velocity | 50 points |
| Microtremor Measurement | Get natural period of ground | 50 points |

Ref: JICA Project Team




Ref: JICA Project Team

Figure 3.2.1 Locations of ground survey sites

### 3.2.2 Survey Results

(1) Boring Survey (includes SPT and Groundwater Level)

The boring survey results revealed that:

- The ground is mainly composed of sand and gravel in the central city of UB. The mean N value is above 30, while the top soil at site UB_BO_04 is 24. However, N value mentioned here is the value measured at site without any correlation.
- The borings in Nalaikh district were conducted near riverbed. The soil composition is dominated by lean clay, and sandy clay with gravel. Moreover, permafrost was confirmed at site NH_02. The mean N value of clay is about 40, while for sand is 29.
- In Bagakhangai district, the soil is mainly composed of sand and gravel at site BI_01, while clay is dominant at site BI_03. The mean N value is above 21 in the sand layer at site BI_01, while at other sites it is above 30.
- In Baganuur district, the upper part is composed of clayey sand, sand with gravel, while the lower part is composed of sandy clay. The mean N value is above 30 in sand layer, and above 40 in clay layer.

The groundwater level measurements after boring drilling are as flowing.

- deeper than -3.2 m from the ground surface in the central city of UB.
- 0m and -2.8 m at Nalaikh district.

- deeper than GL-14.5ｍat Bagakhangai district.
- deeper at site BR_01 and GL-11.2ｍ, but shallower at site BR_02 and GL-3.5 ｍ in Baganuur district.

(2) Particle Size Distribution of Soils
The soil type based on particle size distribution test was shown in Table 3.2.2
The data sheets of particle size distribution test, grain size accumulation curves were summarized in Databook.

Table 3.2.2 Result of soil test

| No. | Sample | Depth（m） | Soil type | Name of soil |
|---|---|---|---|---|
| UB_Bo_01 | 18 | 0.2-16.5 | GP | Poorly graded GRAVEL with sand |
| | | 16.5-30.0 | GP-GC | Poorly graded GRAVEL with sand and clay |
| UB_Bo_02 | 8 | 0.2-4.0 | GP | Poorly graded GRAVEL with sand |
| | | 4.0-30.0 | GP-GC | Poorly graded GRAVEL with sand and clay |
| UB_Bo_03 | 12 | 0.2-7.0 | GP | Poorly graded GRAVEL with sand |
| | | 7.0-13.0 | GP-GC | Poorly graded GRAVEL with sand and clay |
| | | 13.0-16.0 | GC | Clayey GRAVEL with sand |
| | | 16.0-30.0 | GP-GC | Poorly graded GRAVEL with sand and clay |
| UB_Bo_04 | 15 | 1.0-9.5 | GP | Poorly graded GRAVEL with sand |
| | | 9.5-24.5 | GC | Clayey SAND with gravel |
| | | 24.5-30.0 | SC | Clayey SAND with gravel |
| NH_01 | 15 | 0.5-8.40 | SC | Clayey SAND with gravel |
| NH_01 | | 8.4-30.0 | CL | Sandy lean CLAY |
| NH_02 | 12 | 0.2-30.0 | CL | Lean CLAY with sand |
| BI_01 | 10 | 0.4-5.2 | GP | Poorly graded GRAVEL with sand |
| BI_01 | | 5.2-30.0 | GC | Clayey GRAVEL with sand |
| BI_03 | 15 | 0.4-5.0 | SC | Clayey SAND with gravel |
| BI_03 | | 5.0-30.0 | CL | Sandy lean CLAY |
| BR_01 | 14 | 0.3-18.0 | SC | Clayey SAND with gravel |
| BR_01 | | 18.0-30.0 | CL | Sandy lean CLAY |
| BR_02 | 13 | 1.0-10.0 | SP-SC | Poorly graded SAND with gravel and clay |
| | | 10.0-17.2 | SC | Clayey SAND with gravel |
| | | 17.2-30.0 | CL | Sandy lean CLAY |
| Total | 132 | | | |

Ref: JICA Project Team

(3) PS Logging
The S wave velocity values obtained from the PS Logging indicated that:

- The strata are mainly composed of gravel, the S wave velocity value is above 290 m/s excludes the top surface at UB_BO_03 in UB central city. However, the velocity values ranged from 155 to 898 m/s with dispersion.
- Low velocity value of 155 m/s obtained in sand deposits in the upper strata at site NH_01 hole. However, in same sand deposit in the upper layers at site BR_01 and BR_02, the values are larger than 250 m/s.
- Clay layer in the lower part of NH_01 and at site NH_02 is larger than 200 m/s.

The S-wave velocity structure, velocity value obtained from PS Logging were summarized in Databook.

(4) Surface Wave Exploration
The results of surface wave exploration were used to determine AVS30 value of the ground model. The AVS30 values obtained from the surface wave exploration are listed in Table 3.2.3.

The AVS30 is calculated as follows

First, the S wave traveling time at depth of 30 m in each stratum is calculated as shown in Formula 4.2.1 based on the thickness of stratum and S wave velocity. Then the AVS30 at each survey site is determined based on Formula 4.2.2 (Japan Cabinet office, 2005).

$$T30 = \Sigma (Hi/Vsi) \quad (3.2.1)$$

$$AVS30=30/T30 \quad \text{(m/s)} \quad (3.2.2)$$

*Where:*
*T30*; S wave traveling time form surface to 30m depth (sec)
*Hi* ; thickness of *i* layer (m)

The wave form records, velocity model were summarized in Databook. And all raw data of ground survey was storage in separated CD.

Table 3.2.3 Results of surface wave exploration

| No. | AVS30 (m/s) | No. | AVS30 (m/s) |
|---|---|---|---|
| UB_01 | 438.8 | UB_26 | 741.7 |
| UB_02 | 507.6 | UB_27 | 465.0 |
| UB_03 | 501.8 | UB_28 | 463.7 |
| UB_04 | 387.1 | UB_29 | 348.6 |
| UB_05 | 361.1 | UB_30 | 540.7 |
| UB_06 | 433.3 | UB_31 | 435.4 |
| UB_07 | 523.4 | UB_32 | 624.0 |
| UB_08 | 544.7 | UB_33 | 699.5 |
| UB_09 | 447.4 | UB_34 | 556.1 |
| UB_10 | 474.1 | UB_35 | 350.6 |
| UB_11 | 912.5 | UB_36 | 480.6 |
| UB_12 | 724.3 | UB_37 | 433.9 |
| UB_13 | 673.9 | UB_Bo_01 | 399.3 |
| UB_14 | 855.0 | UB_Bo_02 | 662.2 |
| UB_15 | 404.6 | UB_Bo_03 | 420.2 |
| UB_16 | 417.3 | UB_Bo_04 | 496.5 |
| UB_17 | 398.3 | NH_01 | 475.8 |
| UB_18 | 476.8 | NH_02 | 543.0 |
| UB_19 | 900.9 | NH_03 | 798.9 |
| UB_20 | 447.0 | BI_01 | 477.1 |
| UB_21 | 719.3 | BI_02 | 1008.2 |
| UB_22 | 648.5 | BI_03 | 332.4 |
| UB_23 | 521.4 | BR_01 | 397.7 |
| UB_24 | 728.1 | BR_02 | 417.4 |
| UB_25 | 494.7 | BR_03 | 322.2 |

Ref: JICA Project Team

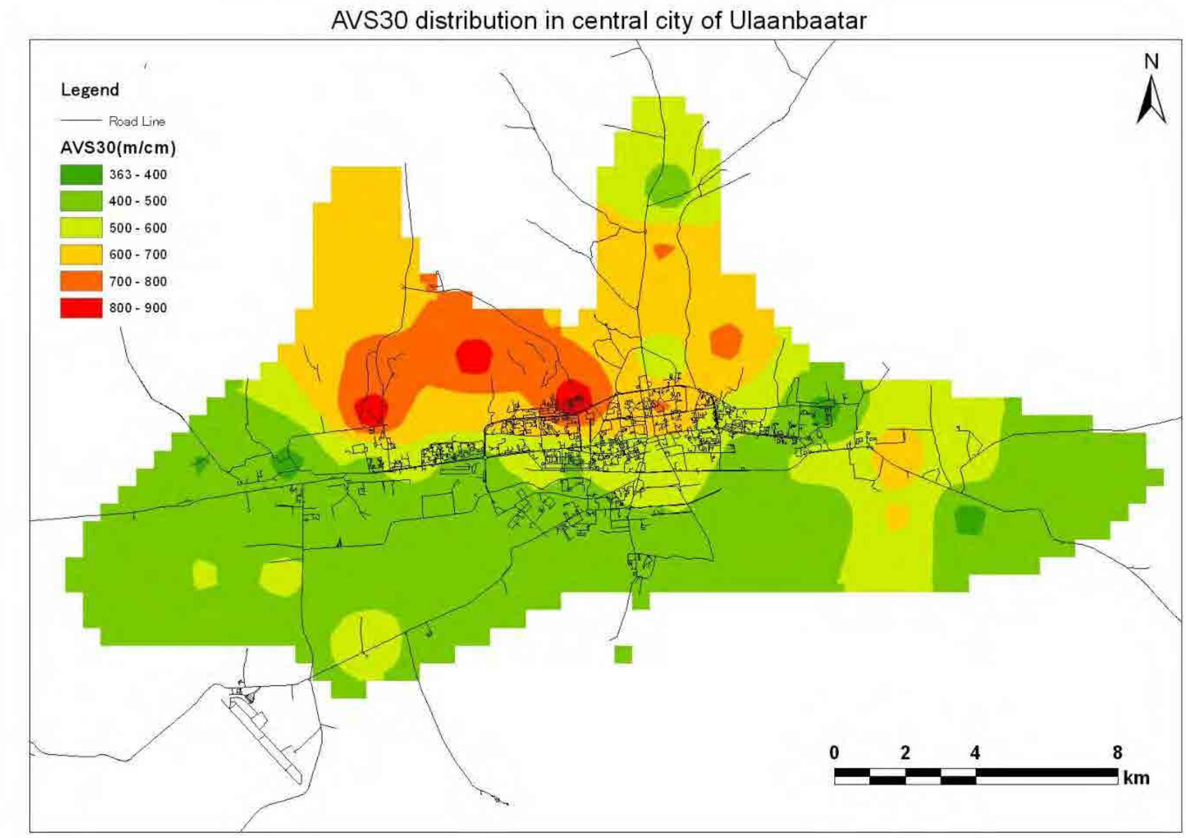



Figure 3.2.2 Distribution of AVS30 in central UB city

(5) Microtremor Measurement

The ratio of the vertical component with horizontal component was calculated from the microtremor measuring result (waveform record), which was used for ground classification.

The natural period of ground was calculated from the H/V predominant value of frequency. The dominant frequency, dominant period of ground is shown in Table 3.2.4.

The spectral of each component, graph of H/V spectral ratio were summarized in Databook. The raw data was stored in separate CD.

Table 3.2.4 Result of microtremor measurement

| No. | Frequency (Hz) | Dominant Period（s） | No. | Frequency (Hz) | Dominant Period(s) |
|---|---|---|---|---|---|
| UB_01 | 8.276 | 0.12 | UB_26 | 7.430 | 0.13 |
| UB_02 | 2.209 | 0.45 | UB_27 | 5.103 | 0.20 |
| UB_03 | 8.228 | 0.12 | UB_28 | 5.562 | 0.18 |
| UB_04 | 4.456 | 0.22 | UB_29 | 2.661 | 0.38 |
| UB_05 | 3.174 | 0.32 | UB_30 | 2.929 | 0.34 |
| UB_06 | 8.410 | 0.12 | UB_31 | 2.405 | 0.42 |
| UB_07 | 7.861 | 0.13 | UB_32 | 7.507 | 0.13 |
| UB_08 | 8.007 | 0.12 | UB_33 | 4.456 | 0.22 |
| UB_09 | 8.313 | 0.12 | UB_34 | 4.956 | 0.20 |
| UB_10 | 3.222 | 0.31 | UB_35 | 11.047 | 0.09 |
| UB_11 | 15.783 | 0.06 | UB_36 | 5.383 | 0.19 |
| UB_12 | 11.450 | 0.09 | UB_37 | 9.216 | 0.11 |
| UB_13 | 19.238 | 0.05 | UB_Bo_01 | 2.405 | 0.42 |
| UB_14 | 6.323 | 0.16 | UB_Bo_02 | 9.960 | 0.10 |
| UB_15 | 13.293 | 0.08 | UB_Bo_03 | 1.696 | 0.59 |
| UB_16 | 5.261 | 0.19 | UB_Bo_04 | 7.238 | 0.14 |
| UB_17 | 2.343 | 0.43 | NH_01 | 13.488 | 0.07 |
| UB_18 | 10.388 | 0.10 | NH_02 | 7.837 | 0.13 |

| | | | | | |
|---|---|---|---|---|---|
| UB_19 | 8.056 | 0.12 | NH_03 | 12.377 | 0.08 |
| UB_20 | 5.737 | 0.17 | BI_01 | 3.699 | 0.27 |
| UB_21 | 5.285 | 0.19 | BI_02 | 12.194 | 0.08 |
| UB_22 | 5.639 | 0.18 | BI_03 | 2.453 | 0.41 |
| UB_23 | 14.355 | 0.07 | BR_01 | 1.831 | 0.55 |
| UB_24 | 18.957 | 0.05 | BR_02 | 4.260 | 0.23 |
| UB_25 | 9.204 | 0.11 | BR_03 | 4.150 | 0.24 |

Ref: JICA Project Team

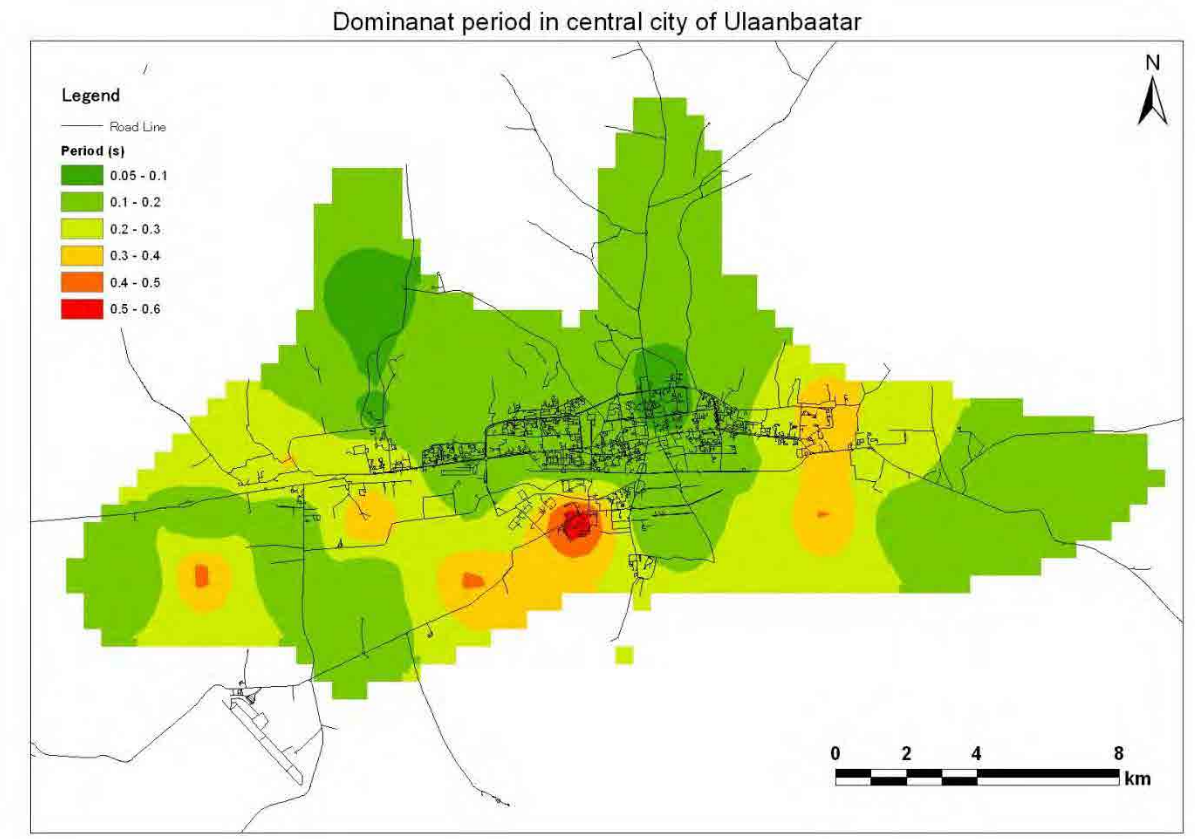



Figure 3.2.3 Distribution of dominant period of surface groung in central UB city

## 3.3 Ground Model

### 3.3.1 Ground Classification

In order to clarify the geological situation of UB city, a digital geological map was compiled from existing geological maps. In the central city area, the 1:100,000 scale geological map (NGIC) was used, while the 1:1,000,000 scale geological map (NGIC) was employed in Bagakhangai and Baganuur districts (Figure 3.3.1).

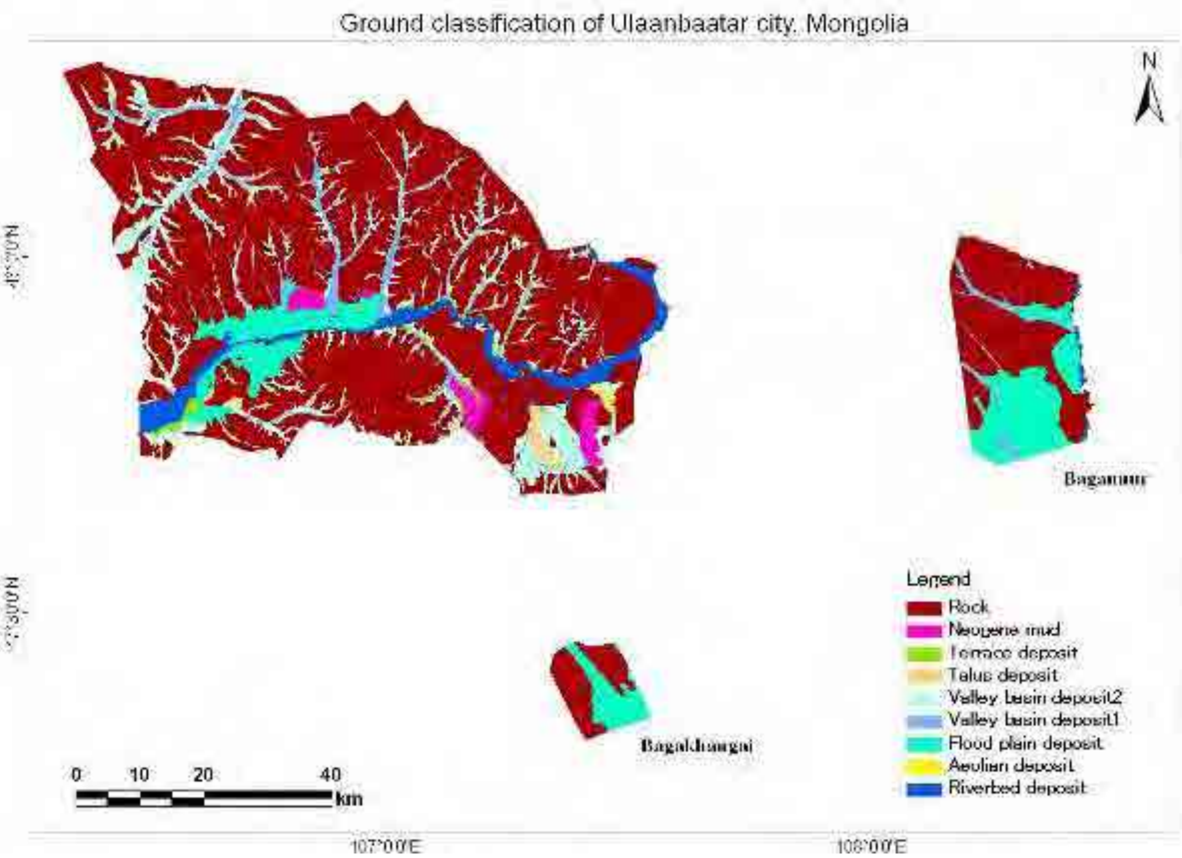
Based on the existing geological map field survey results and ground survey, the study area was classified as follows.

- Riverbed deposits: Including riverbed deposits, old river channel, natural levees, backswamp of the Tuul River and the Herlen River. According to field and boring surveys, river bed deposit of the Tuul River is mainly composed of gravel, imbedding sand and clay. The N value is larger than 20.
- Aeolian deposits: Holocene deposits, deposited by wind. Shows same characteristics as fluvial deposits.
- Flood plain deposits: Most of the city area of the UB city is located on this deposit. Mainly composed of sand and gravel. The N value ranges from 20 to 60.

- Valley basin deposits: Deposits distributed along the valley basins of the tributaries of the Tuul River and Herlen River. N value is above 20.
- Terrace, fan and talus deposits: Rarely distributed along downstream of the Tuul river. Estimated same as the valley basin deposits based on its composition.
- Neogene mud: Sediments of hills located in the northern side of UB city and along the left tributaries of the Tuul River. Composed of reddish, yellowish and mixed mud, gravel, sand, low consolidated conglomerate, gravel loam, sandy loam. N value is larger than 50.
- Base Rock: The part excludes above classification, distributed in mountainous area. The geology is older than Neogene.

Based on ground and field survey results, Riverbed deposits and Aeolian deposits are considered as the same ground condition, while the Valley basin deposits (/Terrace/fans/Talus deposits) are shown the same ground conditions. Therefore, five different ground types of AVS30 were classified as Base rock, Neogene mud, Terrace/Fan and Valley basin deposits, Floodplain deposits, Riverbed deposits/Aeolian deposits.

This classification is purposed for calculated the AVS30 which necessary for ground motion evaluation. In the case of detailed ground information needed such as determining foundation of building, it is recommended that detailed ground survey should be conducted at the target site.




Ref : Created by JICA Project Team based on Geological maps of NGIC

Figure 3.3.1 Ground classification map of UB city

### 3.3.2 Ground Model

(1) AVS30

According to PS logging results conducted at the boring survey points and surface wave exploration at each point, S wave average velocity from surface to depth of 30 m was calculated (Table 3.3.1).

However, in the locations where PS Logging and surface wave exploration were conducted, the results of PS Logging were selected because the measuring depth is deeper in PS Logging than surface wave exploration. Taking into consideration the dispersion of the data, statistically average-1.28σ (90% confidence interval) was chosen as the representative value of the corresponding ground in the model.

(2) Ground Classification
Since the ground classification is necessary for calculation of lifeline risk assessment, ground classification was conducted for each ground type. The selection of ground types was based on the natural period of corresponding ground. The natural period of ground, *TG,* can be calculated from S wave velocity as shown in Formula 4.3.1 (Japan Road Association, 2000).

$$TG = \sum_{i=1}^{n} \frac{H_i}{V_{si}} \qquad (3.3.1)$$

Where:
*TG* is the natural period of ground, *H* is thickness of the ground, *Vs* is *S* wave velocity of the ground.

The ground is classified as, *Ground Type 1* if $TG<0.2$, *Ground Type 3* if $TG>0.6$, and the others are *Ground Type 2*. The *TG* value used here was calculated based on the ground survey of PS Logging and surface wave exploration conducted in the study area. However, the *TG* value was the maximum value in the value range. The ground classification results are listed in Table 3.3.1.

(3) Ground Model
After ground classification, the results were converted to polygons on ArcGIS, and then converted as the center point of each 250 m mesh grid. The total grid number is 75,403 in the study area. The ground model was constructed with the ID number of whole grids and obtained location information (latitude and longitude), AVS30 value, Ground Type and liquefaction index, which will be mentioned after. In addition, a low pass filter was performed in order to smooth abrupt change around the geological boundary.

The grid size of the study area was selected as 250 m according to local ground information.

Table 3.3.1 AVS30 and ground type list

| Rock | | | | Neogene rock | | | | Terrace, talus and valley basin deposits | | | | Flood plain deposit | | | | Riverbed deposits and aeolian deposits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey point | AVS30 | Frequency | TG | Survey point | AVS30 | Frequency | TG | Survey point | AVS30 | Frequency | TG | Survey point | AVS30 | Frequency | TG | Survey point | AVS30 | Frequency | TG |
| UB_25 | 741.7 | 3.6 | 0.10 | UB_14 | 855.0 | 8.0 | 0.17 | UB_11 | 912.5 | | 0.07 | UB_1 | 459.8 | 8.0 | 0.13 | UB_17 | 368.3 | 2.5 | 0.40 |
| NH_03 | 798.9 | | 0.09 | UB_19 | 960.9 | 8.6 | 0.13 | UB_12 | 724.3 | 10.3 | 0.10 | UB_2 | 597.6 | 2.0 | 0.50 | UB_32 | 524.0 | 11.0 | 0.09 |
| BI_02 | 1008.2 | 10.5 | 0.10 | UB_Ba_02 | | 5.2 | 0.19 | UB_13 | 673.9 | 11.0 | 0.09 | UB_3 | 501.9 | 8.0 | 0.13 | UB_35 | 350.6 | 10.2 | 0.10 |
| | | | | UB_Ba_02/PS | 479.4 | | | UB_20 | 447.0 | 5.5 | 0.18 | UB_4 | 387.1 | 4.5 | 0.22 | UB_36 | 480.6 | 5.2 | 0.19 |
| | | | | | | | | UB_21 | 719.3 | 5.6 | 0.20 | UB_5 | 351.1 | 3.2 | 0.31 | UB_37 | 493.9 | 9.0 | 0.11 |
| | | | | | | | | UB_22 | 698.5 | | 0.12 | UB_6 | 433.3 | 8.0 | 0.13 | BR_02 | | 4.0 | 0.25 |
| | | | | | | | | UB_23 | 521.4 | 10.5 | 0.10 | UB_7 | 523.9 | 8.0 | 0.13 | BR_02/PS | 451.6 | | |
| | | | | | | | | UB_24 | 728.1 | 10.8 | 0.09 | UB_8 | 504.7 | 8.0 | 0.13 | NH_01 | | | |
| | | | | | | | | UB_33 | 699.5 | 3.3 | 0.30 | UB_9 | 447.4 | 9.0 | 0.11 | NH_01/PS | 229.0 | | 0.09 |
| | | | | | | | | UB_34 | 556.1 | 4.0 | 0.25 | UB_10 | 474.1 | 3.0 | 0.33 | NH_02 | | | |
| | | | | | | | | UB_Ba_04 | | 7.6 | 0.13 | UB_15 | 404.6 | 10.5 | 0.10 | NH_02/PS | 354.6 | | 0.09 |
| | | | | | | | | UB_Ba_04/PS | 406.7 | | | UB_16 | 477.3 | 5.0 | 0.20 | | | | |
| | | | | | | | | | | | | UB_18 | 476.8 | 10.1 | 0.10 | | | | |
| | | | | | | | | | | | | UB_25 | 494.3 | 9.0 | 0.11 | | | | |
| | | | | | | | | | | | | UB_27 | 465.0 | 5.0 | 0.20 | | | | |
| | | | | | | | | | | | | UB_28 | 463.7 | 5.5 | 0.18 | | | | |
| | | | | | | | | | | | | UB_29 | 349.5 | 2.3 | 0.43 | | | | |
| | | | | | | | | | | | | UB_30 | 540.7 | 4.0 | 0.25 | | | | |
| | | | | | | | | | | | | UB_31 | 435.4 | 2.2 | 0.45 | | | | |
| | | | | | | | | | | | | UB_2a_01 | | 2.3 | 0.43 | | | | |
| | | | | | | | | | | | | UB_2a_01/PS | 602.4 | | | | | | |
| | | | | | | | | | | | | UB_Ba_03 | | 1.7 | 0.59 | | | | |
| | | | | | | | | | | | | UB_3a_03/PS | 483.2 | | | | | | |
| | | | | | | | | | | | | BI_01 | | 3.5 | 0.29 | | | | |
| | | | | | | | | | | | | BI_01/PS | 485.6 | | | | | | |
| | | | | | | | | | | | | BI_03 | | 2.5 | 0.40 | | | | |
| | | | | | | | | | | | | BI_03/PS | 335.4 | | | | | | |
| | | | | | | | | | | | | BR_30 | 322.2 | | | | | | |
| | | | | | | | | | | | | BR_01 | | 1.8 | 0.56 | | | | |
| | | | | | | | | | | | | BR_30/PS | 408.8 | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| **Average** | **849.6** | **7.0** | **0.10** | | **745.1** | **6.4** | **0.16** | | **621.5** | **7.5** | **0.16** | | **450.5** | **5.3** | **0.27** | | **415.3** | **7.0** | **0.17** |
| Maximum | 1008.2 | 10.5 | 0.10 | | 960.9 | 8.00 | 0.19 | | 728.1 | 11.0 | 0.30 | | 602.4 | 10.5 | 0.59 | | 524.0 | 11.0 | 0.40 |
| Minimum | 741.7 | 3.6 | 0.09 | | 479.4 | 5.20 | 0.13 | | 447.0 | 3.3 | 0.09 | | 322.2 | 1.7 | 0.10 | | 229.0 | 2.5 | 0.09 |
| Standard deviation | 114.5 | 3.4 | 0.00 | | 188.8 | 1.18 | 0.03 | | 100.7 | 3.0 | 0.07 | | 67.4 | 2.9 | 0.15 | | 107.4 | 3.2 | 0.10 |
| **1.28σ** | 146.6 | 4.3 | | | 241.7 | 1.5 | | | 128.9 | 3.8 | | | 86.2 | 3.7 | | | 137.5 | 4.1 | |
| **Representative value** | **703.0** | **2.7** | **0.1** | | **503.4** | **4.9** | **0.19** | | **492.5** | **3.7** | **0.30** | | **364.3** | **1.5** | **0.59** | | **277.8** | **2.8** | **0.40** |
| **Ground Classification** | | | **I** | | | | **I** | | | | **II** | | | | **III** | | | | **III** |

Ref: JICA Project Team

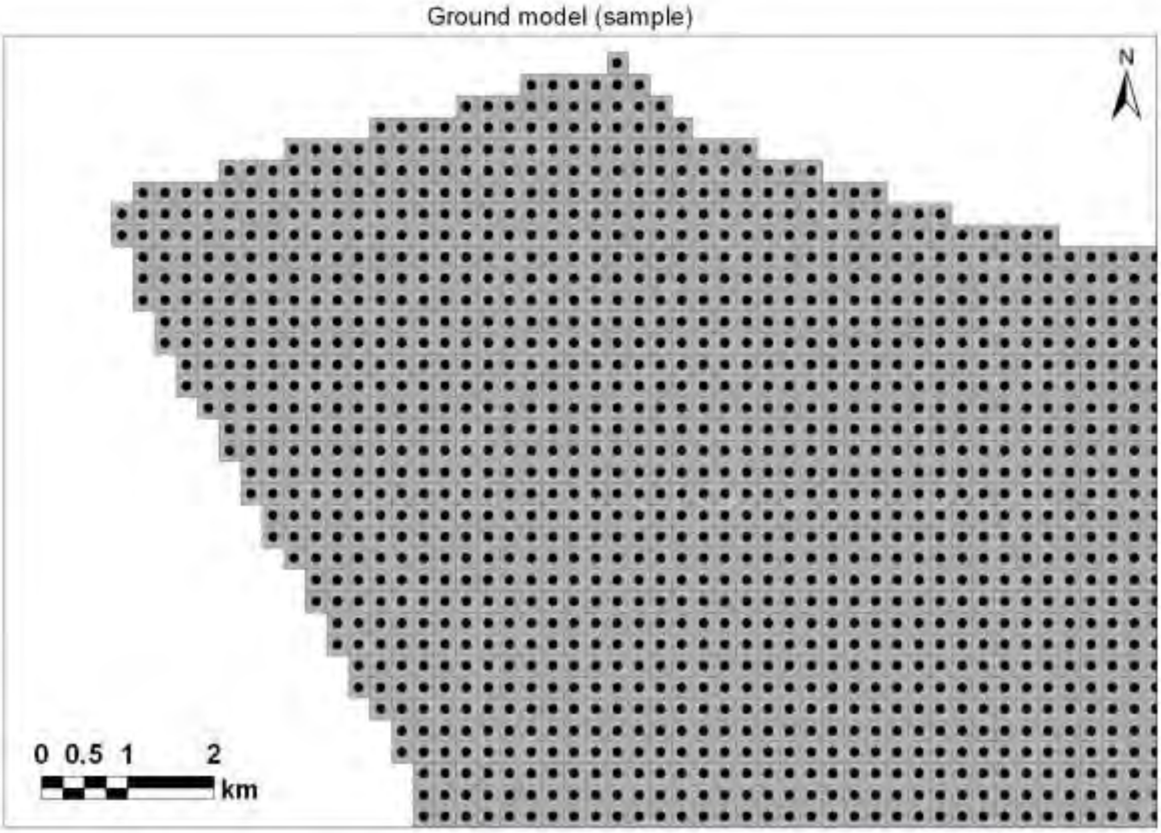



Figure 3.3.2 Sample of Ground Model

# Chapter 4 Implementation Process and Results of Seismic Hazard Assessment and Seismic Risk Assessment

## 4.1 Evaluation Policy

In both seismic hazard assessment and seismic risk assessment, it is required that state-of-the-art technology be duly reflected in the project and procedure transferred to CPs be fully conductible so that CPs can carry out the assessments by themselves after completion of the project. Outline of each assessment is described below.

(1) Seismic Hazard Assessment

Empirical method that employs attenuation formula for ground motion prediction, is used in this project, in order to correspond to future findings related to active faults. Seismic zone model in this project is the current one proposed by RCAG. Attenuation formula will be selected considering the compatibility to the existing hazard evaluation and to the risk evaluation of various type of structures of concern.

(2) Seismic Risk Assessment for Buildings

The Limit Strength Method (LSM) is used to evaluate building damage state accurately. Since ground motion is modeled by the response spectrum at site and building is modeled by skeleton curve of the equivalent single degree of freedom system in LSM, further revisions in ground motion and in building will be easily reflected to the evaluation. Calculation procedure is also relatively simple and the result is stable compared to the dynamic response analysis. This means that the technical transfer can easily be done.

(3) Seismic Risk Assessment for Infra-structures

All the bridges have their seismic risk evaluated separately based on the static analysis and dynamic response analysis of some representative bridges. In the static analysis and dynamic response analysis, Japanese software is utilized with data assembled in UB city. Damages to structures such as roads, water lines, sewage, electric lines are evaluated by the product of the length and damage rate that is given corresponding to the ground motion intensity.

Though pipeline for heating in out of scope of this project, the risk evaluation procedure will be arranged, since it is a critical structure for support lives in UB city, especially in the winter time.

(4) Assessment of Fire Following Earthquake

Japanese method is used to evaluate the number of break out and the area of fire spreading for collapsed buildings and uncollapsed ones. It is noted that the method will differ corresponding to the area of concern, namely, urbanized area or Ger area. Causes of ignition will be identified after site investigation.

## 4.2 Seismic Hazards Evaluation

### 4.2.1 Ground Motion Evaluation

(1) Outline of Evaluation Method

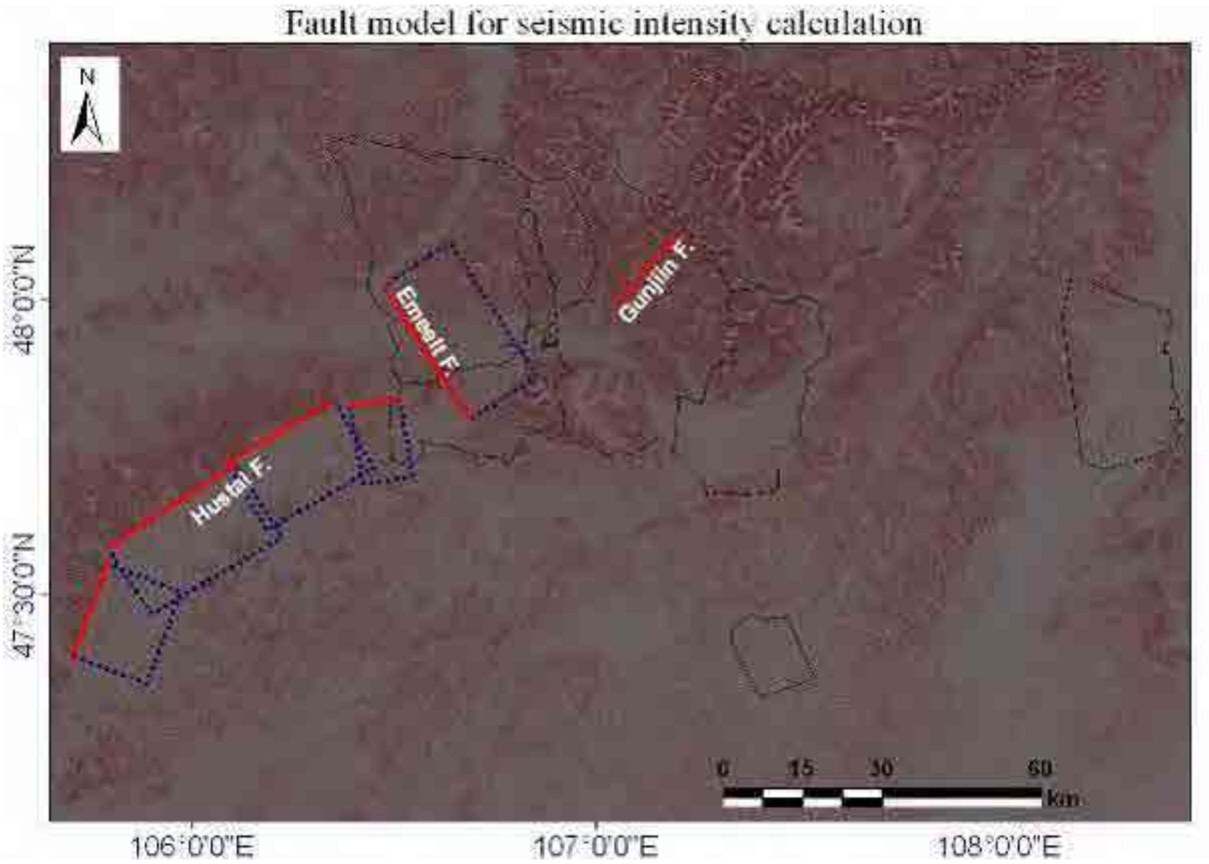
Based on studies for earthquakes and active faults in and around the UB city, upon the condition that UB city can does risk assessment by themselves, and also for achieve stable results, a deterministic method for ground motion evaluation was conducted under the maximum earthquake estimated on the target fault. Cconsidering the connection to risk assessment, not only peak ground acceleration (PGA) but also peak ground velocity (PGV) or response acceleration was necessary, Kanno et al., (2006) [1]is considered an appropriate method for ground motion evaluation in this project.

[1] Kanno et al. (2006): A New Attenuation Relation for Strong Ground Motion in Japan Based on Recorded Data, Bulletin of the Seismological Society of America, Vol. 96, No. 3, pp. 879–897, doi: 10.1785/0120050138

However, the details of scenario earthquakes, attenuation law were summarized in Databook.

(2) Source Fault Model

According to previous studies about the active faults around UB city (Demberel, 2011, RCAG report), the source model was constructed as shown in Figure4.2.1. The details of the source fault modes are shown in Table 4.2.1.




Ref: JICA Project Team

Figure4.2.1 Fault models used in ground motion evaluation

Table 4.2.1 Parameters of the fault models

| Fault segment | | Location | | Length | Width | Depth from ground surface | Dip angle | Dip to | Max Mw |
|---|---|---|---|---|---|---|---|---|---|
| Name of segment | Tip of segment | Lon | Lat | | | | | | |
| Hustai_1 | Hustai_1_1 | 105.70442 | 47.39615 | 18.6 | 21.2 | 15 | 45 | SE | 7.6 |
| | Hustai_1_2 | 105.79451 | 47.55174 | | | | | | |
| Hustai_2 | Hustai_2_1 | 105.79507 | 47.57951 | 28.5 | 21.2 | 15 | 45 | SE | |
| | Hustai_2_2 | 106.11590 | 47.71708 | | | | | | |
| Hustai_3 | Hustai_3_1 | 106.09456 | 47.71963 | 23.6 | 21.2 | 15 | 45 | SE | |
| | Hustai_3_2 | 106.36787 | 47.82438 | | | | | | |
| Hustai_4 | Hustai_4_1 | 106.40933 | 47.81339 | 9.3 | 21.2 | 15 | 45 | SE | |
| | Hustai_4_2 | 106.53182 | 47.82535 | | | | | | |
| Emeelt | Emeelt_1 | 106.70842 | 47.78515 | 30.1 | 21.2 | 15 | 45 | NE | 7.0 |
| | Emeelt_2 | 106.49649 | 48.01542 | | | | | | |
| Gunjiin | Gunjiin_1 | 107.07920 | 47.96992 | 18.0 | 15.0 | 15 | 90 | — | 6.6 |
| | Gunjiin_2 | 107.24081 | 48.09007 | | | | | | |

Ref: JICA Project Team

(3) Results of Seismic Hazard Evaluation

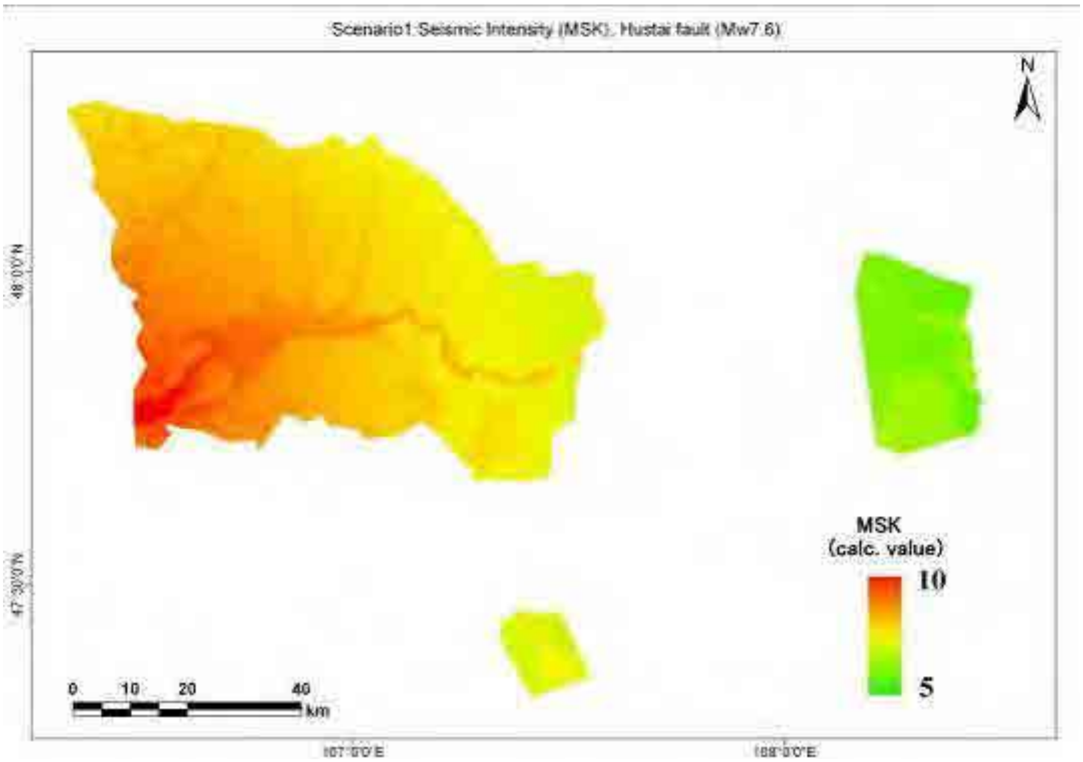
Among the active faults in and around the UB city, two earthquake scenarios were set targeting the Hustai fault, Emeelt fault and Gunjiin fault: Scenario 1 (Hustai fault, Mw7.6) and Scenario 2(maximum value of Emeelt fault Mw7.0 and Gunjiin fault Mw6.6).

In Scenario 1, the MSK intensity ranged from 5.65 to 10.12, while the Scenario 2 ranged from 5.16 to 10.14 (Figure4.2.3). In Scenario 2, compared to Scenario 1, it shows higher values in the northwestern side of the city and high value in northeastern side. This is due to these areas close to the source faults of the Scenario 2, the Emeelt fault and the Gunjiin fault. However, in the central city area of UB, there is no remarkable difference between Scenario 1 and 2. For example, in the Sukhbaatar square, Scenario 1 shows intensity 8.6 (Figure4.2.4) while Scenario 2 shows intensity 8.7 (Figure4.2.5).

After converting to 12 scale MSK intensity, in the central city area, Scenario 1 and 2 both shows scale VIII to IX Below is the relationship between calculated intensity and 12 scale intensity.

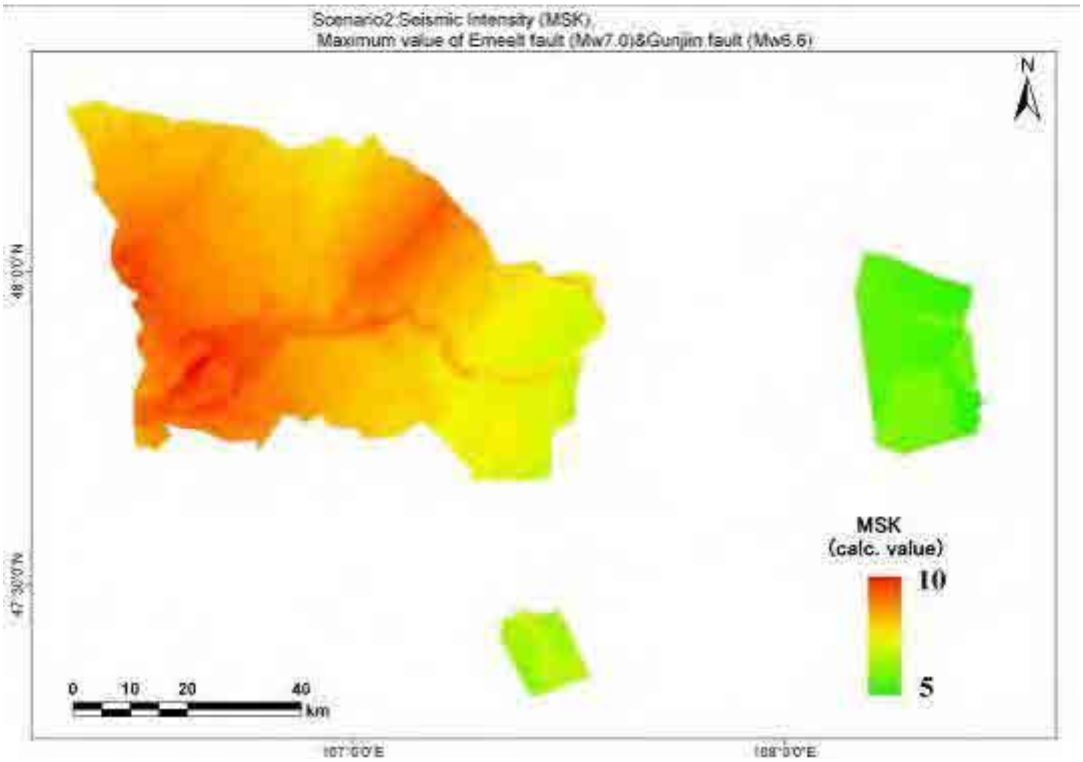
V:4.50～5.49
VI:5.50～6.49
VII:6.50～7.49
VIII:7.50～8.49
IX:8.50～9.49

The PGA and PGV were summarized inDatabook.



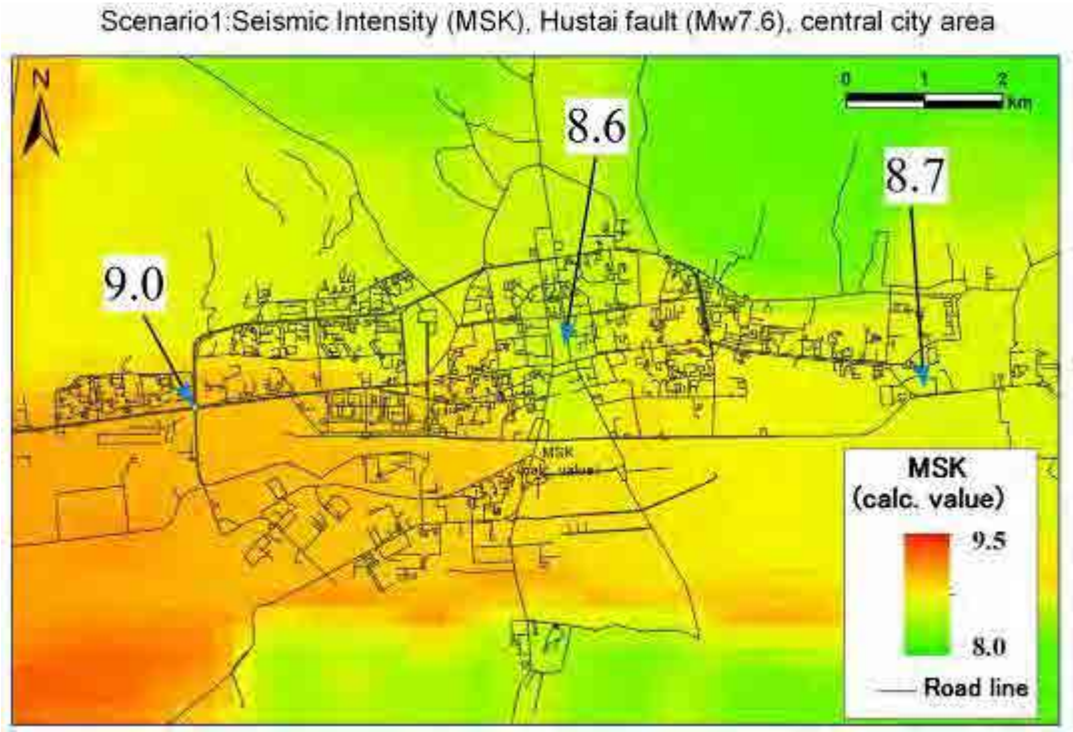

Ref: JICA Project Team

Figure 4.2.2 MSK intensity distribution of the Scenario 1



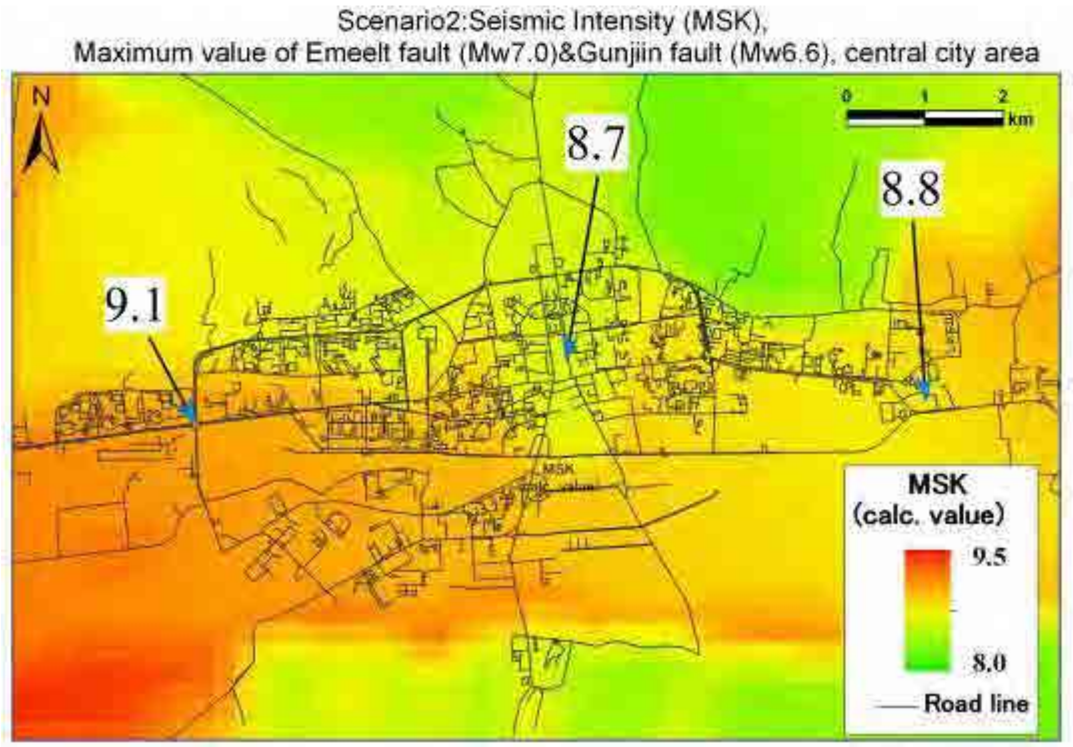

Ref: JICA Project Team

Figure4.2.3 MSK intensity distribution of the Scenario 2




Ref: JICA Project Team

Figure4.2.4 MSK intensity distribution in central UB city of the Scenario 1




Ref: JICA Project Team

Figure4.2.5 MSK intensity distribution in central UB city of the Scenario 2

(4) Discussion

In the case of Scenario 1, the obtained MSK intensity in the central city area of the UB city is VIII-IX. This is the calculation result under estimation of the maximum earthquake on the target faults, but not considering when the earthquake will occur. Moreover, the evaluation result is only for damage estimation under the scenario earthquake, not for other task such as building code.

In the case of the Scenario 2, the result is almost the same as the Scenario 1. In the Scenario 1, because large maximum magnitude of earthquake estimated on the Hustai fault, the MSK intensity is VIII-IX in the central city, even though the distances of about 30 km from the source fault. On the other hand, even though the estimated earthquake on the Emeelt fault is smaller than that of the Hustai fault, due to it relatively closes to the city area, resulted similar condition of ground motion evaluation with the Scenario 1. These results suggested that the ground motion evaluation results could not be simply compared based only on distance from the source faults. Consequently, while utilizing the evaluation results must be considered comprehensively upon the magnitude of earthquake, distance from source fault and ground information.

In this study, the ground motion was evaluated using deterministic method based on estimation of maximum earthquake on the target active faults. The results of ground motion evaluation are possibly different due to different source faults and different evaluation methods. Also, this study is conducted for damage estimation but not for set earthquake resistance standards. Therefore, while utilizing the ground motion evaluation results of this study, it is recommended to pay attention for the methods, purpose and range of application of the evaluation. In the case of using for building earthquake resistance standards, it is highly recommended to take detailed study separately for the ground motion evaluation.

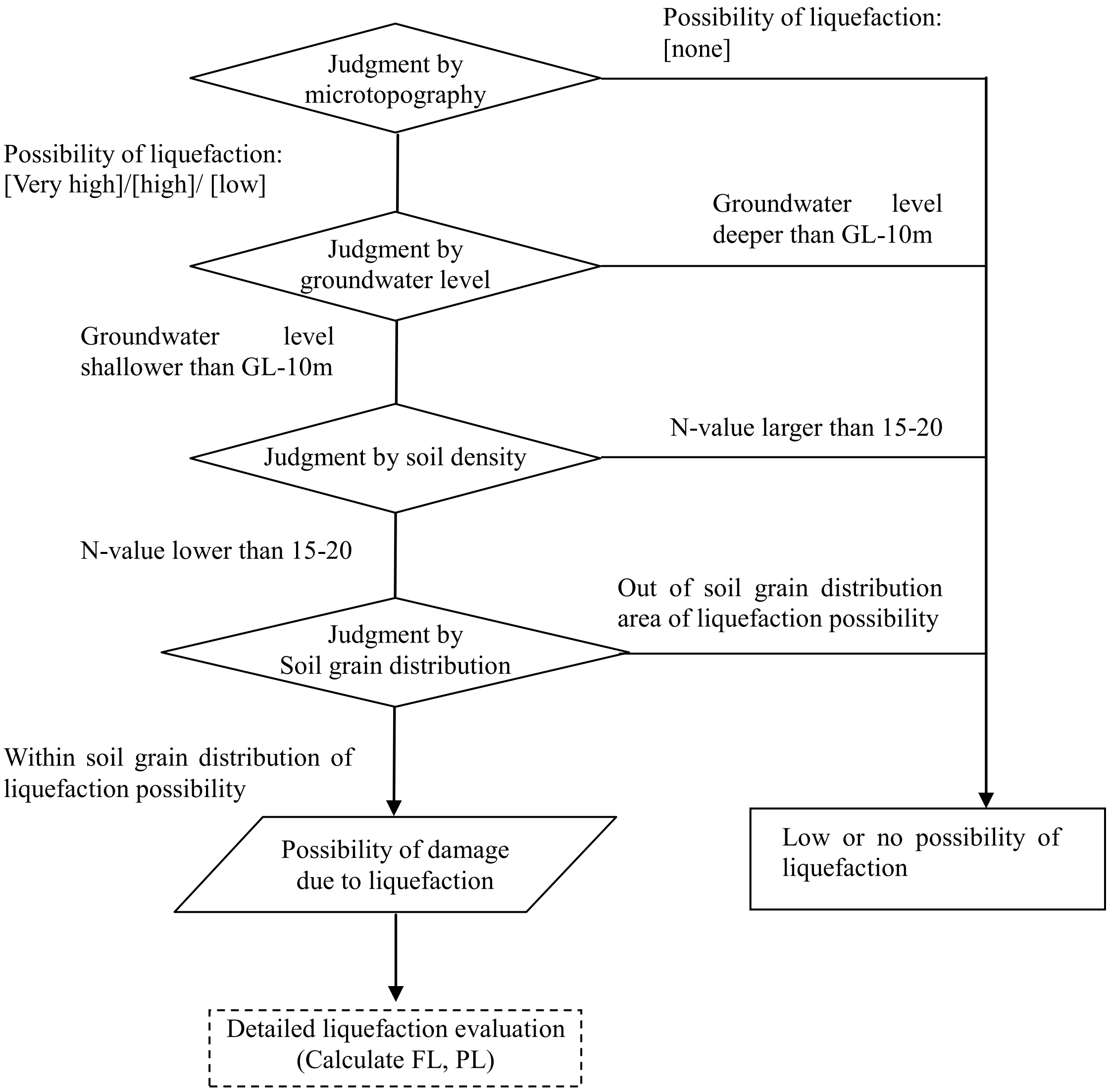
### 4.2.2 Evaluation of Ground Liquefaction

Generally, following methods used for liquefaction evaluation.

(a) a subsidiary method using geomorphology/geology and liquefaction history;
(b) a general method which uses the results of soil survey and test;
(c) a detailed method of conducting a dynamic survey, test and analysis;
(d) a method using model experiment and site experiment.

In this project, the method “a” was used to classify the rank of liquefaction possibility, and while method “b“ was used to confirm and certify the results. About the details of liquefaction evaluation see the Supporting Report.

In this project, ground liquefaction was evaluated as following flow (Figure4.2.6)




Ref: JICA Project Team

Figure4.2.6 Flow of judgment for ground liquefaction

(1) Result of Liquefaction Evaluation

The liquefaction evaluation results from the boring points based on the simple evaluation method are shown in Table 4.2.2.

Table 4.2.2 Evaluation result for possibility of liquefaction

| Boring location | Microtopography classification | N-value in under groundwater level | Grain distribution | Judgment |
|---|---|---|---|---|
| UB_BO_01 | Flood plain | 28-50 up | FC<35% | Possibility of liquefaction is low due to high soil density |
| UB_BO_03 | Flood plain | 31-50 up | FC<35% | Possibility of liquefaction is low due to high soil density |
| UB_BO_04 | Valley basin deposit 1 | 20-50 up | FC<35% | Possibility of liquefaction is low due to high soil density |
| NH_01 | Alluvial deposit | 19-50 up | About FC＞35%, but gain distribution is out of liquefaction condition | Possibility of liquefaction is low due to soil grain distribution is out of liquefaction condition |
| NH_02 | Alluvial deposit | 23-50 up | About FC＞35%, but gain distribution is out of liquefaction condition | Possibility of liquefaction is low due to soil grain distribution is out of liquefaction condition |
| BR_02 | Alluvial deposit | 31-49 | FC<35% | Possibility of liquefaction is low due to high soil density. |

Ref: JICA Project Team

The judgment of ground density results show the soil layer which located within the possibility of liquefaction. The N value is about larger than 20. However, sites where the grain size is out of the possible liquefaction range were observed to have low possibility of liquefaction or no liquefaction.

(2) Discussion

In this study, the ground was estimated as low liquefaction possibility or no liquefaction based on the results of microtopography classification, boring survey and soil test. Due to the result of liquefaction is derived from limited survey, it should be noted while applying the result. For example, it is cannot be completely denied that there is no liquefaction possibility in possible higher groundwater level area along the Tuul River if existing looser sandy soil, and in the places where was filled by sand after large scale excavation. A detailed survey should be conducted for infrastructural construction with higher groundwater levels, especially for constructing important facilities.

### 4.2.3 Landslide Susceptibility Evaluation

(1) Method Selection for Landslide susceptibility evaluation

For the earthquake-induce landslide, the occurrence of landslides will be influenced by earthquake (PGA, intensity) as well as causative factors of the slopes, such as slope and curvature. Since there is no landslide data, an appropriate method that only uses the PGA from earthquake scenario, and topographical factors derived from elevation data, Uchida et al., (2004) was used.

$$F = 0.075I - 8.9C + 0.0056a_{\max} - 3.2 \qquad (4.2.1)$$

Where:

I is slope angle (°), C is average curvature ($m^{-1}$) and $a_{max}$ is PGA (gal). In the calculation if the *F* is larger than 0, then there is a possibility of land sliding; if the *F* is lower than 0, then the unit mesh will not cause landslides.

The method for derivation topographical factors, calculation of used data and evaluation items were summarized in Supporting Report.

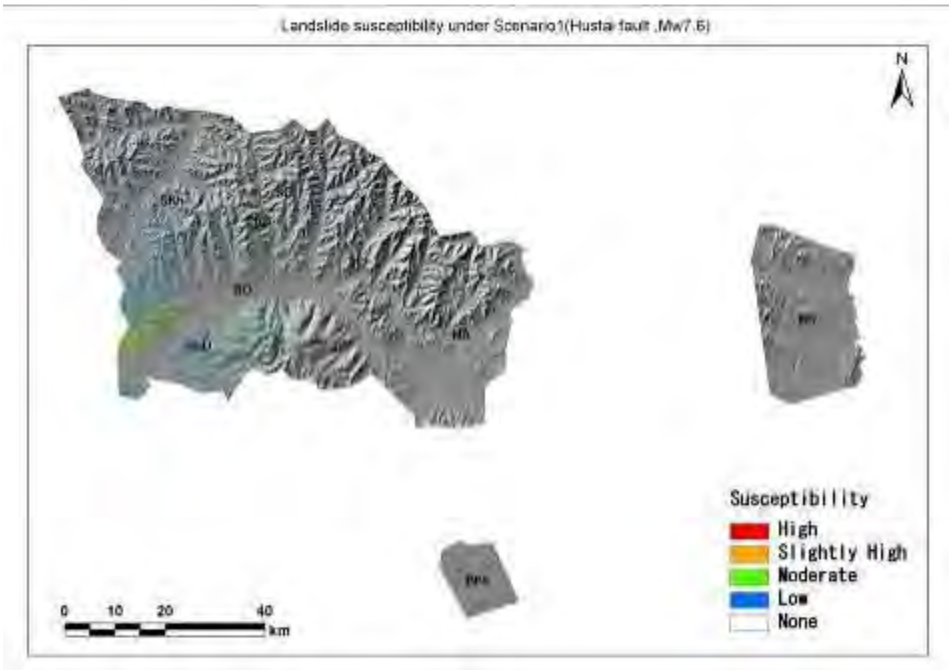
(2) Result of Susceptibility of Landslide

1) Scenario 1

The *F* value is shown in Formula 5.1.9 was calculated for landslide susceptibility evaluation. The result of the calculation is shown in Figure4.2.7.

Based on distribution of *F* values, the susceptibility ranks were set as high, relatively high, moderate, andow.

In the case of Scenario 1, high susceptibility ranked meshes are distributed in the Songino mountains, which located on the western side of the city. The northwest faced slope meshes in the northern slopes of the southern mountain areas of the cityshows relatively high susceptibility. In addition, lowsusceptibility ranked slope meshes are sparsely distributed in the northern mountain areas.

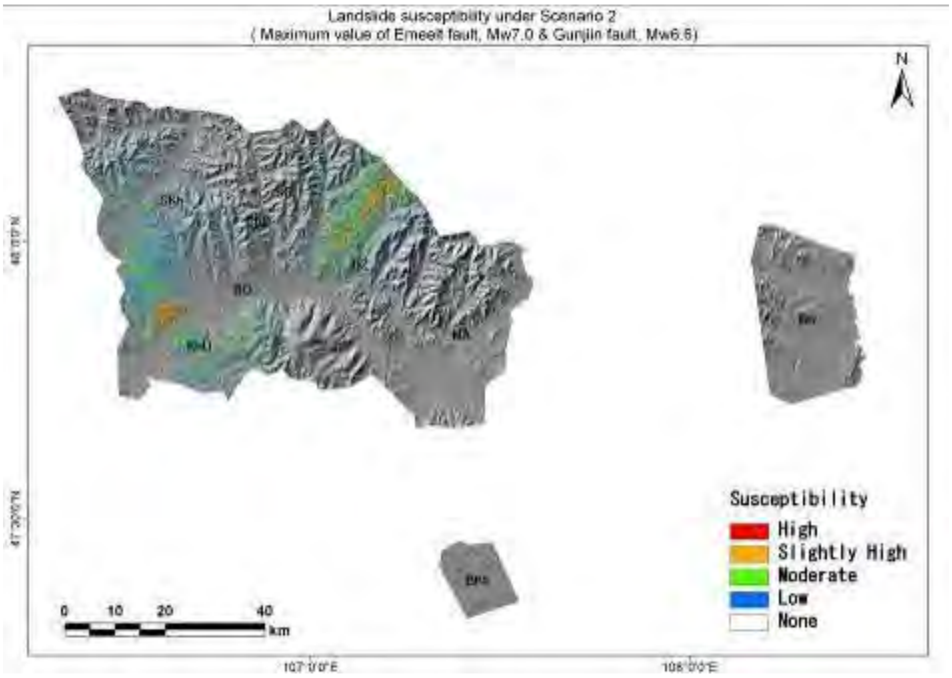



Ref: JICA Project Team

Figure4.2.7 Landslide susceptibility of Scenario 1

2) Scenario 2

In Scenario 2, the high ranked susceptibility meshes are concentrated in western mountainous and the mountainous area along the Gunjiin fault in eastern side of Ulaanbaatar city (Figure4.2.8). In the mountainous area along the Emeelt fault, high and relatively high meshes are observed. Furthermore, there are some high and relatively high meshes in the southern mountainous area of the city, along the northwestern faced slopes. Note that rare meshes of low ranked slopes are also observed.




Ref: JICA Project Team

Figure4.2.8 Landslide susceptibility of Scenario2

(3) Discussion

According to the results of the landslide susceptibility evaluation of Scenario 1 and 2, most of the meshes which had high susceptibility are distributed near source faults.

These coincide with the higher values of PGA earthquake Scenario.

However, in the places that far from the source fault, some meshes shown high susceptibility where there is steep slope angle, but the number is not so large. These suggested that the results of susceptibility appropriately reflect both the topographical features and ground motion.

## 4.3 Seismic Risk Evaluation for Buildings

### 4.3.1 Survey of Building's Actual Condition and Material Testing

(1) Review of Safety of existing Apartment house

Report on seismic capacity evaluation for existing buildings conducted by UB city was assembled and examined. The evaluation method is based on three-dimensional finite element method. In order to incorporate the condition properly, following surveys are also conducted.

- Measurement of material strength: Material strength of concrete, reinforcement, steel, brick or other is measured by UB city, using Schmitt Hummer method. Strength test as well as adhesion test for brick is carried out by MUST.

As well as the deterioration of material, it is important to check the change in building's strength by the change in building's usage. For example, walls in the first floor in some buildings are removed after democratization in 1992, so that the buildings can be used as shops. Removal of walls makes the buildings unbalanced both in elevation and in plane. Seismic capacity evaluation by UB city duly reflects the real situations described above.

Result of the seismic capacity evaluation by UB city is the ground motion intensity in MSK scale that corresponds to the state that the building reaches to the elastic limit. This ground motion intensity will be compared with the design intensity, to judge if the building is safe or not.

(2) Quality of Design and of Construction

As one of the important factor to control the building seismic capacity, mentioned are the quality of design and that of construction. In order to grasp the above quality in Mongolia, hearing survey was conducted to three design and construction companies.

The factors of insufficient quality are summarized below;

- The number of engineers is not sufficient for the current construction rush.
- It is difficult to be an expert since construction is limited in season.
- Budget is insufficient.

Detailed information of hearing survey is given in the Supporting Report.

(3) Safety Assessment
Thirty (30) buildings were selected for Evaluation of seismic capacity through the WG activity. Detail information of safety assessment is given in the Supporting Report.

(4) Building Material Testing
At first, strength test for concrete members were planned. However, by considering the building inventory in UB city, it was concluded that it is necessary to investigate the strength of steel member and of brick as well as of concrete member. So ten buildings were selected for material testing.

By testing it is shown that real strength of concere is greater than nominal strength regardless of construction year. On the contrary, real strength of brick is considerably lower than nominal ones. There is no correlation between brick strength and construction year, so that it can be said that construction quality or site's circumstance might affect on the strength.

4.3.2 Building Inventory Survey
(1) Outline of Building Database Provided by UB City
Building inventory was established by combining the database provided by UB city and that by UBMPS. UB city's database was established in 2010 by KOICA and now is being modified by UB city. It is a very reliable database but has less information on buildings in Ger area since the target area of this database is central area in UB city. On the other hand, UBMPS's database was established in 2007 and includes building data outside of central city, however its reliability is a little bit low since data upgrading has not been done.

(2) Establishment of Building Inventory
Based on the two databases mentioned before, building inventory for risk assessment was constructed. In combining databases, following policy was employed.

- UB city's database is principal, on which UBMPS's data are added if they are not included UB city's database.
- For attributes, UB city's attributes are principal, on which UBMPS's attributes are added if they are not included.
- New attributes listed below are evaluated from shape files and included in database for risk assessment.
- Only attributes related to risk ass*essmen*t shall be included.

For data management, six-digit-number is employed. Longitude, latitude and building area are calculated from the shape file, respectively.

4.3.3 Seismic Risk Assessment for Buildings
(1) Policy of Seismic Risk Assessment
In this project, the Limit Strength Method (LSM) is employed for the reasons listed below.

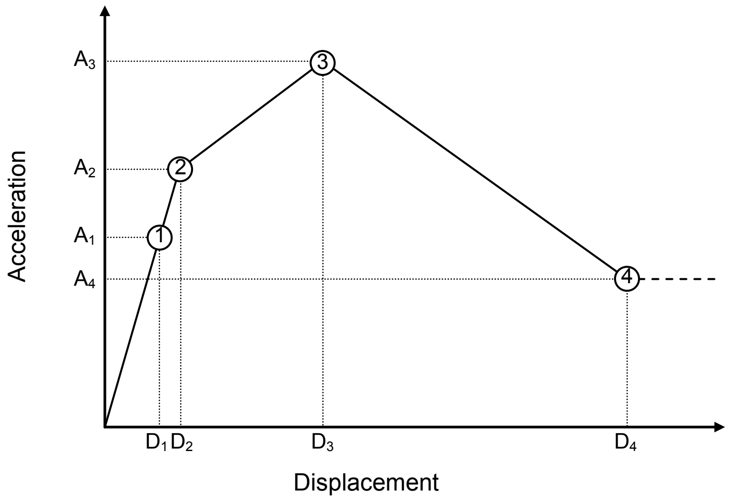
- Use of response spectrum as ground motion index
- Use of skeleton curve to express building characteristics
- Stability in evaluation

(2) Outline of Limit Strength Method
Limit Strength Method (LSM) is a procedure to obtain the response displacement and response

acceleration from the intersectional point of combined spectrum and skeleton curve of equivalent single degree of freedom system (hereinafter called eSDOF).

Procedure of conducting LSM is illustrated in detail in Supporting Report and has been transferred to the counterpart through relevant workshop. Supporting reports illustrates that LSM gives the damage rate similar to one by the usage of vulnerability functions.

(3) Modeling of Building
As mentioned before, buildings are modeled as a skeleton curve of eSDOF. The shape of skeleton curve is regulated by four points shown in Figure 4.3.1. Point [1] is a reference point, which is given based on Mongolian design standard. Point [2] to [4] is employed to regulate the behavior after exceeding the design capacity. It is assumed that building will maintain the capacity when the displacement exceeds point [4].




Ref: JICA Project Team
Figure 4.3.1 Point to regulate skeleton curve of eSDOF

The procedure to determine the each point is illustrated in the Supporting Report. It is noted that the procedure is examined and approved by the domestic supporting committee and process examination committee.

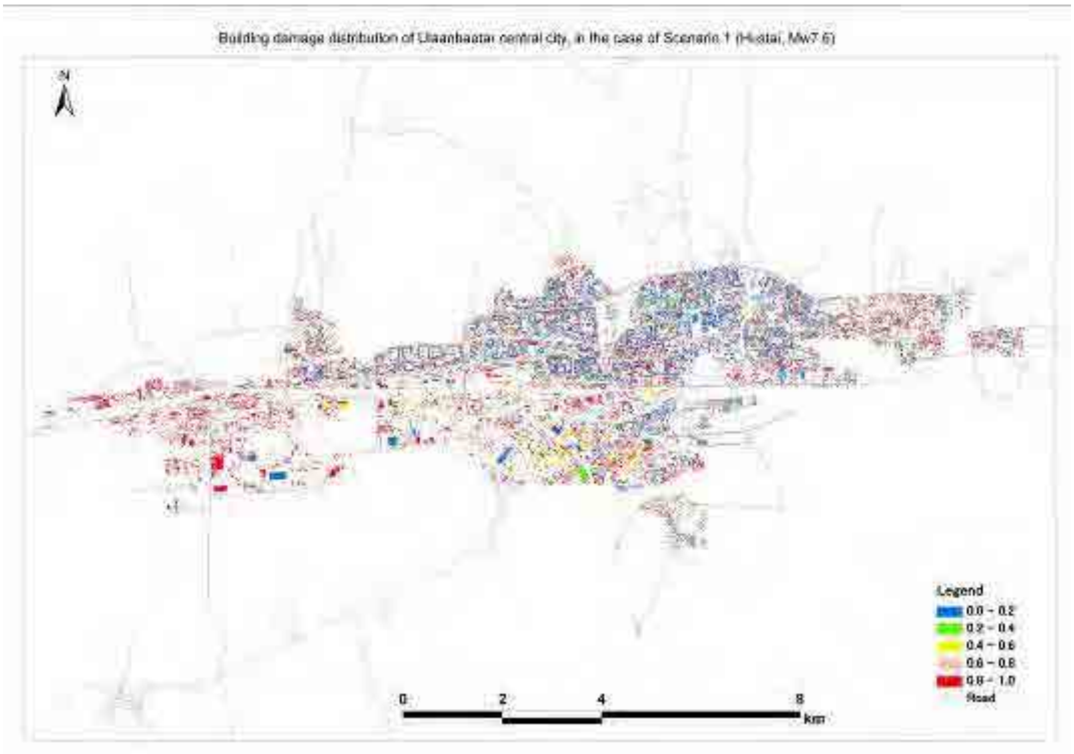
(4) Result of Seismic Risk Assessment
Figure 4.3.2 and Figure 4.3.3 show the distribution of building collapse in case of scenario I and II, respectively. The building judged “collapse” may survive and the building judged “severe” or less may collapse.

Damage rate for building collapse is summarized in Table 4.3.1.

Table 4.3.1 Damage rate for building collapse

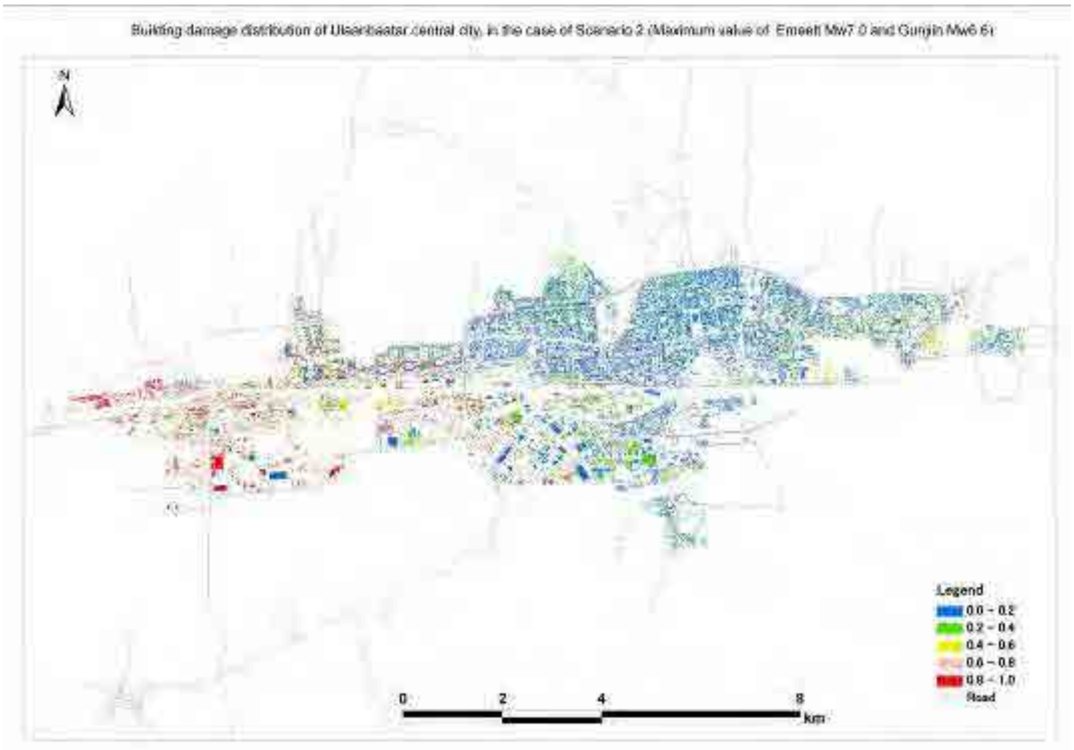
| Earthquake Scenario | Building Area [m$^2$] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | -50 | 50-100 | 100-200 | 200-500 | 500-1000 | 1000-2000 | 2000-5000 | 5000- |
| Scenario I | 75.4 | 85.5 | 81.7 | 60.1 | 44.8 | 47.9 | 53.9 | 59.4 |
| Scenario II | 41.6 | 47.6 | 46.5 | 31.0 | 20.8 | 23.6 | 23.4 | 33.1 |

Ref: JICA Project Team




Ref: JICA Project Team

Figure 4.3.2 Distribution of building collapse probability in central six districts (scenario I)




Ref: JICA Project Team

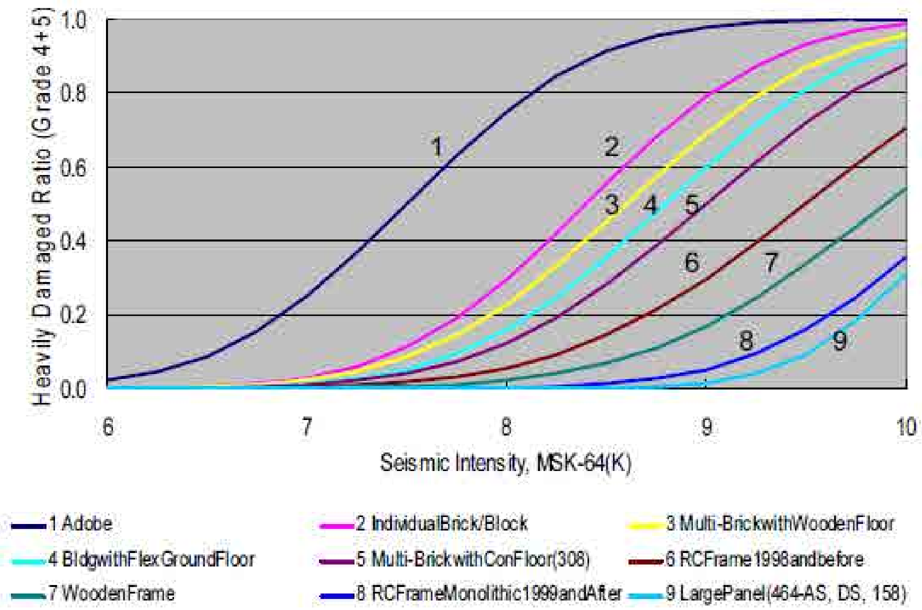
Figure 4.3.3 Distribution of building collapse probability in central six districts (scenario II)

(5) Discussions on the Results of Seismic Risk Assessment

The damage rate shown in Table 4.3.1 are considerably larger than those in the damage estimation conducted for Almaty, Kazakhstan, in which damage rate was assessed 11% for apartment house and 33% for individual residential house. Discussion is given to this difference.

1) Comparison of Seismic Capacity of Building

In the damage estimation for Almaty, Kazakhstan (Almaty D.E) , the vulnerability functions shown in Figure 4.3.4 were used. Vulnerability function is the cumulative distribution of ground motion intensity corresponding the given damage state. At the ground motion intensity when the damage ratio is equals to 0.5, the building reaches to the given damage state in average.




Ref: JICA Report 09-13

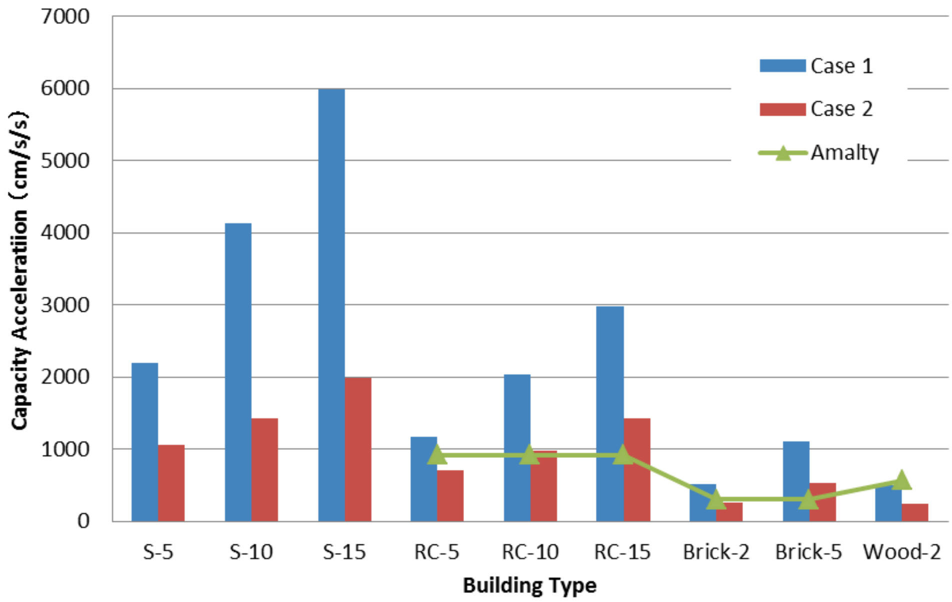
Figure 4.3.4 Vulnerability function used in Almaty damage estimation

The following structures with some variations in height are employed for the comparison.

- Steel : 5 floors, 10 floors, 15 floors
- RC : 5 floors, 10 floors, 15 floors
- Brick : 2 floors, 5 floors
- Wood : 2 floors

Two types of drift angles for collapse are employed; Case 1 is the drift angle suggested by domestic supporting committee and process examination committee and Case 2 is the drift angle given as halves of Case 1. Case 2 was introduced by Project Team considering the low quality control and state of deterioration.

Comparison of *PGAs* by which the building reaches to the given damage states is shown in Figure 4.3.5. From the comparison, it can be seen that Case 2 and vulnerability function show a good agreement for reinforced concrete structure and brick structure, and Case 1 and vulnerability function show a good agreement for wooden structure.




Ref: JICA Project Team

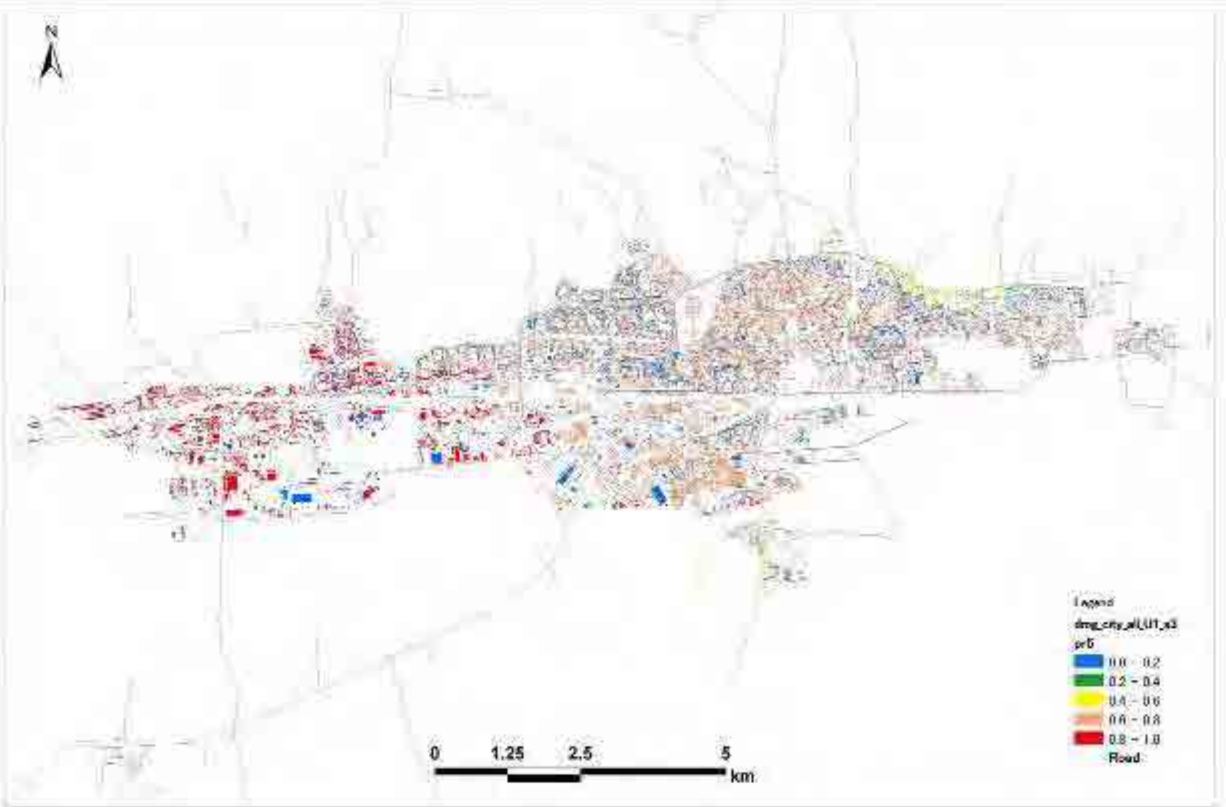
Figure 4.3.5 Comparison of *PGA*

2) Comparison of Risk Assessment Method

The previous comparison was conducted from the viewpoint of seismic capacity of building. This comparison aims to the examine the difference in results by the different risk assessment method.

Instead of conducting LSM, vulnerability functions used in Almaty D.E are employed to assess the seismic risk of UB city for scenario I. Normal Gaussian distribution is assumes for vulnerability functions.

Distribution of building collapse probability is shown in Figure 4.3.6, and damage rates are shown in Table 4.3.2, respectively. The results by LSM are also indicated in the table for reference. The trends of damage distribution are similar to the one by LSM, for example, higher damage probability is observed in the western part. Also, it can be seen that method using vulnerability functions gives the high damage rate as LSM does.




Ref: JICA Project Team

Figure 4.3.6 Distribution of building collapse probability in central six districts using vulnerability functions

Table 4.3.2 Damage rate for building collapse using vulnerability functions

| Method | Building Area [m$^2$] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 |
| Vulnerability Function | 44.1 | 58.9 | 66.3 | 59.1 | 53.4 | 56.2 | 61.0 | 63.4 |
| LSM | 75.4 | 85.5 | 81.7 | 60.1 | 44.8 | 47.9 | 53.9 | 59.4 |

Ref: JICA Project Team

3) Conclusion

From the comparison explained above, it can be seen that evaluation of seismic capacity of buildings are not so much different regardless of methods.

As stated before, the damage rate of apartment house was 11% and that of individual residential housing was 33% for 1887 Verny scenario in Almaty D.E. This can be due to the fact that ground motion intensity in in Almaty D.E is less than that in this project, for example, MSK intensity ranges from 8 to 9 in Almaty D.E and 9 to 10 in this project.

Therefore, it can be concluded that the main cause to bring the high damage rate in case of scenario I is that ground motion intensity estimated is relatively high.

4.3.4 Casualty by building collapse

(1) Outline of estimation

Casualty is estimated by the following formula:

- wooden buildings, brick masonry buildings, concrete block masonry buildings
  Casualty = Population x casualty rate = Population x 0.0676 x building collapse rate
- Other buildings

Casualty = Population x casualty rate = Population x 0.0167 x building collapse rate

It is noted that above calculations are carried out for each mesh and the results are summed up to obtain total casualty.

(2) Result of estimation of casualty

Casualty is summarized as follows;

- Scenario I
  - Urban area : 7,552 (1.45%)
  - Ger area : 38,063 (5.55%)
- Scenario II
  - Urban area : 3,442 (0.66%)
  - Ger area : 16,285 (2.37%)

It is noted that each casualties in Baganuul district, Bagakhangai district and Nalaikh district is obtained as one in urban area.

A breakdown of casualty is shown in the Supporting Report.

## 4.4 Risk Assessment for Transportation and Lifeline Structures

### 4.4.1 Survey of Existing Structure

The objective survey structure is bridge. Ahead of this project, JICA project "The Project for Construction of Ajilchin Flyover in Ulaanbaatar City" completed a similar survey and kindly provided their results, such as, survey sheets, design drawings as well as concrete strength test results, etc., which were used here as the basic information for bridge inventory and risk assessment. Static and dynamic analyses for a total of eight bridges were performed for the purpose of risk assessment. The eight bridges, shown in Table 4.4.1, were selected in consultation with the road department from those whose design drawings were available. Field survey for the selected bridges was carried out, where the design drawings, bearing and deterioration were confirmed.

Table 4.4.1 Bridges for static and dynamic analysis

| Bridge No. | Name of bridge | Length (m) | Construction year |
|---|---|---|---|
| 4 | Arslantai Bridge | 34.2 | 1962 |
| 5 | Uliastai tsaad Bridge - Left | 96.2 | 1967 |
| 18 | Dund gol Deed Bridge | 50.2 | 1975 |
| 19 | Ikh Tenger Bridge | 258.0 | 1994 |
| 24 | Sonsgolon Bridge | 289.4 | 1971 |
| 26 | Poultry farm Bridge | 256.0 | 1989 |
| 34 | Sharga Morit Bridge | 50.4 | 1982 |
| 56 | Uliastai tsaad Bridge - Right | 96.2 | 2010 |

### 4.4.2 Inventory of Transportation and Lifeline Structures

The inventory of transportation and lifeline structures covers road, bridge, water supply, sewerage, power and hot water pipeline. The bridge inventory was created based on the data from "the project for construction of Ajilchin flyover in Ulaanbaatar city", having the content of bridge name, location (longitude, latitude), road name, length, width, pier height, number of span, girder type, superstructure material, substructure material, girder falling-off prevention, girder support length, ground classification and construction year. Others inventory was made basically from the data provided by UB city. In the case of road and pipeline, the inventory was arranged according to district and khoroo

### 4.4.3 Seismic Risk Assessment for Transportation and Lifeline Structures

(1) Approach and objective structures

Seismic risk is the function of seismic hazard and the fragility of structure. The fragility can be evaluated either with the past earthquake damage or through analysis. It is generally preferable to use the fragility specified for the country or region concerned. Unfortunately, there is neither earthquake damage data nor exist of fragility in Mongolia.

As an alternative, the risk of bridges are estimated analytically using results of static analysis for eight bridges and ones of dynamic analysis for three bridges. Also the risk of road, water supply, sewerage, hot water heating system and power system are estimated using the existing empirical methods.

(2) Risk assessment of road

The damages of road, such as crack, upheaval and slope collapse, are mainly caused by ground deformation and can be considered more related to roadbed (embankment, earth cut) and ground condition (hard, soft) than road pavement. Since the embankment and earth cut are not the majority of UB road, the damage estimation method, which can take into account the effect of ground condition, was used here. By the method, the road damage was estimated by the road length and damage rate, a function of JAM intensity and ground classification (Table 4.4.2, ref: damage estimation investigation report of Saitama city, 2010). Due to JMA intensity was not the output of hazard analysis, it was calculated from the ground velocity (Vmax) by

$$I_{JMA}=2.519+1.931*\log(Vmax)$$

(ref: Fujimoto and Midorikawa, empirical method for estimating JMA instrumental seismic intensity from ground motion parameters using strong motion records during recent major earthquakes, 2005). The damage of road in terms of damage spot was estimated with the formula below.

Number of damage spot = road length (km) × damage rate (spot/km)

The number of damage spot was first estimated for each 250m×250m mesh area based on the seismic analysis results and they were then summarized according to the district. The results are shown in Table 4.4.3.

It was estimated there were 66 damage spots for scenario I and 60 damage spots for scenario II. The average damage rate was about 0.07 spot/km. Khan Uul district had the longest road length, damage rate and damage spots for both scenario I and II earthquakes, followed by Bayangol, Bayanzurh and Songino districts. Nalaih and Baganuur districts had little damages.

Table 4.4.2 Road damage rate

| Ground motion \ Ground classification | | Type 1-2 | Type 3 | Type 4 |
|---|---|---|---|---|
| JMA Intensity | Vmax (cm/s) | Tg ＜ 0.4s | 0.4s ≦Tg ＜ 0.6s | 0.6s ≦Tg |
| 7 | 116 ≦Vmax | 0.11 | 0.16 | 0.25 |
| 6+ | 64 ≦Vmax ＜ 116 | 0.09 | 0.13 | 0.20 |
| 6- | 35 ≦Vmax ＜ 64 | 0.07 | 0.10 | 0.16 |
| 5+ | 20 ≦Vmax ＜ 35 | 0.05 | 0.07 | 0.12 |
| 5- | 11 ≦Vmax ＜ 20 | 0.03 | 0.04 | 0.06 |

Note: Tg - dominant period of ground

Table 4.4.3 Damage estimation results of road

| District | Total Length (km) | Scenario 1 | | Scenario 2 | |
|---|---|---|---|---|---|
| | | Damage Rate (points/km) | Number of Damage Point | Damage Rate (points/km) | Number of Damage Point |
| Baganuur | 38.767 | 0.029 | 1 | 0.000 | 0 |
| Bagakhangai | — | — | — | | |
| Bayangol | 124.234 | 0.087 | 11 | 0.079 | 10 |
| Bayanzurkh | 152.135 | 0.082 | 12 | 0.068 | 10 |
| Nalaikh | 32.475 | 0.035 | 1 | 0.022 | 1 |
| Songinokhairkhan | 144.957 | 0.088 | 13 | 0.088 | 13 |
| Sukhbaatar | 116.198 | 0.065 | 8 | 0.055 | 6 |
| Khan-Uul | 158.519 | 0.101 | 16 | 0.099 | 16 |
| Chingeltei | 72.407 | 0.061 | 4 | 0.054 | 4 |
| Total | 839.692 | | 66 | | 60 |

(3) Risk assessment of bridge

The risk assessment of bridge was conducted by (1) girder falling possibility by a statistical method and (2) pier strength by means of response ductility ratio. The final judgment was made by combining the two results. The detail procedure is described below from (i) through (ix).

According to JICA "the project for construction of Ajilchin flyover in Ulaanbaatar city", there were 67 bridges in UB city. The bridge damage caused by an earthquake can be generally attributed to ground shaking and ground failure, such as land subsidence and liquefaction. Since the liquefaction was not predicted, the damage caused by ground shaking was concerned here. The static analysis (8 bridges) and dynamic analysis (3 bridges) were carried out to obtain a relationship between response ductility ratio and damage for the purpose of risk assessment. The bridges for static analysis were selected from those whose design drawing had been collected after discussion with road department. The bridges for dynamic analysis were chosen from the static analysis bridges with considering the difference on ground motion intensity. According to "design specifications for highway bridges, Japan", the analysis was performed for a single standard pier because the bridges were simple girder type and for both axial and transverse directions. The results of weak direction were used.

(i) Girder falling assessment

Girder falling possibility was assessed by a statistical method. The items, score and damage criteria are shown in Table 4.4.4 Items, score and damage criteria for girder falling possibility (ref: report of earthquake damage estimation of Miyagi prefecture, 2004). The damage level was defined by total score, shown as below.

Level A － Collapse or significant deformation
Level B － Partially deformed
Level C － No damage or slight damage which has little effect

The possibility of girder falling was considered high for damage Level A, low for Level B and non for Level C.

The girder falling possibility was estimated for each bridge with the data listed in bridge inventory and the maximum ground velocity from seismic hazard analysis. The damage level for all bridges was C. It was considered there was no girder falling possibility for the scenario earthquakes.

Table 4.4.4 Items, score and damage criteria for girder falling possibility

Items and score

| Category | Item | Score |
|---|---|---|
| Ground classification | Type 1 (Tg<=0.2s) | 0.50 |
| | Type 2 (0.2s<Tg<0.4s) | 1.00 |
| | Type 3 (0.4s<Tg<0.6s) | 1.50 |
| | Type 4 (0.6s<=Tg) | 1.80 |
| Liquifaciton | No | 1.00 |
| | Possible | 1.50 |
| | yes | 2.00 |
| Costructure | Arch, frame | 1.00 |
| | Continuous bridge | 2.00 |
| | Simple bridge | 3.00 |
| Bearing | Fall prevention | 0.60 |
| | Conventional | 1.00 |
| | Two moving bearing | 1.15 |
| Height of pier | <=5m | 1.00 |
| | 5-10m | interpolation |
| | >=10m | 1.70 |
| No. of span | = 1 | 1.00 |
| | >= 2 | 1.75 |
| Girder support | Long (support length (cm)/span length(m)>=1) | 0.80 |
| | Short (support length (cm)/ span length (m)<1) | 1.20 |
| JMA Intensity | 5- (11 ≦Vmax ＜ 20) | 1.00 |
| | 5+ (20 ≦Vmax ＜ 35) | 1.70 |
| | 6- (35 ≦Vmax ＜ 64) | 2.40 |
| | 6+ (64 ≦Vmax ＜ 116) | 3.00 |
| | 7 (116 ≦Vmax) | 3.50 |
| Foundation | Other than pile | 1.00 |
| | Pile | 1.40 |
| Substructure Member | Brick・Concrete | 1.40 |
| | Others | 1.00 |

Total score (= product of scores of all item) and damage criteria

| Damage level | Total score |
|---|---|
| A | More than 55 |
| B | Between 35and 55 |
| C | Less than 35 |

(ii) Flowchart of pier damage assessment

The pier damage was assessed by making use of the static and dynamic analysis results. Since the number of analysis was limited, a method was proposed to apply the static and dynamic results to all the bridges. The flowchart for pier damage assessment is shown in Figure 4.4.1. The pier damage defined by the public works research institute (PWRI), Japan, was employed.

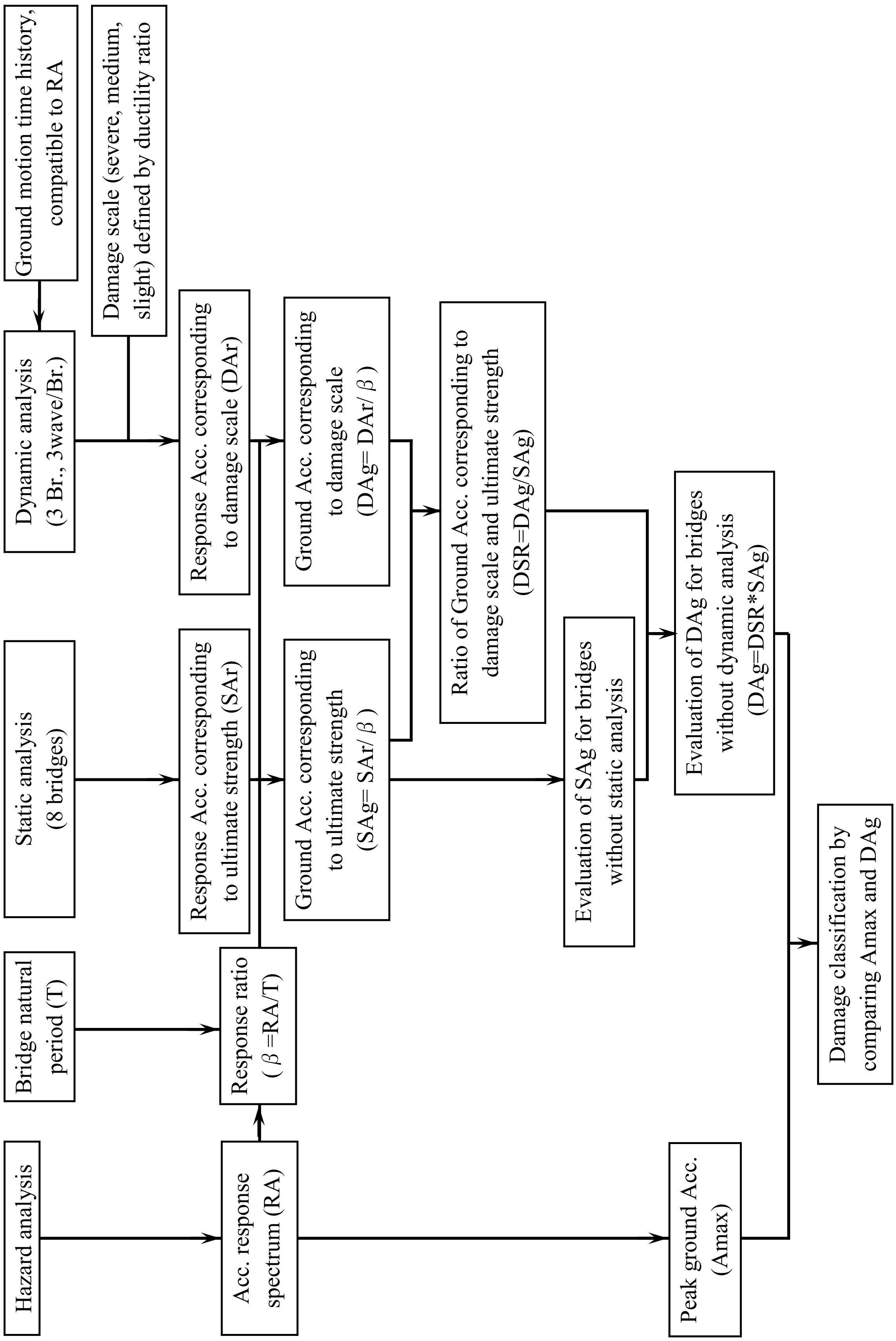



Figure 4.4.1 Flow chart of bridge damage assessment

(iii) Bridges for static and dynamic analysis
Eight bridges for static analysis have been shown in Table 4.4.1. Three bridges for dynamic analysis were selected from the static analysis bridges in order to consider the difference in ground motion characteristics.

(iv) Model of bridge pier
The static and dynamic analysis were performed by a popularly used software named UC-win/ FRAME(3D). The parameters of concrete were that most close to the Schmidt Hammer test conducted by “the project for construction of Ajilchin flyover in Ulaanbaatar city”. The reinforcing bar, according to design drawings, is A-I and A-II, which are Russian (former Soviet Union) standard. A-I and A-II are approximately corresponding to SR235 and SD295A of the Japanese standard, respectively.

(v) Time history for dynamic analysis
According to the “design specifications for highway bridges”, the time history for dynamic analysis can be that of the typical strong motion records and modified to fit the response spectrum of concerned site. To consider the phase effects on non-linear response, it is recommended to use the average of three waves. Since there was no strong motion records in Mongolia, two waves were chosen from the records of Japan. another one was artificially created for both horizontal and vertical components in order to see the effects of vertical component. Considering the earthquake type (local earthquake) and ground condition of bridge site (type 2), the two strong motion records were selected from those widely used in Japan, i.e. Takatori railway station (NS), and Fukiai gas transfer station (N27W). The artificial wave was created with uniform random phase.

(vi) Static analysis and the results
Pushover analysis was carried out for static analysis with 10 cm/s/s response acceleration as increment. During analysis, when the section stress reached the allowable stress, the corresponding response acceleration was specified and called elastic limit response acceleration. When the section force reached the ultimate strength, the corresponding response acceleration was defined and called ultimate strength response acceleration (SAr).

The ultimate strength response acceleration could be used for damage assessment for the analyzed bridges but, for the other bridges, it was not an appropriate choice because the response acceleration could not be decided due to unknown natural period. To solve the problem, one consideration was to use ground acceleration instead of response acceleration. Thus, the ultimate strength response acceleration (SAr) was divided by response ratio (β) and ultimate strength ground acceleration (SAg) was obtained. The natural period, response ratio and ultimate strength ground acceleration of the eight bridges are listed in Table 4.4.5.

Table 4.4.5 Ground acceleration corresponding to ultimate strength

| Bridge No. | Construc-tion year | Natural period (sec) | Ultimate strength response Acc. (cm/s/s) | Scenario I | | Scenario II | |
|---|---|---|---|---|---|---|---|
| | | | | Response ratio | Ultimate strength ground Acc. (cm/s/s) | Response ratio | Ultimate strength ground Acc. (cm/s/s) |
| 4 | 1962 | 0.16 | 140.0 | 1.91 | 73.3 | 2.05 | 68.3 |
| 5 | 1967 | 0.7 | 150.0 | 1.42 | 105.6 | 1.15 | 130.4 |
| 24 | 1971 | 1.3 | 120.0 | 0.96 | 125.0 | 0.78 | 153.8 |
| 18 | 1975 | 0.83 | 180.0 | 1.34 | 134.3 | 1.09 | 165.1 |
| 34 | 1982 | 0.66 | 160.0 | 1.26 | 127.0 | 1.06 | 150.9 |
| 26 | 1989 | 0.24 | 480.0 | 2.10 | 228.6 | 2.13 | 225.4 |
| 19 | 1994 | 0.68 | 280.0 | 1.36 | 205.9 | 1.17 | 239.3 |
| 56 | 2010 | 0.46 | 510.0 | 1.67 | 305.4 | 1.52 | 335.5 |

(vii) Damage criteria
Bridge damage is usually classified into severe, medium and slight damages. The Japan road association proposed a damage criteria by eye inspection after an earthquake (ref: handbook for dealing with road disaster, recovery section). The public works research institute suggested a quantitative damage criteria based on the relationship between damage degree and response ductility ratio (Figure 4.4.2). From Figure 4.4.2, it was noticed the damage criteria differed from the bridges that what design code was applied. The seismic code of Japan before 1980 was based on the elastic design concept. The examination of deformation performance was introduced in the revision of 1980. The examination of ultimate lateral strength was required when revised in 1990. The seismic design was further strengthened in the following revisions by introducing level 1 and level 2 ground motion. In Mongolia, the seismic code of former Soviet Union was directly used from 1960 to 1991 and Mongolia introduced its own seismic code in 1992. Neither of the seismic codes stipulated the examination of deformation performance and it was considered the pier did not have enough deformation capacity. In this regard, the seismic code of Mongolia was supposed to equivalent to that of Japan before 1980. The damage criteria became: slight damage: ductility ratio 1.0 - 1.5; medium damage: ductility ratio 1.5 - 3.0; severe damage: ductility ratio more than 3.0.

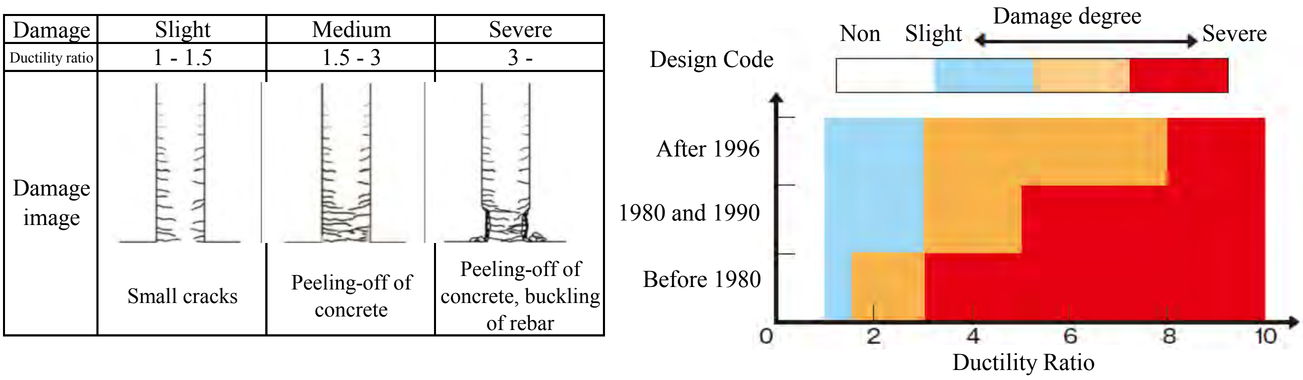



Figure 4.4.2 Relationship of pier damage and response ductility ratio

(viii) Dynamic analysis and the results
In order to apply the dynamic analysis results to the damage assessment of other bridges, the bridges for dynamic analysis were selected to have different ground motion and strength. The target bridges were bridge No.5, No.19 and No.26. During the analysis, the amplitude of input time history was adjusted to make the response having the ductility ratio of 1.0, 1.5 and 3.0. For each ductility ratio, the input response acceleration was calculated and called damage response acceleration (DAr). Same as the conversion from SAr to SAg, the damage response acceleration DAr was converted to damage ground acceleration (DAg) for the later use.

In order to link the results of static and dynamic analysis for damage assessment, the ratio (DSR) of damage ground acceleration (DAg) to ultimate strength ground acceleration (SAg) was calculated (DSR=DAg/SAg), shown in Table 4.4.6 Ratio of damage and ultimate ground acceleration. It was found the ratio was stable for different ground motion and phase. Therefore, the average of the ratio (DSRa) for the 9 cases (3 bridges * 3 waves) was calculated. It would be used to estimate the damage ground acceleration for the bridges without dynamic analysis.

Table 4.4.6 Ratio of damage and ultimate ground acceleration

| Bridge No. | Time history | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|---|
| | | Ducktility ratio | | | Ducktility ratio | | |
| | | 1.0 | 1.5 | 3.0 | 1.0 | 1.5 | 3.0 |
| 05 | Random | 0.753 | 1.205 | 2.350 | 0.688 | 1.438 | 2.877 |
| | II-II-1 | 0.843 | 1.386 | 2.741 | 0.844 | 1.564 | 3.096 |
| | II-II-3 | 0.934 | 1.356 | 2.259 | 0.938 | 1.501 | 2.658 |
| 19 | Random | 0.762 | 1.378 | 2.351 | 0.747 | 1.479 | 2.615 |
| | II-II-1 | 0.778 | 1.540 | 2.562 | 0.837 | 1.494 | 2.839 |
| | II-II-3 | 0.892 | 1.232 | 2.189 | 0.837 | 1.718 | 2.465 |
| 26 | Random | 1.083 | 1.319 | 1.861 | 1.160 | 1.637 | 2.529 |
| | II-II-1 | 1.049 | 1.353 | 2.199 | 1.131 | 1.637 | 2.440 |
| | II-II-3 | 1.218 | 1.522 | 2.199 | 1.279 | 1.785 | 2.529 |
| Average (DSRa) | | 0.924 | 1.366 | 2.301 | 0.940 | 1.584 | 2.672 |

(ix) Seismic risk of bridge

Seismic risk of bridge was estimated by the static and dynamic analysis results obtained before. The procedure is as below.

- Estimation of ultimate strength ground acceleration (SAg)
  For the bridges where the static analysis were performed, their ultimate strength ground acceleration were directly used. For the other bridges, the ultimate strength ground acceleration were evaluated by construction year.
- Estimation of damage ground acceleration (DAg)
  For the bridges where the dynamic analysis were performed, the average of 9 cases was directly used. For the other bridges, the damage ground acceleration was evaluated by the average ratio (DSRa,

Table 4.4.6) and the ultimate strength ground acceleration obtained at the first step.

DAgi = DSRai * SAg

Where i is the subscript, representing ductility ratio and having the value of 1.0, 1.5, and 3.0.

- Damage assessment

Bridge damage was estimated by comparing the damage ground acceleration (DAg) with the maximum ground acceleration (Amax) obtained from seismic hazard analysis.

no damage: Amax < DAg1.0
Slight: DAg1.0 <= Amax < DAg1.5
Medium: DAg1.5 <= Amax < DAg3.0
Severe: DAg3.0 <= Amax

The damage estimated for each bridge is shown in Table 4.4.7. For scenario I, 28 bridges were estimated severe damage. The damage rate was 42%. For scenario II, the severe damage bridges were 22 with the damage rate of 33%.

It was difficult to verify the damage estimation because there was no damage data in Mongolia. The relation between design intensity and the intensity of scenario earthquake, the damage of bridges in Armenia earthquake (1994), which was considered under the similar seismic design code, were examined to explain indirectly the reason of the damage.

Table 4.4.7 Results of bridge damage estimation

| ID | Name of Bridge | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|---|
| | | Amax (cm/s/s) | Pier Damage | Falling Down | Amax (cm/s/s) | Pier Damage | Falling Down |
| 4 | Arslantai Bridge | 338.9 | Severe | no | 353.3 | Severe | no |
| 5 | Uliastai tsaad Bridge /Left/ | 318.9 | Severe | no | 409.4 | Severe | no |
| 6 | Uliastai tsaad Bridge | 343.0 | Severe | no | 445.1 | Severe | no |
| 7 | Uliastai tsaad Bridge | 336.8 | Severe | no | 442.9 | Severe | no |
| 8 | Bridge over the Hol river | 238.6 | Medium | no | 312.3 | Medium | no |
| 9 | Chuluut am Bridge | 226.8 | Medium | no | 269.3 | Medium | no |
| 10 | Bayanzurkh Bridge | 316.3 | Severe | no | 423.3 | Severe | no |
| 11 | Zaisan West am Bridge | 325.6 | Severe | no | 349.6 | Medium | no |
| 12 | Bridge in front of the 14th khoroo | 331.2 | Severe | no | 347.1 | Medium | no |
| 13 | Enkhtaivan Bridge | 344.9 | Severe | no | 363.8 | Severe | no |
| 14 | Yarmag Bridge | 389.0 | Severe | no | 420.9 | Severe | no |
| 15 | Yarmag Bridge to Airport | 425.7 | Severe | no | 473.8 | Severe | no |
| 16 | Tolgoit Parallel Bridge | 408.4 | Severe | no | 436.2 | Severe | no |
| 17 | Selbe dund Bridge | 351.9 | Medium | no | 369.7 | Slight | no |
| 18 | Dund gol Deed Bridge | 348.1 | Severe | no | 366.5 | Medium | no |
| 19 | Ikh Tenger Bridge | 334.5 | Medium | no | 358.1 | Slight | no |
| 20 | Ikh Tenger dwon stream Bridge | 314.4 | Severe | no | 337.4 | Medium | no |
| 21 | Zaisan Bridge | 374.1 | Severe | no | 400.9 | Severe | no |
| 23 | Dund gol Dood Bridge | 400.0 | Severe | no | 427.1 | Severe | no |
| 24 | Sonsgolon Bridge | 423.9 | Severe | no | 474.9 | Severe | no |
| 25-1 | Turgen river Bridge-1 | 417.0 | Severe | no | 516.5 | Severe | no |
| 25-2 | Turgen river Bridge-2 (closed to traffic) | 595.2 | Severe | no | 540.8 | Severe | no |
| 26 | Poultry farm Bridge | 774.8 | Severe | no | 671.2 | Severe | no |
| 27 | Gurvaljin Bridge | 393.2 | Medium | no | 418.2 | Slight | no |
| 28 | Naran Bridge | 369.1 | Severe | no | 394.0 | Severe | no |
| 29 | Bridge behind of Meat Factory | 384.7 | Severe | no | 412.7 | Severe | no |
| 30 | Nairamdal Bridge | 369.8 | Severe | no | 408.2 | Severe | no |
| 31 | Rashaant Bridge | 269.3 | Slight | no | 271.9 | Slight | no |
| 32 | Khailaast Bridge | 293.8 | Severe | no | 301.4 | Medium | no |

| ID | Name of Bridge | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|---|
| | | Amax (cm/s/s) | Pier Damage | Falling Down | Amax (cm/s/s) | Pier Damage | Falling Down |
| 33 | Chingeltei Bridge | 259.4 | Medium | no | 264.1 | Medium | no |
| 34 | Sharga Morit Bridge | 260.6 | Medium | no | 265.0 | Medium | no |
| 35 | Selbe gol Deed Parallel Bridge -1 | 292.4 | Severe | no | 302.5 | Medium | no |
| 36 | Selbe gol Deed Parallel Bridge -2 | 292.4 | Severe | no | 302.4 | Medium | no |
| 37 | Bridge for behind of Chinggis hotel | 318.1 | Slight | no | 330.4 | Slight | no |
| 38 | Dambadarjaa Bridge | 279.8 | Slight | no | 283.6 | Slight | no |
| 39 | Dambadarjaa naad Bridge | 248.1 | Slight | no | 263.2 | Slight | no |
| 40 | Gachuurt Bridge | 257.7 | Medium | no | 391.2 | Severe | no |
| 41 | Gachuurt Bridge | 233.9 | Medium | no | 343.0 | Medium | no |
| 43 | Nalaikh Bridge | 190.8 | Medium | no | 180.2 | Slight | no |
| 44 | Zaisan East Bridge | 337.5 | Severe | no | 362.4 | Severe | no |
| 45 | Milk factory Bridge | 414.9 | Medium | no | 443.4 | Medium | no |
| 46 | Baruun-uul Dithc Bridge | 414.1 | Severe | no | 446.9 | Severe | no |
| 47 | Bridge over the ditch west behind the 1st khoroolol | 351.0 | Medium | no | 371.9 | Slight | no |
| 48 | Bridge to Khandgait-Sanzai | 228.9 | Slight | no | 236.8 | no | no |
| 49 | South Bridge to Khandgait-Sanzai | 236.5 | Slight | no | 244.2 | no | no |
| 50 | Tolgoit ger area road Bridge | 306.9 | Slight | no | 328.2 | Slight | no |
| 52 | Bridge behind the 1st district | 353.6 | Medium | no | 374.1 | Slight | no |
| 53 | Naran river Bridge | 424.8 | Medium | no | 461.6 | Medium | no |
| 54 | Damdinsuren street Bridge over the Selbe river | 346.9 | Medium | no | 363.2 | Slight | no |
| 55 | Bridge over the ditch west of the 39-th secondary school | 301.1 | Slight | no | 311.5 | Slight | no |
| 56 | New right side Bridge of the Uliastai river Bridge to become parallel | 318.9 | Slight | no | 409.1 | Slight | no |
| 57 | Morin/Horse/Hill Bridge | 505.2 | Medium | no | 594.5 | Medium | no |
| 58 | Khailaast 1.1 km length road Bridge-1 | 263.7 | Slight | no | 270.2 | Slight | no |
| 60 | Bridge behind 1st khoroolol over drainage ditch | 371.2 | Medium | no | 394.8 | Slight | no |
| 63 | Bridge on Chingeltei – KhaiIaast Road | 251.4 | Slight | no | 256.3 | Slight | no |
| 77 | Wooden bridge rehabilitation work for front side of the Songino's nursing station | 635.6 | Severe | no | 778.1 | Severe | no |
| 78 | Belkh river's RC bridge direction to Dambadarjaa-Belkh road | 247.1 | Slight | no | 299.5 | Slight | no |
| 89 | Bridge for Bayanhoshuu ger area | 315.4 | Slight | no | 330.5 | Slight | no |
| 90 | RC bridge Direction to the Orbit-Takhilt | 465.7 | Medium | no | 511.7 | Medium | no |
| 93 | Golden park bridge of selbe river RC bridge | 306.6 | Slight | no | 317.7 | Slight | no |
| 95 | Songino khairkhan district .4th and 5th khoroo's borderline road | 330.4 | Slight | no | 352.2 | Slight | no |
| 96 | Shadivlan, for Selbe bridge | 267.4 | Slight | no | 269.7 | Slight | no |
| 97 | Goodoin bridge | 255.5 | Medium | no | 258.3 | Medium | no |
| 98 | Upper bridge of Sharga morit | 250.7 | Medium | no | 257.1 | Medium | no |
| 99 | Upper bridge of Chingeltein am | 249.8 | Slight | no | 255.4 | Slight | no |
| 100 | behind the 4th khoroolol flood channel's bridge | 313.9 | Slight | no | 328.1 | Slight | no |
| 103 | Bridge for Bayanhoshuu ger area(north) under construction | 288.4 | Slight | no | 303.0 | Slight | no |

(4) Risk assessment of water pipeline

The damage of water pipeline was calculated as below.

Number of damage spot = damage rate (Rsm, spot/km) × pipe length (km)

Where, damage rate (Rsm) was calculated by standard damage rate: Rs (spot/km) and the modification factors for liquefaction, pipe material and pipe diameter.

$Rsm = Cl \times Cpd \times Rs$

$Rs = 2.24 \times 10^{-3} \times (Vmax - 20)^{1.51}$ (Vmax >= 20cm/s)

Cl : Modification factor for liquefaction and being 1.0 because no liquefaction.

Cpd : Modification factor for pipe material and diameter, shown in Table 4.4.8.

The damage estimation of water pipeline was based on the GIS data provided by UB city. The total length of the pipeline was 718.6km and only 65km (about 9%) had pipe material and diameter information. For the pipe without material and diameter information, the material was supposed being steel and cast iron and the weighted average diameter was used.

The damage estimation of water pipeline is shown in Table 4.4.9. There were 68 damage spot for scenario I (damage rate 0.09) and 44 damage spot for scenario II (damage 0.06). Since there was no damage data in Mongolia, the results was compared with that of Almaty, Kazakhstan, performed by another JICA project. The conditions of Almaty damage estimation were Mw=7.3 and acceleration between 300 - 800 cm/s/s, similar to this project. The damage rate of Almaty was 0.21. Since most pipe diameter were unknown here, the weighted average diameter was used. The average diameter could be considered relatively big because it was larger than the medium value of maximum and minimum. If a smaller diameter was used, the damage rate would become 0.18, closing to that of Almaty. In this regard, more pipe material and diameter data are needed to improve the results.

Table 4.4.8 Modification factor for water pipeline (Cpd)

| Material \ Diameter | - 75mm | 100-250mm | 300-450mm | 500-900mm | 1000mm - |
|---|---|---|---|---|---|
| Ductile iron | 0.60 | 0.30 | | 0.09 | 0.05 |
| Cast iron | 1.70 | 1.20 | 0.40 | | 0.15 |
| Steel | 0.84 | 0.42 | 0.24 | | |
| PVC | 1.50 | 1.20 | | | |
| Asbestos cement | 6.90 | 2.70 | 1.20 | | |

Table 4.4.9 Damage estimation results of water pipeline

| District | Total Length (km) | Scenario 1 | | Scenario 2 | |
|---|---|---|---|---|---|
| | | Damage Rate (points/km) | Number of Damage Point | Damage Rate (points/km) | Number of Damage Point |
| Baganuur | — | — | — | — | — |
| Bagakhangai | — | — | — | — | — |
| Bayangol | 190.202 | 0.112 | 21 | 0.072 | 14 |
| Bayanzurkh | 168.530 | 0.056 | 9 | 0.026 | 4 |
| Nalaikh | 3.961 | 0.001 | 0 | 0.000 | 0 |
| Songinokhairkhan | 107.866 | 0.135 | 15 | 0.097 | 11 |
| Sukhbaatar | 78.752 | 0.059 | 5 | 0.027 | 2 |
| Khan-Uul | 129.031 | 0.126 | 16 | 0.091 | 12 |
| Chingeltei | 40.271 | 0.055 | 2 | 0.026 | 1 |
| Total | 718.613 | | 68 | | 44 |

(5) Risk assessment of sewerage pipeline
The damage of sewerage pipeline was calculated as below.

Damage length (km) = damage rate (Rsm, %) × pipe length (km)

Where damage rate (Rsm) is showing in Table 4.4.10 for different pipe material, liquefaction and intensity.

The damage estimation of sewerage pipeline was based on the GIS data provided by UB city. The total length of the pipeline was 734km and 136km (about 19%) had pipe material information. For the pipes without pipe material information, it was assumed to be PVC and the others with a proportion of 77:58. The damage estimation of sewerage pipeline are shown in Table 4.4.11. The damaged pipe of scenario I was 192km (damage rate 0.26) and that of scenario II was 176km (damage 0.24).

Table 4.4.10 Damage rate of sewerage pipeline

| Material | Liquefaction | Intensity and ground velocity (cm/s) | | | | |
|---|---|---|---|---|---|---|
| | | 5-<br>11≦V＜20 | 5-<br>20≦V＜35 | 5-<br>35≦V＜64 | 5-<br>64≦V＜116 | 5-<br>116≦V |
| PVC, ceramic | All | 19.0 | 30.8 | 39.3 | 48.6 | 57.0 |
| Others | 15<PL | 11.4 | 17.4 | 23.1 | 28.0 | 33.4 |
| | 5<PL≦15 | 8.7 | 13.6 | 17.0 | 20.8 | 24.6 |
| | 0<PL≦5 | 8.0 | 12.6 | 15.6 | 19.1 | 22.5 |
| | PL=0 | 7.6 | 12.1 | 14.6 | 18.1 | 21.2 |

Table 4.4.11 Damage estimation results of sewerage pipeline

| District | Total Length (km) | Scenario 1 | | Scenario 2 | |
|---|---|---|---|---|---|
| | | Damage Rate (%) | Damage Length (km) | Damage Rate (%) | Damage Length (km) |
| Baganuur | — | — | — | — | — |
| Bagakhangai | — | — | — | — | — |
| Bayangol | 194.967 | 25.561 | 49.835 | 24.020 | 46.831 |
| Bayanzurkh | 166.405 | 24.961 | 41.536 | 21.690 | 36.093 |
| Nalaikh | 0.218 | 22.817 | 0.050 | 14.110 | 0.031 |
| Songinokhairkhan | 111.567 | 27.817 | 31.034 | 26.687 | 29.774 |
| Sukhbaatar | 94.607 | 25.723 | 24.335 | 21.724 | 20.553 |
| Khan-Uul | 126.317 | 26.826 | 33.886 | 26.545 | 33.531 |
| Chingeltei | 39.733 | 27.687 | 11.001 | 23.175 | 9.208 |
| Total | 733.814 | | 191.677 | | |

(6) Risk assessment of power system

Electric poles in Ger area were selected for risk assessment. Damage to electric poles consists of the damage by oscillation and damage caused by building collapse. The former is obtained by following equation;

Number of damaged electric poles = Number of poles × Damage rate.

The latter is obtained by following equation;

Number of damaged electric poles = Number of poles × Damage rate by building collapse.

Risk evaluation was conducted for each 250m mesh, followed by summing up the results to obtain the total damage in each district. The results are summarized in Table 4.4.12.

Table 4.4.12 Damage estimation results of electric pole

| District | Number of Electric Poles | Scenario 1 | | Scenario 2 | |
|---|---|---|---|---|---|
| | | Damage Rate (%) | Number of Damaged Poles | Damage Rate (%) | Number of Damaged Poles |
| Baganuur | — | — | — | — | — |
| Bagakhangai | — | — | — | — | — |
| Bayangol | 2060 | 2.302 | 48 | 0.639 | 13 |
| Bayanzurkh | 12242 | 3.217 | 395 | 1.016 | 124 |
| Nalaikh | — | — | — | — | — |
| Songinokhairkhan | 7763 | 2.974 | 231 | 2.075 | 161 |
| Sukhbaatar | 3123 | 1.889 | 60 | 0.228 | 7 |
| Khan-Uul | 609 | 5.421 | 33 | 4.929 | 30 |
| Chingeltei | 4174 | 1.865 | 78 | 0.408 | 17 |
| Total | 29971 | | 845 | | 352 |

(7) Risk assessment of hot water pipeline

Central heating system are provided to the central area of UB through hot water pipeline. About 82% of the hot water pipeline was under ground and the remained part (18%) was over ground. There are two types of underground pipeline: buried type and common duct type. The over ground pipeline is supported by supporting strut and the pipe are not fixed to the strut in most cases.

There is no such central heating system in Japan and no statistical fragility for damage estimation. Since the mechanism of damage is different, it is necessary to estimate the damage differently for underground part and over ground part.

The damage of underground pipeline was estimated by the method used for water pipeline because they were similar in pipe material and both deliver the water with pressure. The damage estimation of hot water pipeline was based on the GIS data provided by UB city. The total length of the pipeline was 1109km and 218km (about 20%) had the pipe material and diameter information. For the pipe without material and diameter information, the pipe material was supposed to be steel. The weighted average diameter from the known data was used for the pipes without diameter information.

The damage estimation of underground hot water pipeline are shown in Table 4.4.13. There were 97 damage spot for scenario I (damage rate 0.09 spot/km) and 59 damage spot for scenario II (damage rate 0.05 spot/km).

Table 4.4.13 Damage estimation results of hot water pipeline

| District | Total Length (km) | Scenario 1 | | Scenario 2 | |
|---|---|---|---|---|---|
| | | Damage Rate (points/km) | Number of Damage Point | Damage Rate (points/km) | Number of Damage Point |
| Baganuur | — | — | — | — | — |
| Bagakhangai | — | — | — | — | — |
| Bayangol | 301.547 | 0.090 | 27 | 0.056 | 17 |
| Bayanzurkh | 225.288 | 0.062 | 14 | 0.029 | 7 |
| Nalaikh | — | — | — | — | — |
| Songinokhairkhan | 152.440 | 0.140 | 21 | 0.100 | 15 |
| Sukhbaatar | 151.405 | 0.057 | 9 | 0.027 | 4 |
| Khan-Uul | 210.766 | 0.103 | 22 | 0.071 | 15 |
| Chingeltei | 67.568 | 0.063 | 4 | 0.030 | 2 |
| Total | 1109.014 | | 97 | | 59 |

## 4.5 Flow of fire risk estimation

### 4.5.1 Building Structures and Fire using Equipment's in UB city

UB city has central area which apartment houses are main and Ger area surrounding central area. Brick buildings, reinforced concrete buildings are main buildings in central area and Ger, Wooden houses, Brick or Adobe reinforced by wood and combined type bricks or adobe structures with wood above wall part and roof are main buildings in Ger area.

Fire using equipment in UB city,

Fire using equipment and electronic equipment in Ger is mostly Coal stove which used for heating and cooking. Electric equipment in house is Refrigerator, TV, Radio, Iron, Washing Machine, Vacuum cleaner PC. Fire using equipment and electric equipment in apartment houses in central area Refrigerator, Iron, Washing machine, Vacuum cleaner, Dryer, TV, Radio, and PC. Heating system is hot water heating system in all apartment houses in central area in UB city (Hot water is supplied from October to April). Bath is by hot water supply system as same as heating system. There is very few to use propane gas.

### 4.5.2 Method of Fire Breakout Risk and Fire Spread Risk

(1) Estimation of number of fires breakout in Earthquake

Fire breakout consists of fires from collapsed buildings and fires from non-collapsed buildings. The number of fires breakout is therefore sum of fires from collapsed and not collapsed buildings. The number of fire breakout from collapsed buildings is calculated as the fire breakout ratio of collapsed building multiple numbers of collapsed buildings. The fire breakout ratio used here is made by Tokyo Fire Department. The number of fire breakout from non-collapsed buildings is calculated as the fire breakout ratio from collapsed building multiple numbers of non-collapsed buildings. The fire breakout ratio is determined for each building use respectively. This ratio is also by Tokyo Fire Department.

Risk of fire breakout from Ger area is considered beside above stated method. UB city has unique urban structure which area of urban developed area consist of inflammable buildings such as Bricks, RC or Steel Structure buildings and Ger area which consist of mostly flammable structures such as Ger, wooden house. Also coal stove is indispensable for Ger area to heating and cooking. Therefore fire break out ratio from coal stove is applied for breakout ratio in Ger area.

(2) Fire Spread Risk
Fire Spread Risk Evaluation Method using "Inflammable area ratio" This method is based on the ratio of inflammable zone area against whole area. Development of fire spread risk in Ger area is developed as same as fire break out method.

Ger area is widely exist surrounding of developed area of UB city consist of mostly flammable buildings including Ger, Bricks, wooden houses. Therefore Ger area is also obviously high risk of fire spread risk. Even so, the density of buildings in Ger area are quite various according to the field survey and this difference does not come clear from "Inflammable Area Ratio Method". Therefore, it is needed to develop new method to express the difference of fire spread risk by density of building in Ger area using "Fire Spread Cluster".

### 4.5.3 Assumption of Fire Risk

Earthquake Fire risk is very dependent to seasons, time, and weather conditions. Therefore 2 cases of conditions are set to assess the risk of fire as follow for 2 earthquakes. Are, which moderate condition and extreme

- ✓ Two case for earthquake; scenario 1 and scenario 2
- ✓ Two case of Conditions;
  - ➢ Case 1; Evening of Winter, Wind velocity 10m/sec
  - ➢ TwC; Noon of Summer, Wind velocity 3m/sec

As the result, 4 cases are simulated.

### 4.5.4 Estimation of number of fire breakout and number of houses burned by fire spread

Simulation result is shown in Table 4.5.1 and Table 4.5.2. Figure 4.5.1 shows fire breakout and fire spread risk in 5 ranking for each 250m mesh of UB city. 1st rank is 0.00-0.01 houses/mesh, 2nd rank is 0.01-0.1 houses/mesh, 3rd rank is 0.1-1.0 houses/mesh, 4th rank is 1.0-10 houses/mesh and 5th rank is over 10 houses/mesh.

Table 4.5.1 Fire Risk of Scenario 1

| Scenario 1 Earthquake | Winter, Evening, 10m/sec | | Summer, Noon, 3m/sec | |
|---|---|---|---|---|
| | Number of Fire Breakout | Number of houses burned | Number of Fire Breakout | Number of houses burned |
| Baganuur | 0 | 0 | 0 | 0 |
| Bagahangai | 0 | 0 | 0 | 0 |
| Bayangol | 13 | 1067 | 13 | 648 |
| Bayanzurkh | 27 | 1654 | 24 | 884 |
| Nalaikh | 0 | 0 | 0 | 0 |
| Songinokhairkhan | 27 | 1541 | 26 | 792 |
| Suhbaatar | 15 | 886 | 14 | 453 |
| Khaan Uur | 7 | 49 | 7 | 26 |
| Chingeltei | 25 | 2404 | 23 | 1531 |
| UB city Total | 114 | 7601 | 107 | 4334 |

Ref: JICA Project Team

Table 4.5.2 Fire Risk of Scenario 2

| Scenario 2 Earthquake | Winter, Evening, 10m/sec | | Summer, Noon, 3m/sec | |
|---|---|---|---|---|
| | Number of Fire Breakout | Number of houses burned | Number of Fire Breakout | Number of houses burned |
| Baganuur | 0 | 0 | 0 | 0 |
| Bagahangai | 0 | 0 | 0 | 0 |
| Bayangol | 9 | 883 | 6 | 280 |
| Bayanzurkh | 20 | 1297 | 8 | 305 |
| Nalaikh | 0 | 0 | 0 | 0 |
| Songinokhairkhan | 25 | 1434 | 17 | 530 |
| Suhbaatar | 11 | 725 | 3 | 95 |
| Khaan Uur | 7 | 64 | 5 | 23 |
| Chingeltei | 19 | 1938 | 7 | 478 |
| UB city Total | 91 | 6341 | 46 | 1711 |

Ref: JICA Project Team

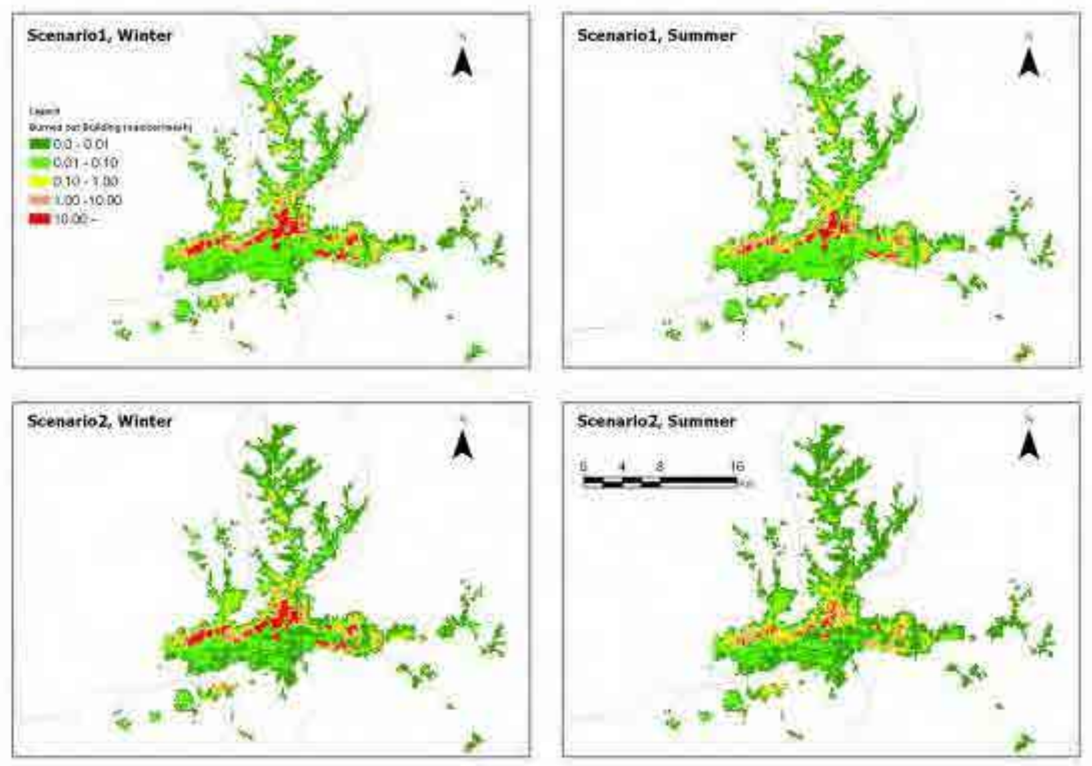



Figure 4.5.1 Fire Risk

4.5.5 Discussion

High risk rank meshes are Ger areas locate near city center in every cases. Ger areas near city center are convenient area therefore densities of houses are high. These Ger areas expand on the hill where basic infrastructures such as road networks, water supply, and sewerage system are not provided. Therefore Firefighting activities may face difficulty. If actually earthquake occurs, houses burned by spread fire may increase much more.

4.5.6 Human Damage by Fire Following

Human damage by fire following was evakuaterd as the product of the number of fire break out and the rate of human damage to the number of fire break out, which are estimated from the past fire accident.

It is known that dominant factors of casualty are impossibility to evaluate from burnig building or from area surrounded by burning buildings. However, this project estimates the human damage based not on fire spreading but on fire break out for the reasons below; risk of fire spreading in urban area is quite low, evaluation from unburned Gers in Ger area is easy, and, evacuation from buildings in Ger area is also achievable though there may be risk of fire spreading. This concept can also avoid double counting of casualties in collapsed buildings.

It is noted that survey on current situation in fire risk assessment, resukt of field survey, methodology and detailed information on human damage are described in Supporting Report.

Table 4.5.3 Fire Risk of Scenario 2

| | Scenario 1 | | Scenario 2 | |
|---|---|---|---|---|
| | Winter, 18:00 | Summer, 12:00 | Winter, 18:00 | Summer, 12:00 |
| Death by Fire | 48 | 27 | 40 | 6 |
| Injury by Fire | 48 | 27 | 40 | 6 |

# Chapter 5 Earthquake Disaster Scenario

## 5.1 Policy and Method for Establishing Earthquake Disaster Scenario

Following study was done based on the state and subjects of Earthquake Disaster Management Plan

- Issues to be promoted as the earthquake disaster countermeasures
- Issues to be reviewed in the Earthquake Disaster Management Plan

### 5.1.1 Issues to be promoted as the earthquake disaster countermeasures

(1) Countermeasures reducing earthquake damage directly

Most important subject is to reduce highest risk among earthquake damage. These are,

- ✓ Countermeasures of building collapse
- ✓ Countermeasures of fire breakout and fire spread in Ger area

1) Countermeasures of building collapse

Residential building collapse causes not only human damage but also losing living place. It causes big difficulty to recover their life. School building also may cause young people's life.

- ✓ Strengthen of houses and school buildings

Building collapse of important facilities causes difficulty of emergency response.

- ✓ Strengthen of buildings and facilities of headquarter of disaster management, firefighting station, hospitals

2) Countermeasures of fire proof of housing

Houses and wooden fence in Ger area have high risk of fire breakout and fire spread. The risk is relatively high in Ger area near center of UB city

- ✓ Fire proofing countermeasures in flammable houses in Ger are

(2) Countermeasures to reduce factors to obstruct disaster activities

Even if we prepared against disasters but if natural phenomena exceed our effort, damage may occur and we have to respond to the occurred disaster. Therefore it is necessary to reduce the factors which may obstruct response activities.

- ✓ Countermeasures to ensure function of road, function of lifeline
- ✓ Education and awareness activities to react suitable action in case of disaster

1) Countermeasures to ensure function of road and airport which became base of every emergency activities

Emergency repair of damaged road, removal of collapsed buildings and debris along road and collapsed over bridges and also traffic control, alternative root guidance are to be considered as countermeasures.

Airport and access road are also important facilities after disaster occurs to get support from outside of UB city.

2) Strengthening of lifeline facilities

Electricity and water supply is essential in UB city central area. Without Electricity and water supply, Cooking, heating are almost impossible especially in winter seasons in UB city. On the other hand in Ger area where more than 60% of UB citizens living, there is no water supply system through pipe line. Residents in Ger area buy water of 20 litter several times a day. Cool stove are used for Cooking. The other wards, living style in Ger is rather strong life style as living in affected area. Difficulty of electricity cut off is much less than living in apartment house. Even though, difficulty of living after disaster in central city life does not reduce.

3) Education and awareness activities to react suitable action in case of disaster

Without resident's appropriate react against earthquake disaster occur, not only human damage but also physical damage cannot avoid if we consider the capacity of emergency management organizations after event. There are many things depending resident's actions such as action at the time of earthquake, rapid evacuation, removal of fire causes, initial firefighting, assistant for aged people.

Education and awareness activities to react suitable action in case of disaster is highly necessary because of few experience of earthquake disaster in UB city. Please refer chapter 7.

(3) Countermeasures to implement disaster countermeasures

- ✓ Preparation of manual of disaster countermeasures for disaster related organizations
- ✓ Introduction of damage information collection system
- ✓ Preparation of Experts network system to expertize professional response

1) Needs of Manual for Disaster Countermeasures for Disaster related Organizations

Many items to be implement as earthquake disaster countermeasures are listed in UB city earthquake disaster management plan. Subjects to be done are indicated but detail plan, procedures and necessary information which needed to implement these countermeasures are not included in these items. Therefore possibility that the work does not progress is high in actual disasters. Especially in planning division, project implementation division and general affairs divisions except the division in which chain of command is a clear such as fire division, police division and military are not accustom to take action in case of emergency situations may face difficulty of implementation of indicated countermeasures.

It is needed to prepare the more detail plan, Manuals, procedures in which concrete procedures, information are written. These manuals may be included in the plan or may be prepared separately.

2) Information collection system to grasp disaster situations

It is difficult to grasp disaster situations right after the event occurs. It is desired to prepare the system to grasp disaster situations under such circumstance. Information collection system which fit to each disaster management organization such as the image information collection system such as surveillance cameras at all times or real city images by TV stations), Communication system of disaster management organizations dedicated, same wave communication system of the fire and police departments.

3) Experts network system that exerts expertise in case of disaster

Earthquake disaster is not daily phenomena. When disaster occur, things which cannot deal with in dealing with on a daily basis may occur. Therefore it is needed to construct the network of the experts.

Expert of Emergency Medical care

Many injured may visit the hospital when earthquake occurs. Numbers of doctor and nurses may be not sufficient to be taken care these many patients. If hospital suffers damage by earthquake, shortage of medicines may occur and surgical operations may become impossible. In such situation, than to do one patient the tender care of as well as normal times, that to save the patients survive many is important. Also wide network system of hospitals is needed to transfer patients to other city or other country's hospitals. The trained experts who know disaster situation and coordinate such operations needed

Introduce the system to check safety of damaged buildings

To check the safety of damaged buildings against aftershock is important. Especially safety of disaster management organizations headquarter buildings, the school buildings and the hospitals buildings are important for play the role in case of disaster.

The emergency assessment system of damaged buildings is the system to assess the safety of buildings and to mobilize the assessment engineers to the affected site. This system should be introduced to Mongolia.

The guideline of the emergency assessment system of damaged buildings for Mongolia is attached in this report (refer chapter 7 of appendix).

(Tentative name) Disaster assistance agreement of Mongol Water pipe contractor Council

Life line such as Water, Sewage, Heating and other which is Essential for urban life is constructed underground and its distance is long. Furthermore underground pipeline moves as same as earthquake ground motion and easily affected by earthquake movement. Underground pipeline is shaken directly by earthquake ground motion.
Amount of repair of pipeline become huge and should complete in short time for people' living. It is not sufficient to do by water pipe contractor in UB city. Therefore disaster assistance agreement is recommended to agree among the whole of water pipe contractors in Mongolia for complete repair in short period.

### 5.1.2 Items in the earthquake disaster management plan to be considered

(1) Configuration of the earthquake disaster management plan

1) Essential items

Following configuration is recommended to be prepared

- ✓ Basic policy of the plan
  Damage estimation and scenario earthquake
- ✓ Mitigation goal
- ✓ The role of central government, local governments, private sectors, citizens
- ✓ Prevention Plan
- ✓ Emergency response plan
- ✓ Recovery plan

Damage estimation and scenario earthquake, Mitigation goal, The role of central government, local governments, private sectors, citizens are not included in UB city plan (note; The role of central government, local governments, private sectors, citizens is included in the new plan revised in march 2013).

- ✓ Damage estimation is surveyed and draft of the scenario earthquake is also prepared in this report.
- ✓ Mitigation goal is the Goal setting to do earthquake countermeasures. And its disclosure is important.
- ✓ The role of central government, local governments, private sectors, citizens states the role of private sectors, citizens in earthquake disaster management.

2) Basic policy of the plan

Following items are described in the basic policy of the plan.

- ✓ Premise and purposes of plan
  Configuration of the plan
- ✓ proficiency of planning
- ✓ Modification of the plan

3) Damage estimation and scenario earthquake

The scale of the expected earthquake in the plan is described .Estimation of damage to be expected from the earthquake is described here.

4) Mitigation goal

Mitigation goal is the Goal setting to do earthquake countermeasures. For instance,

- ✓ Goal 1 : Halve the number of deaths caused by the earthquake
- ✓ Goal 2 : Halve the number of injuries caused by the earthquake

Such target or goal is set and demonstrate the plan is for achieving this goal.

5) The role of central government, local governments, private sectors, citizens

It is shown that to achieve the mitigation goal by promoting subject of earthquake disaster management plan will take measures by all stakeholders not only government but residents, community, private sectors. The role of each stakeholders are described clearly.

6) Prevention Plan, Emergency response plan, Recovery plan

These items are already set in the plan. Individual items which recommended to add and also to be described in more detail are shown following section...

(2) A study on structure of the earthquake disaster prevention plan and proposed modification

1) Description of as a unit in each disaster countermeasures items in the plan

It is not easily grasped for users because individual items of the earthquake management plan are described in parallel. It is recommended to describe the plan in the general category in disaster prevention measures. Disaster mitigation countermeasures complement each other and to exert the function . Disaster mitigation countermeasures complement each other and to exert the function . Therefore it is recommended to describe related countermeasures together in same category.

An example of classification of category is indicated below.

- ✓ Disaster Proof Urban Planning and Development
- ✓ Safety of Structures
- ✓ Fire Prevention
- ✓ Emergency Response
- ✓ Community Empowerment
- ✓ Business Continuity Plan
- ✓ Earthquake Research and Survey

2) Emergency Response and Disaster Recovery

- ✓ Initial response
- ✓ Support Cooperation and Dispatch Request
- ✓ Security and Traffic Control
- ✓ Emergency Transportation Measures
- ✓ Search and Rescue
- ✓ Fire and hazardous materials measures
- ✓ Medical Relief Measures
- ✓ Refugee Measures
- ✓ Supply of Drinking Water, Food, Daily Necessities, etc.
- ✓ Waste Process, Preparedness of Toilet, excreta disposal, debris processing
- ✓ Handling of Bodies
- ✓ Emergency and Recovery Measures of lifeline Facilities
- ✓ Emergency and Recovery Measures of Public Facilities
- ✓ Public Civil Engineering Facilities
- ✓ Emergency Life Measures

### 5.1.3 Items in the earthquake disaster management plan that desirable to be modified

(1) Concept of Emergency medical care

In emergency medical care plan, Assumption of treatment subject, Transportation of injured patients, Changing hospital by hospital damage, Number of doctors and Quantity of pharmaceuticals, Regional or national wide medical system, Transportations of Injured to other hospital, Triage to take care many patients in limited medical care system and others are included in the plan.

Following are pointed in present plan.

- As deterrence measures
    - 0.23 Relocation hospital project formations
    - 0.26 Construction of earthquake-resistant hospital
    - 3.2 Seismic diagnosis National School
    - 3.4 Seismic diagnosis of health facilities
- As mitigation measures
    - 1.6 Training of emergency medical care
- As emergency response
    - 0.26 Ensuring blood
    - 5.8 Disaster medical care plan
    - 5.13 Epidemic correspondence

5.22 Disaster medical care activities

As disaster recovery measures

6.3 High quality medical care support

Additionally following items are recommended to be included.

- ✓Seismic diagnosis private school and their retrofit program、
- ✓Triage in affected site
- ✓Establishment of regional or national wide medical network system

(2) The role of central government, local governments, private sectors, citizens

The draft paper of the role of central government, local governments, private sectors, citizens which mentioned at 5.1.2(1) is proposed (refer chapter 7 of appendix). The role of central government, local governments, private sectors, citizens is important to achieve the mitigation goal by promoting subject of earthquake disaster management plan and necessity of publicity of the plan to let stakeholders to understand and have common recognition to play the role of stakeholders for disaster reduction.

This paper was introduced into the new earthquake disaster management plan revised on March of this year.

(3) Guideline for Urban Planning on Disaster

Corresponding to 5.1.2(2) "Needs of Manual for Disaster Countermeasures for Disaster related Organizations", draft of manual for 5.1.2(3) the Disaster Proof Urban Planning and Development is submitted (refer chapter 7 of appendix).

This guideline is to establish the plan for Urban Planning and Development on Disaster of UB city which is taken a while consistent with the UB city master plan by UB urban planning and construction department

(4) Guideline for Emergency Assessment for Damaged Buildings

Corresponding to 5.1.1(3) c "Introduce the system to check safety of damaged buildings" the guideline is submitted (refer chapter 7 of appendix).

### 5.1.4 Summary

Table5.1.1 Summary of modification study of the earthquake disaster management plan

| Items to be reinforced | | Items to be reinforced of high priority | |
|---|---|---|---|
| Disaster Management Countermeasures | Upgrading Seismic Resistance of Buildings | Important Buildings | Headquarter of Emergency Management Organizations |
| | | | Fire and Police Buildings |
| | | | Hospital and Medical Care Buildings |
| | | | School Buildings |
| | | Public Buildings | |
| | | Old apartment houses | |
| | Upgrading of Fire Proof Buildings | Buildings in Ger area | Incombustible wooden building |
| | Ensure Road Function | Road Structures | Reinforcement of Bridges |
| | | Roadside Building | Fall Prevention of Sign Boards of Roadside Buildings |
| | | Designation of Alternative Road | |
| | | Traffic Control | |
| | Reinforcement of Airport Function | | |
| | Upgrading Seismic Resistance of Lifeline Facilities | Electricity System | |
| | | Water Supply System | |
| | | Heating System | |

| | | | |
|---|---|---|---|
| | Disaster Education | Basic Knowledge | How to keep safety in Earthquake |
| | | Response Ability | Initial fire fighting |
| | | Preparedness for Disaster | |
| | Preparedness of Manuals | Response Ability | Planning Division, Implementation Division, Education Division |
| | Information Collection System | Grasp of Damage Situation | Rooftop camera |
| | | | Unified Wave Communication between Police and Fire Division |
| | | | Satellite Communication |
| | Experts Network | Emergency Medical Care | Triage |
| | | Building Expert | Damage Assessment of Damaged Buildings |
| | | Recovery of Lifeline Facilities | Water pipe contractor Council |
| Configuration of the Plan | Basic Cconfiguration of the Plan | Disaster Damage Estimation as a base of the Plan | Damage Estimation Earthquake Scenario |
| | Setting of Mitigation Goal | Level of Mitigation Goal | |
| | The Role of Stakeholders of the Plan | Clarify Role of Stakeholders in Disaster Management | The plan is published to understand the objective of the Plan and to implement |
| | Description of as a unit in each disaster field | Understand the whole figures of countermeasures.in Each field | |
| Proposed Guidelines | Concept of Emergency medical care | | |
| | The role of central government, local governments, private sectors, citizens | | |
| | Guideline for Urban Planning on Disaster | | |
| | Guideline for Emergency Assessment for Damaged Buildings | | |

5.2 Setting of Earthquake Scenario

5.2.1 Earthquake Scenario

(1) Scenario Earthquake

Two scenario earthquakes were set in this project. One is considering the Hustai fault as Scenario 1 Earthquake, and the other is considered the Emeelt fault and the Gunjiin fault from the active faults around Ulaanbaatar city as Scenario 2 Earthquake. Based on the result of these two scenario earthquake hazard evaluation, Earthquake Scenario was described base on the Scenario 1 Earthquake.

(2) Earthquake occurrence time

Earthquake occurs evening of fine day of winter season with 10m/sec wind. According the result of fire risk evaluation, evening of winter season is mostly high risk. Heavy wind blows in May or June In UB city, but fire using chance is high and severe living in winter, above Assumption is selected.

5.2.2 Items of Scenario

(1) 3 steps correspondents to disaster response phases

Emergency Response
Temporary Response
Recovery
Rehabilitation

(2) Items in each phases

Emergency Response
- Establish Headquarter of Disaster Response
- Rescue and Firefighting
- Disaster Medical care
- Evacuation

Temporary Response
- Food and Water supply
- Electricity, Heating Systems, Fuels supply
- Temporary Housing, Permanent Housing
- Disaster Support

Recovery
- Education
- Infrastructure such as Road
- Debris Removal

Rehabilitation
- Reconstruction of life of affected peoples

### 5.2.3 Scenarios corresponding to response phaze

Scenarios are prepared for each items using the form of following table format.

Table5.2.1 Earthquake Scenario Table Format

<table>
<tr><td>Description of Damage</td><td colspan="2">Damages such as Buildings, Lifeline damage are described</td></tr>
<tr><td rowspan="3">State after the earthquake,example Day1 to Day3</td><td>Disaster Response Activities</td><td>Recommendations</td></tr>
<tr><td>・In order to clarify the situation that placed the subject of scenario, to describe position and the situation.</td><td></td></tr>
<tr><td>・Since setting of the situation, to be described in the simplified situation where it is necessary to avoid that the description is long, the corresponding</td><td>This column shows the items that should be prepared in advance, planning, subsidy, projects, such as stockpiling</td></tr>
<tr><td colspan="3">・Necessary documents are attached at the end of sections.</td></tr>
</table>

### 5.2.4 Issues to be promoted as the earthquake disaster countermeasures

Following 3 subjects are considered to select the issues to be promoted as the earthquake disaster countermeasures

- ✓ Countermeasures reducing earthquake damage directly
- ✓ Countermeasures to reduce factors to obstruct disaster activities
- ✓ Countermeasures to implement disaster countermeasures smoothly

(1) Items related " Countermeasures reducing earthquake damage directly"

a) Countermeasures of building collapse

According to the result of risk evaluation of earthquake damage, Building damage is serious. Residential building collapse causes not only human damage but also losing living place. It causes big difficulty to recover their life. School building also may cause young people's life. Building collapse of important facilities causes difficulty of emergency response.

Strengthen of buildings and facilities such as headquarter of disaster management, firefighting station, hospitals are desired.

b) Countermeasures of fire proof of housing

Houses and wooden fence in Ger area have high risk of fire breakout and fire spread. The risk is relatively high in Ger area near center of UB city

(2) Items related "Countermeasures to reduce factors to obstruct disaster activities"

a) Education and awareness activities to react suitable action in case of disaster

Without resident's appropriate react against earthquake disaster occur, not only human damage but also physical damage cannot avoid if we consider the capacity of emergency management organizations after event. There are many things depending resident's actions such as action at the time of earthquake, rapid evacuation, removal of fire causes, initial firefighting, assistant for aged people.

b) Countermeasures to ensure function of road and which became base of every emergency activities
Countermeasures to ensure function of road and airport which became base of every emergency activities

Emergency repair of damaged road, removal of collapsed buildings and debris along road and collapsed over bridges and also traffic control, alternative root guidance are to be considered as countermeasures.

Access roads from airport are also important facilities after disaster occurs to get support from outside of UB city.

c) Countermeasures to ensure function of airport which became base of every emergency activities from outside of UB city
UB city is a capital of Mongolia and half of the population is in UB city. Comparing to UB city, The surrounding cities are small cities. Supports from surrounding cities may not sufficient if UB city is affected by earthquake disaster. It is considered that the railway and roads between cities also expect a sufficient capacity are difficult, support of goods by air is the principal. Therefore ensure the function of airport become important.

d) Strengthening of lifeline facilities
Electricity and water supply is essential in UB city central area. Without Electricity and water supply, Cooking, heating are almost impossible especially in winter seasons in UB city. On the other hand in Ger area where more than 60% of UB citizens living, there is no water supply system through pipe line. Residents in Ger area buy water of 20 litter several times a day. Cool stove are used for Cooking. The other wards, living style in Ger is rather strong life style as living in affected area. Difficulty of electricity cut off is much less than living in apartment house. Even though, difficulty of living after disaster in central city life does not reduce.

(3) Items related " Countermeasures to implement disaster countermeasures smoothly"
a) Needs of Manual for Disaster Countermeasures for Disaster related Organizations
Many items to be implement as earthquake disaster countermeasures are listed in UB city earthquake disaster management plan. Subjects to be done are indicated but detail plan, procedures and necessary information which needed to implement these countermeasures are not included in these items. Therefore possibility that the work does not progress is high in actual disasters. Especially in planning division, project implementation division and general affairs divisions except the division in which chain of command is a clear such as fire division, police division and military are not accustom to take action in case of emergency situations may face difficulty of implementation of indicated countermeasures.

It is needed to prepare the more detail plan, Manuals, procedures in which concrete procedures, information are written. These manuals may be included in the plan or may be prepared separately.

b) Information collection system to grasp disaster situations
It is difficult to grasp disaster situations right after the event occurs. It is desired to prepare the system to grasp disaster situations under such circumstance. Information collection system which fit to each disaster management organization such as the image information collection system such as surveillance cameras at all times or real city images by TV stations), Communication system of disaster management organizations dedicated, same wave communication system of the fire and police departments

c) Experts network system that exerts expertise in case of disaster
Earthquake disaster is not daily phenomena. When disaster occur, things which cannot deal with in dealing with on a daily basis may occur. Therefore it is needed to construct the network of the experts.

d) Expert of Emergency Medical care
Many injured may come the hospital when earthquake occurs. Number of doctor's ad nurses may be not sufficient to take care these many patients. If hospital suffers damage by earthquake, shortage of medicines may occur and surgical operations may become impossible. In such situation, than to do one patient the tender care of as well as normal times, that to save the patients survive many is important. Also wide network system of hospitals is needed to transfer patients to other city or other country's hospitals. The trained experts who know disaster situation and coordinate such operations needed

e) Introduce the system to check safety of damaged building
To check the safety of damaged buildings against aftershock is important. Especially safety of disaster management organizations headquarter buildings, the school buildings and the hospitals buildings are important for play the role in case of disaster.
The emergency assessment system of damaged buildings is the system to assess the safety of buildings and to mobilize the assessment engineers to the affected site. This system should be introduced to Mongolia.

f) (Tentative name) Disaster assistance agreement of Mongol Water pipe contractor Council
Life line such as Water, Sewage, Heating and other which is Essential for urban life is constructed underground and its distance is long. Furthermore underground pipeline moves as same as earthquake ground motion and easily affected by earthquake movement. Underground pipeline is shaken directly by earthquake ground motion.

Amount of repair of pipeline become huge and should complete in short time for people' living. It is not sufficient to do by water pipe contractor in UB city. Therefore disaster assistance agreement is recommended to agree among the whole of water pipe contractors in Mongolia for complete repair in short period.

Table 5.2.2 Earthquake Scenario for UB city Disaster Management Headquarter (UB city Senior officials)

| | | |
|---|---|---|
| Building Damage | ・UB City Hall does not collapse. ・Bookshelves are scattered ・PC fall down from desks ・Window grass are broken and scattered ・Elevators stop | |
| Lifeline Damage | ・Electricity cut off （At least Day1）・Water suspended(Toilet cannot use for some time ) ・Telephones are congested ・Mobile phones are also congested | |
| casualty | ・Officers in city hall are few because of off of office hour. Few officers injured ・Officers may suffer human damage in their home. | |
| Day1-Day3 | Disaster Response Activity | Improvement |
| | ・There are some officers still working at 6 o'clock even office hour is until 5 o'clock. City Hall suddenly began shaking. .It was big shaking such as Hall may collapse. But Hall is not collapse fortunately. Bookshelves are fall down; PC is also fall down from desks. Many apartment houses are collapsed and raising cloud of dust. It was twilight when the earthquake occurred, but was in the dark gradually.There are no light in city and only the head lights of congested cars, but lights are not moving at all.<br>・Disaster countermeasures headquarter is established and also UB city headquarter is established when national wide disaster occurs according the Disaster Countermeasures Act issued 10th of July, 2009. Disaster countermeasure headquarter is not located in city hall and it is established in EMDC office. I am not in charge of disaster management but consider that I should take action as senior officer. City mayor is not in city hall and not able to contact to mayor. I think Disaster Countermeasure Headquarter should be started by the senior officers in city hall and dispatch my staff to other senior officers to gather in front of city hall.<br>Following indicated the situation that will come up after and comments for | |

| | | |
|---|---|---|
| | improvement | |
| | Set up of Disaster Countermeasures Headquarter<br>・Manual of operations and list of contact persons are not prepared.<br>・Emergency contact list and tools are not equipped. How to calling together.<br>・Is it permitted to set up UB city disaster countermeasures headquarter? Who decide to set up HQ? | ・Manual of Operation of HQ.<br>・Convened drills of HQ<br>・Convocation standard and its well-known<br>・Prepare of Information collection tool |
| | Set up of Disaster Countermeasures Headquarter<br>・There is no branch of EMDC in UB City Hall. Who will be secretariat of HQ?<br>・Where is HQ place? City Hall is not collapsed but certain damage occurs and need to check its safety.<br>・Telephones are congested ・Mobile phones are also congested<br>・Put desks and chairs in parking space in front of City Hall with Tent.<br>・Dark, cold<br><br>・Light up only Headquarter by Car light.<br>・Documents are scattered on the floor and difficult to find documents needed. | ・Emergency Assessment of Damage Buildings<br>・Need of stock Emergency Generator, Tent, Heating ,Food<br>・City Hall building must be construct strong enough against expected earthquake and fixing of furniture |
| | Operation of Headquarter<br>・Requests and complaints comes from peoples. Officers have to correspondent and cannot operate other issues.<br>・Request of report from National lever organizations frequently come. It makes difficulty to implement operation needed. | |
| | | |

Table5.2.3 Rescue and Firefighting (101,105)

(EMDC Senior officials)

| | | |
|---|---|---|
| Building Damage | ・Risk of collapse of UB fire stations are high.<br>・Communication functions of the command afraid of stop<br>・Multiple fires break out after earthquake.(141 fires break out, 7600houses burned) | |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,Water supply off (water pipe are damaged in 68 points), ・Telephones are congested ・Mobile phones are also congested | |
| casualty | ・Some officers may be injured in EMDC Office.<br>・Off-duty firefighters may suffer injured in their own houses. | |
| Damage of UB city | ・Many buildings collapsed in the city( More than 60% of buildings are estimated to suffer damages) and multiple fires break out after earthquake.<br>・Bridges also suffer damages<br>・Heavy traffic jam still continue. | |
| | Disaster Response Activity | Improvement |
| | EMDC office shaking violently, then PC fell from the desk and wall got a crack. I think this building is dangerous, and ran away from the building while shouting to staff around. To try to ascertain the safety of the family, but the mobile phone is not through. Normally the door of EMDC Garage is closed. Not even have time to open the door; beams on the building fell down. Fire truck, cannot go outside. Only vehicle that had been put out by chance became possible dispatch.<br>It is necessary to check the status of the city. There is a building under construction next to the EMDC. From the top floor, I will confirm visually around. Old apartment collapsed, cloud of dust is rising from there. Further, in the direction of north, the gel area, smoke is rising. Fire has occurred clearly in the gel area.<br>I do a safety check of all duty. Then, I carried out to confirm the possibility of mobilization of the vehicle.<br>Side by side desk on the road side of the building, to the construction headquarters of EMDC.<br>The following presents a situation where the predicted arise later, improvements to it | |

| | | |
|---|---|---|
| Day1 | Initial period<br>・Damage information begins to enter in contact on foot gradually.<br>・The fire reports do not come into (due to telephone congestions, a power failure, etc.)<br>・Does the off-duty staff respond the Emergency assembling after the earthquake?<br>・Directive function works? For which fire? | ・Iinformation collection means<br>・Emergency generators, radio<br>・Assembling of people provisions enactment and to well-known<br>・Creating the Disaster response guidelines<br>・Need of building earthquake-resistant |
| | Response at Collapsed Building site and/or Fire site.<br>・It takes a long time to arrive traffic congestion, traffic accidents, by building collapse of the roadside.<br>・Many buildings collapse occurs. It is difficult to look for Where is the injured<br><br>・I cannot rescue activities without heavy equipment.<br>・Risk by aftershocks such as is high in the site<br>・Cannot be ensured fire water conservancy in Ger area Securing water for fire-fighting in Gel area is difficulty<br>・Fire spread risk is high because there are many fire site where fire engines cannot be arrived | ・water for fire-fighting in Gel area<br>・Initial firefighting by Residents |
| Day 1 to Day 3 | ・Ask support the ffire fighters, the emergency response teams from other cities<br>・Ask military support<br>・Takes time vehicle of support forces to enter the city | ・Road reopening, Traffic Control |

Table5.2.4 Emergency Medical Care

(Hospital Doctor)

| | |
|---|---|
| Building Damage | ・16 hospitals among 47 hospitals that floor area are more than 1000m$^2$ assumed to be collapsed or severely broken.<br>・Drug shelves and shelves medical record are fallen down. Also Surgical instruments are suffering damages by fall down or moving.<br>・Surgical instruments are suffer damages by falling or moving. |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,Water supply off (water pipe are damaged in 68 points),・Telephones are congested・Mobile phones are also congested |
| casualty | ・Inpatient, physician, nurse are injured by the building broken by earthquake.<br>Nurse or doctor who is off-duty also suffers injury due to earthquake damage at home. |
| Damage of UB city | ・Many buildings collapsed in the city (More than 60% of buildings are estimated to suffer damages) |

| | Disaster Response Activity | Improvement |
|---|---|---|
| | Outpatient care in the afternoon is over, hospitalized patients has begun to take dinner. Suddenly the building began shaking wobbly. Various things ran out shelf chemicals, such as medical records from the shelf.<br>The power outage immediately.<br>There was no injury to me because I did not hit the shelf that I fell barely. However I decided to evacuate outside because it is an old hospital. However, some hospitalized patients. Some patients or need oxygen inhalation, doing dialysis in the patient .I thought there is also a need to go to the confirmation of those patients.<br>The following shows the improvements to it and situation that may occur thereafter | |
| Day 1 to Day 3 | Hospital response immediately after Earthquake Damage<br>・There were some confused corresponding about patients evacuation outside of hospital to avoid the aftershock.<br>・Doctor, nurse corresponds to the injury of the inpatient<br>・chemicals is damaged by the fall of the drug shelf,<br>・Surgical instruments, etc. is subject to damage<br>・urgent response to the dialysis patient and oxygen inhalation<br>・The test equipment do not work for the power failure.<br>・Elevators out of order because of electricity power down | -Earthquake response manual<br>-Fall prevention equipment<br>And securing of emergency power |

| | | |
|---|---|---|
| | Responding to emergency patients<br>・Injured visit on foot. Waiting room is soon full<br>・Doctor hits the treatment of emergency patients. Drug comes quickly run out<br>・And hospitals are flooded with patients, support by preparing these bets in the outdoors<br>・hospitalization patients with mild to promote the discharge<br>・It is necessary to determine priority or viewed from a patient of any degree<br>・Recommendation of leaving hospital to hospitalized patients medical condition of mild | Stockpile of chemical, procurement<br>Preparation and training of triage |
| | Collaboration with hospitals outside<br>・Information is not transmitted emergency first-aid station will also be installed, the patient rushed to hospital<br>・Where the hospital is either not affected, there is no information unknown<br>・shortage of stockpile of medical records<br>・request to government to dispatch doctors and nurses<br>・Request of Transportation of severe patient to the hospital of the other cities | ・The request of announcement of hospitals to broadcasting stations |
| Day4 to 1 Week | Emergency request of the drug shortage<br>・the condition of the patient changes from trauma to Cardiovascular disease and respiratory disease. Required pharmaceutical also varies along with it | |

Table5.2.5 Evacuation

(House wife)

| | |
|---|---|
| Building Damage | ・Many buildings collapsed in the city( More than 60% of buildings are estimated to suffer damages).<br>・Multiple fires break out after earthquake.(141 fires break out, 7600houses burned)<br>・Many people lost their houses |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,<br>・Water supply off (water pipe are damaged in 68 points),<br>・Telephones are congested・Mobile phones are also congested |
| casualty | |
| Damage of UB city | ・Bridges also suffer damages<br>・Heavy traffic jam still continue. |

| | Disaster Response Activity | Improvement |
|---|---|---|
| Day 1 to Day 3 | From shaking to go outside of her house<br>・She is her apartment house of 10th floor.<br>・Husband has not come home yet.<br>・Earthquake occurred suddenly when I was preparing for dinner, and the house began to shake big.<br>・The window glass broken, furniture fell, tableware jumped out of the cupboard. TV fell from the table, electricity is gone. I felt fear<br>Child was watching TV in another room, but was bleeding from the face to become buried under clothes case.<br>・To get away to the outside opened the door of the apartment, but it is not open. Elevator does not move and light of corridor is off. Then I go down the stairs, stairs is likely fall.<br>・Upon exiting out of the apartment building somehow, their neighbors also are coming out all. Apartment across the street is collapsed. Some people are calling hard the family who is in a building that was broken.<br>・I come frozen with two children, and being outside in the cold. Injuries of the face of the children I'm worried about. You want to bandage instead to tear the hem of the shirt. I forgot burns their feet, but the pain came out and made it to blister. Husband has not come back yet. Since the earthquake happened when you are making dinner, the family does not eat dinner yet. Children complain of hunger.<br>・I wanted to get back to the house, but the aftershocks happening at that time, the sound come from the apartment. It is very scary. We decided to away from the apartment as much as possible, so we decided to stay at the park for children.<br>・As our home broken, no place to spend the night. I do not know where we should go.<br>The following shows the improvements to it and situation that may occur thereafter. | ・Eeducation of Action for safety when Earthquake occur<br>・ Preparation of emergency pack<br>• The family meeting about the evacuation of the case of emergency and safety check of the family. |
| | ・(According to the analysis of survey results from) 40% to evacuate to relatives houses. 20% evacuate in the school for residents of the gel area. 10% evacuate to the school for residents in the apartment area. 20% of residents remain in their own | |

| | | |
|---|---|---|
| | house or apartment garden. | |
| | The school as evacuation place<br>・How to contact evacuees family where they evacuated.<br>・There is no person in charge at the evacuation sites, there is no heating evacuation sites even if the cold, there is no stockpile of blankets to evacuation sites<br>・Stockpiling supplies from UB city and national does not reach | ・Planning and management of shelter<br>・Stockpiling plan of evacuation house<br>・Information of evacuation sites opened<br>・Dispersion-based stockpile of one |
| Day 4 to 1 Week | ・Food, drinking water, etc. are raised gradually<br>・Find and human refugees come many<br>・Ccomplaints come out narrowness of the shelter, the issue of privacy, etc.<br>・Family to relocate homes and relatives, the gel that you bring your own also come out | ・Creating a refugee list |
| 1 Week to 1 Month | ・Family to move to temporary housing the government was also prepared to come out<br>・Shelter(School, square) is being returned to the intended purpose | |

Table5.2.6 Food, Drinking Ware Supply

(House wife)

| | | |
|---|---|---|
| Building Damage | ・Many buildings collapsed in the city( More than 60% of buildings are estimated to suffer damages)<br>・Multiple fires break out after earthquake.(160 fires break out, 7600houses burned)<br>・Many people lost their houses | |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,Water supply off (water pipe are damaged in 68 points),・ Telephones are congested・ Mobile phones are also congested | |
| casualty | | |
| Damage of UB city | ・Bridges also suffer damages<br>・Heavy traffic jam still continue. | |
| | Disaster Response Activity | Improvement |
| Day 1 to Day 3 | Food and water immediately after Earthquake<br>・No meal and drinking water after Earthquake.<br>・Some material to be eating and drinking for the time being people who can bring out food and water from the house.<br>・Cooking become difficult because there is no electricity even if there is food. | ・Stockpile at home<br>・Prohibition of unfair sales<br>・Stockpile of portable stove. |
| | Such as the grocery store<br>・People buy more than usual. Food and water sold out immediately.<br>・The customer make line to buy in the shop<br>・In some store, limit the amount to buy the one person .<br>The place goes up to make money.<br>・Theft occurs at the store unattended | ・Security plan |
| | Distribution of food, etc.<br>・Food, fuel, clothes, etc. is secured to stockpile warehouse, But there is only one place.<br>・If personnel arrangements is delayed, transport stagnates may occur for the transportation from the warehouse stockpile;.<br>・The interruption such as traffic congestion, supply of goods is delayed to shelter from the stockpile warehouse<br>・Provision of food, etc. Begin. Unknown where to supply much<br>・Bias comes into supply. People who do not get food coming out | ・Installation of stockpiling multiple warehouses<br>・Transportation plans for stockpile<br>・Disaster traffic control<br>・Plans to keep determined to designated evacuation places, such as the location of the food supply |
| After Day 4 | Food, drinking water, etc. are raised gradually<br>・Without hot meal such as shelter, discontent is over for those cold is often | ・Request to provide meals to the troops, request a lunch vehicle |

Table5.2.7 Electric Power Supply

(Emergency Management Division of Electric Power Supply)

| | |
|---|---|
| Facility Damage | ・Power generation plants, substations subject to strong shaking, there is a pause of power generation for verification of damage situation<br>・But as long as it is not subjected to severe damage, recovery in a certain period of time is expected<br>・Transmission and distribution lines of damage part unknown |

| | | |
|---|---|---|
| | ・UB City power plant is located in the western part of UB City there is a place where ground motion is assumed large. | |
| | Disaster Response Activity | Improvement |
| Day 1 to 1 Month | ・· In order to confirm the damage status of the plant itself, power to suspend<br>· To carry out emergency inspection, but the number of facilities power plants, substations, transmission, and distribution in many cases, It is not completed in a short period of time because over the long distance.<br>• To start the resumption of power transmission from district that ended the inspection, regional transmission of power is resumed in two days about the day at the earliest in many cases.<br>· Collapse of the building, in the spread area of a fire, it is necessary to perform the installation of distribution lines; it takes time to recover in the affected locations such. large | ・BCP |
| | Inquire of power restoration comes and answer recovery prospects | ・Restoration of public relations |
| 1 Month to 6 Months | replace sequentially high shockproof power equipment | ・Earthquake resistance plan |

Table5.2.8 Hot Water System

(UB city Hot Water System Division)

| | | |
|---|---|---|
| Facility Damage | ・Power generation plants, substations subject to strong shaking, there is a pause of power generation for verification of damage situation<br>・But as long as it is not subjected to severe damage, recovery of hot water system in a certain period of time is expected<br>・Damage the piping part of the underground afraid of occurrence at 97 sites,<br>・Damage on the ground portion of the piping is unknown, the possibility that part across the railway on road or receive damage is high.<br>・UB City power plant is located in the western part of UB City there is a place where ground motion is assumed large. | |
| Facility Outline | ・Three power plants(second, third, fourth plants) generate electricity and supply hot water .<br>The fourth power plant supplies hot water. Pipe total length of 141km in the city.<br>・Pipe of the main trunk line with 800mm diameter and 1200mm, tube thickness is 8mm and 10mm respectively. The pipe diameter is 400mm in the second power plant. 18% of the whole, piping on the ground portion is 82 percent underground part.<br>・Buried pipe is laid in the common duct to form 0.5-1.0m underground. Through the (some nine) pump center to make a pressure on the way from the power plant, and is supplied to the sub-station of the center to about 3,600 (CTB).<br>・At CTB, it exchanges heat to the water for heating to be supplied to a terminal user.<br>・Temperature is 135 ℃ at the power plant. At CTB, terminal user's water is heated 70 ℃ to 95 ℃. When hot water come back to power plant, temperature is about 70℃<br>・Customers number CTB one cover is not constant. The equipment scale of CTB also different.<br>・Heat supply is not performed until the 15th September from the 15th May. To perform the repair, etc. Unplug the water in the meantime. | |
| | Disaster Response Activity | Improvement |
| Day 1 to 1 Month | ・In order to confirm the damage status of the plant itself, power to suspend<br>・In the pipe line circulation system, water outage of clean water does not affect direct.<br>・Hot water after it has passed through the CTB because it uses clean water, To receive as the influence of the water supply outage. It is correlated with recovery period of drinking water supply system.<br>・Because it is considered damage of CTB of 3600 is large, the resumption of hot water supply is also related to the restoration of CTB individual.<br>・Ttime-consuming work and arrangements of workers damage confirmation of hot water pipe line that assumes the earthquake, procedure of reporting and also without.<br>・In order to check water and sanitation, hot water system, the number of suppliers water pipe construction, cannot cope in a short time the restoration work, it takes a long time to recover<br>・Hot water provided the request of the user come many corresponding difficulty, To provide recovery prospects<br>Customers number CTB one cover is not constant. The equipment scale of CTB also different. | ・BCP<br>・Response of emergency vehicle pre-specified<br>・Lack of skill in the art<br>・Publicity of restoration |

| | | |
|---|---|---|
| | ・Heat supply is not performed until the 15th September from the 15th May. To perform the repair, etc. Unplug the water in the meantime. | |
| 1 Month to 6 Months | ・Replacing in order to high shockproof the main pipe line<br>・Perform based on earthquake urban redevelopment plan, the implementation of the business plan and the supply of new supply in the region | Earthquake resistance plan |

Table 5.2.9 Temporary Housing, Permanent Housing
(Urban Development Department)

| | | |
|---|---|---|
| Building Damage | ・ Many buildings collapsed in the city( More than 60% of buildings are estimated to suffer damages)<br>・Multiple fires break out after earthquake.(160 fires break out, 7600houses burned)<br>・Many people lose three houses. | |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,Water supply off (water pipe are damaged in 68 points),・ Telephones are congested・ Mobile phones are also congested | |
| casualty | | |
| Damage of UB city | ・ ・Bridges also suffer damages<br>・Heavy traffic jam still continue. | |
| | Disaster Response Activity | Improvement |
| Day 1 | ・After most staff left office, earthquake occurred in the evening. PC, shelves fall down and power was down<br>・Senior officials hold meeting. Staff does not come back to office.<br>Check the response to the earthquake by staff that could be gathered in the next day.<br>・It was decided to set up as a shelter the school gymnasium, to accommodate the citizens who lost their homes. Thereafter, it was decided to perform the preparation and provision of temporary housing.<br>・These decision is transfer to the Headquarter of Earthquake Disaster Management of UB city. | ・BCP |
| 1 Week to 1 Month | ・It was decided to evacuate to a shelter immediately after the disaster.<br>Such as people who have a Gel to stay in Ger. People who have relatives in or near UB city stay in relative' houses.<br>・As many apartments are collapsed, New apartments for the people will be construct in 1 to several years. | ・Guide of Evacuation |
| | Construction process of the emergency temporary housing<br>・Administrative design temporary housing, construction<br>・What to do provided as temporary housing, or gel, or large-scale military tents, or prefabricated housing, renting of vacant apartment?<br>・How to set the number of temporary housing, grasp of demand<br>・Selection method of temporary housing residents subject, priority of the residents<br>・Water and supply of temporary housing, electricity and heating | ・Temporary housing plan<br>Procurement of military tents<br>・Study of design requirements for emergency temporary housing<br>・Examination of residents procedures |
| 1 Month to 6 Months | Problems with emergency temporary housing<br>・Response to complaints against the living environment in temporary housing<br>・Community building by residents in temporary housing | ・Appointment of residents in charge of dealing with<br>・Necessity of the organization of residents in temporary housing |
| | Process to the Permanent housing construction<br>・The construction and development of urban reconstruction plan<br>・Reconstruction of permanent housing to the site of the individual | ・Adjustment urban reconstruction plan, and urban redevelopment plan |

Table 5.2.10 Education

(Vice-principal of the school of UB city)

| | | |
|---|---|---|
| Building Damage | ・School collapse has occurred. And schools that cannot be used if not destroyed may also occur according to the damage estimation of scenario 1 earthquake | |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,Water supply off (water pipe are damaged in 68 points), ・Telephones are congested ・Mobile phones are also congested | |
| casualty | ・Few students suffer in school because earthquake occurs after school hour.<br>・If earthquake occurs in school hour, more casualty is expected.<br>・School teachers have high possibility of suffering. | |
| Damage of UB city | ・Bridge damage also occurred some<br>・The traffic jam at 6:00 evening | |
| | Disaster Response Activity | Improvement |
| Day 1 to Day 3 | Response to school damage and human suffering of students.<br>• Confirmation of students left in the building by teachers.<br>• There is no information that stays in school building at the time of earthquake.<br>• Telephone is not through.<br>• Visit EMDC station to ask search in school by walk.<br>If earthquake occurs during school time,<br>•Indications to students during shaking. Teachers are upset how should be an instruction to the students.<br>• Number of students who took refuge in the schoolyard, •confirmation of safety<br>• Keep students in the schoolyard since school building safety is not confirmed.<br>• Check visually damage situation around the school. If it does not seem too much damage, the principal determines whether to return home, either waits for pick up by parents. | ・Earthquake resistance of school building<br>・Verification procedure of those who are in school<br>・ Emergency call system<br>・Training and manual for action during an earthquake<br>・How to operate the shelter<br>・Standard of students return home |
| | Problems of school as a place of refuge<br>・Evacuees come gradually to school. What to do to evacuate the indoor judgment until you reach safety or shelter as a school building, in doubt.<br>・In order to avoid the cold of winter, victims begin to get into the school without permission.<br>・No officer come from city. Therefore teachers are forced to respond to the evacuees.<br>・No teachers know how to support the school as a place of refuge.<br>・Various inconvenience occurs in school which is not designed as the shelter.<br>・Evacuees come to a variety of request. | ・ Emergency safety check system<br>・Refugee acceptance of business school faculty<br>・ School refuge management manual |
| Day 3 to 1 Week | Safety check of students, confirmation of shelter<br>・Check the shelter and safety of all the students | |
| 1 Week to 1 Month | Functional recovery as a school<br>・Need to decide from when to start the operation return as school<br>・To consider and determine whether use is as school buildings, the construction of temporary classrooms<br>・It is necessary to adjust the alternative of teachers cannot return to work<br>・Contact the school resumption of the family of student | |
| 1 Month to 6 Months | Repair of the affected school building, renovation, reconstruction<br>・Confirmation of the extent of damage school building affected by the disaster,<br>・Deciding renovating either repair | ・New school building plan |

Table5.2.11 Recovery of Infrastructure

(UB city Road Construction Department)

| | | |
|---|---|---|
| Building Damage | ・ Many buildings collapsed in the city( More than 60% of buildings are estimated to suffer damages)<br>・ Multiple fires break out after earthquake.(160 fires break out, 7600houses burned) | |
| Lifeline Damage | ・Electricity cut off（At least several days of building collapse）,Water supply off (water pipe are damaged in 68 points),<br>・Telephones are congested ・Mobile phones are also congested。 | |
| Damage of UB city | ・Cracks and cave-in in the road.<br>・Bridges also suffer damages<br>・Heavy traffic jam still continue. | |
| | Disaster Response Activity | Improvement |
| Day 1 to Day 3 | Checking the damage situation<br>・No Information of damage places<br>・Try to catch up the disaster place in cooperation with traffic police | |

| | | |
|---|---|---|
| | Identifying of important road disaster<br>・Identifying of road which necessary to disaster activities<br>・Securing of emergency transportation path from the UB and UB city area<br>・Traffic control of general vehicle of important road | ・ Designation of important road<br>・ Designation of Emergency vehicle |
| | Process to the emergency restoration<br>・The implementation of the emergency restoration, such as passing the iron plate for the failure of the step degree<br>・Securing of contractors for the emergency rehabilitation of the road<br>・Ensure the detour road, and PR of detour road | ・ Stockpile of restoration materials<br>・Disaster cooperation agreement |
| Day 3 to 1 Month | Response to the damaged bridge<br>・Construction of temporary bridge in cooperation with army for the collapse of a bridge<br>・The implementation of the reinforcement method of temporarily for minor damage<br>・Update of daily via the Internet recovery situation and failure situation of the road<br>・S tidy of this method of restoration bridge and road (include earthquake resistance strengthening) | Ant seismic design plan |
| 1 Month to 3 Months | Restoration of bridge, road<br>・Examination of the road network development plan in light of the city master plan.<br>・ For Roads in urban area, the implementation of the road construction along the city master plan<br>・ The plan improvements to the high-standard road, and design for highway | ・ Coordination with the city master plan |

Table5.2.12 Debris treatment

（UB city Cleaning office officer）

| | | |
|---|---|---|
| Building damage | Many buildings collapsed in the city( More than 60% of buildings are estimated to suffer damages) and multiple fires break out after earthquake.(160 fires break out, 7600houses burned) | |
| Debris | Main source of debris are apartments made by masonry and reinforced concrete with brick wall<br>Total debris is estimated as 12.14 million $m^3$ (based on the assumption of 0.8 building volume become debris)<br>As debris will be landfilled to treatment plant. It is 2.43 million cars in the 10ton dump truck need to transport to treatment plant if the bricks specific gravity is 2 | |
| Day 1 to 1 Month | Disaster Response Activity | Improvement |
| | Day 1 to several days<br>・Working hours is completed, staff also go home almost<br>Earthquake occurs in such timing. Bookshelves are fall down, Telephones are congested・Mobile phones are also congested.<br>・Situation of the city is not known. I was decided that staff that remained to return home cannot help worrying about each family.<br>・On next day, the staff who could come to office, got the requests from police and fire department. The request is the removal of debris of collapse building along road because road is impassable by.<br>But Removal of building debris because is the work of the private sector as industrial waste; therefore it is usually not covered by health department. It was decided to ask mechanical diggers, trucks and operators to the Corps of Engineers in consultation with the disaster management headquarters of the UB city.<br>・Situation that cannot be collected most of life garbage followed.<br>・Removal of obstacles from the road for disaster activities。<br>・After a few days, broken home furnishings are out on the road in front of the house, debris of these has also been an obstacle to traffic.<br>Health department, to ask the work of removing the debris of the road to the construction companies<br>But it is difficult to raise the machines and the operators for the machines.<br>・Without a place to keep the debris, it is put on the open space for the time being.<br>・Shortage of vehicle fuel occurs, but additional fuel is not supplied The following shows the improvements to it and situation that may occur thereafter | ・Gathered provision of staff in the event of a disaster needs<br>・Planning in advance to perform promptly dispatch of army<br>・Need special consideration for the working fuel<br>・Consider in advance the area of the debris to put temporarily at the time of the big earthquake. |
| 1 month to 6 months | Decision on where to a final disposal site<br>・debris disposal does not slow progress, residents start dumping in dry riverbed without permission<br>・Planning of final disposal site is not decided, it takes a long time to debris disposal<br>・planning the work of reinforcing bar reuse or the like from the debris.<br>・Smoke pollution is generated by the incineration of combustible debris | ・Prepared of the final debris disposal sites<br>・Re-use of resources from the building debris (for example, recovery of reinforcing bar, etc.)<br>・ -Smoke pollution |

| | | |
|---|---|---|
| | | prevention measures when the incineration of combustible trash |

## 5.3 Integrated Earthquake Risk Maps

### 5.3.1 Seismic Disaster Risk Management Database

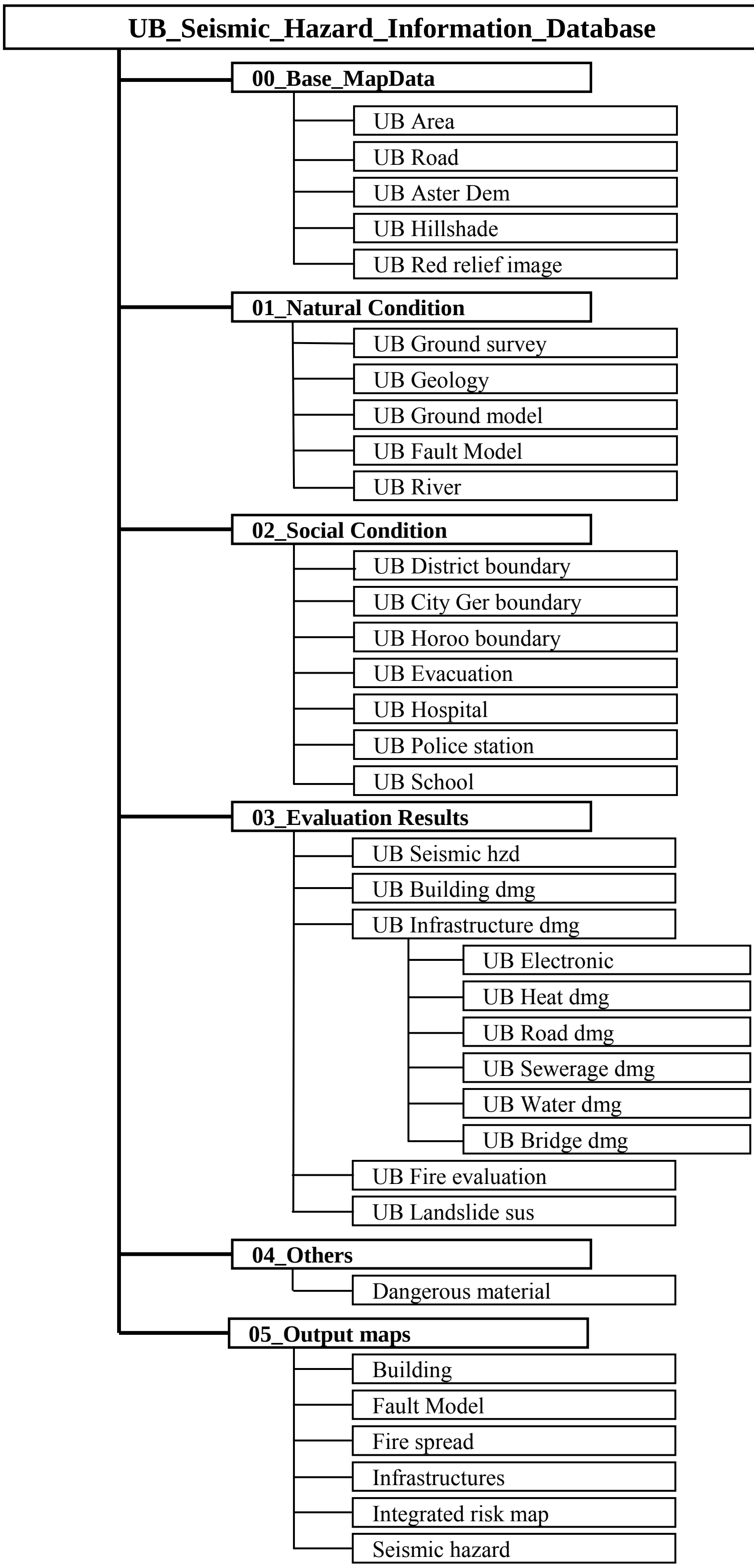
The collected data and evaluation results of this project were summarized as database.

Figure 5.3.1 shows the structure of the database.

The database includes items as below.

- Base map:DEM, Red relief image map, Road
- Natural Condition: Fault model, Geological map, Ground classification map, Ground model, Ground survey point, River
- Social Conditions. District and Horoo boundaries, Hospital, School, Police station, Evacuation site and route
- Evaluation results:
  - Results of ground motion evaluation
  - Results of landslide susceptibility
  - Results of building damage evaluation (includes the building inventory )
  - Results of infrastructures (Bridges, Road, Electronic, Heat pipeline, Water pipeline, Sewerage pipeline)
  - #Results of fire evaluation (Burned buildings, Fire spread)
  - #Layout maps of the evaluation results

These data and evaluation results were arranged to could be output and displayed in the integrated seismic risk map described in next section. Moreover, this database is constructed with simple structure so as to add and modify the data, and can be displayed on ArcGIS. The manual for install and operate the database is described in Supporting Report.




Ref: JICA Project Team

Figure 5.3.1 Structure of seismic hazard information database

### 5.3.2 Integrated Seismic Risk Map

Base on the survey data and evaluation results, integrated seismic risk maps of the UB city has been drawn. The data, mapping method, displaying method of the mapping is shown in Figure 5.3.2 Flow for drawing integrated seismic risk map
.

The output maps of evaluation were included in Supporting Report.

The output maps include:

- Ground motion evaluation maps (PGA, PGV, MSK intensity)
- Building damage evaluation maps (Stories, Structure, Use, Distribution of building collapse probability, Damaged population)
- Fire evaluation (Burned Buildings, Area of Fire spread )
- Transformation and life line structure damage evaluation map (Road, Bridge, Power, Hot water pipeline, Water Pipeline, Sewerage Pipeline)
  - Bridge: Damage estimation map
  - Road: Road length distribution map, Road extension within mesh, Damage rate map within mesh, Damage spot within mesh
  - Hot Water Pipeline: Pipeline distribution map, Pipeline distribution within mesh, Damage map within mesh, Damage spot within mesh
  - Water supply: Distribution map, Pipeline distribution within mesh, Damage rate within mesh, Damage spot within mesh, Water-off map
  - Sewerage pipeline: Distribution map, Pipeline distribution within mesh, Damage rate within mesh, Damage extension within mesh
- Landslide susceptibility map
- Integrated seismic risk map: (MSK intensity overlap with road, bridge damage, hospital, school, police station, evacuation site and route)

These maps were described in each chapters.

### 5.3.3 Conclusion

Examples of comprehensive risk maps are shown in Figure 5.3.3 and Figure 5.3.4, respectively. These figures show the evacuation routes and refuges, so that it can be seen that the refuges are located far from the urban ares in UB city. There may be the risk that evacuation route cannot be used considering the damage to roads and bridges as well as the risk of difficulty in evacuation becouce of the fire spreading in Ger area in the northern paet of UB urban area. So it can be concluded that the current evacuation routes and refuges may loose their functions in case of earthquake disaster and assignment of alternetive ones will be necessary. This is to be reported so that relevant organization in UB city can take proper actions.

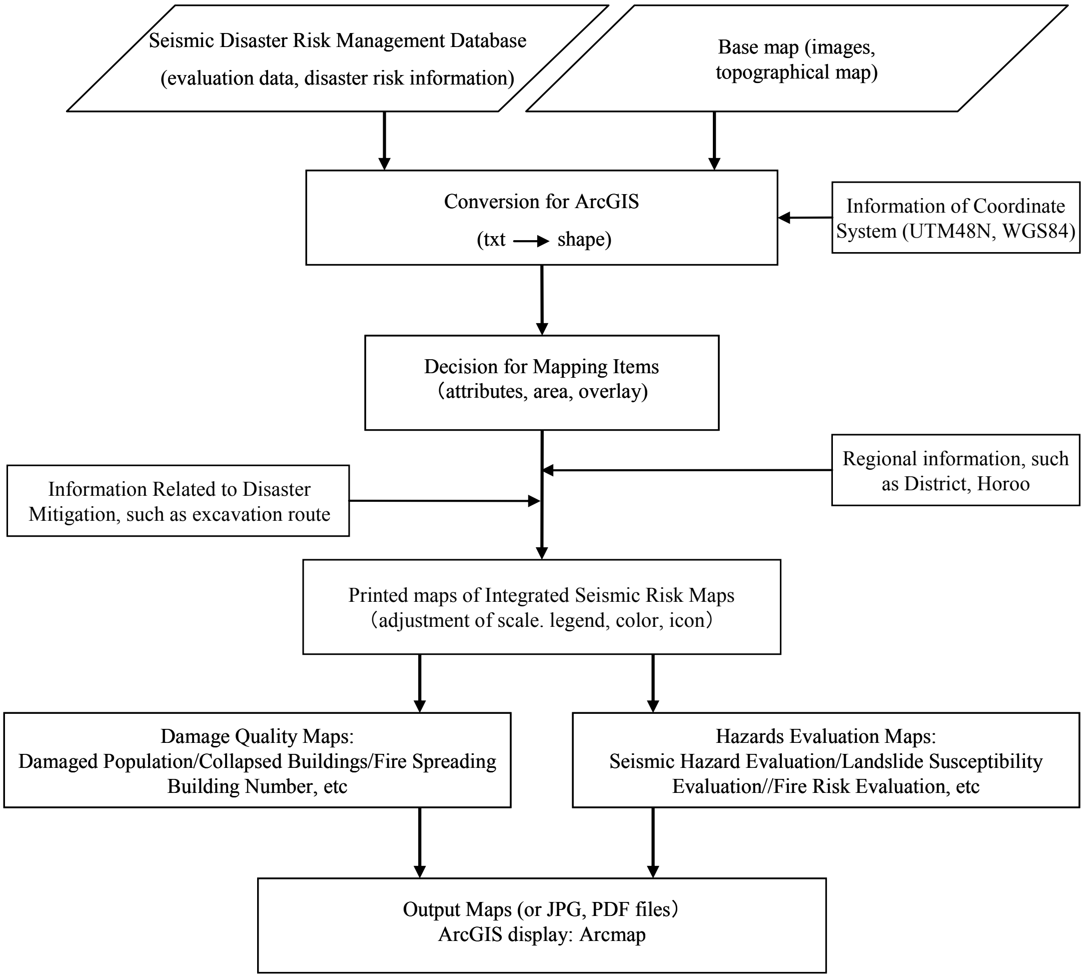



Figure 5.3.2 Flow for drawing integrated seismic risk map

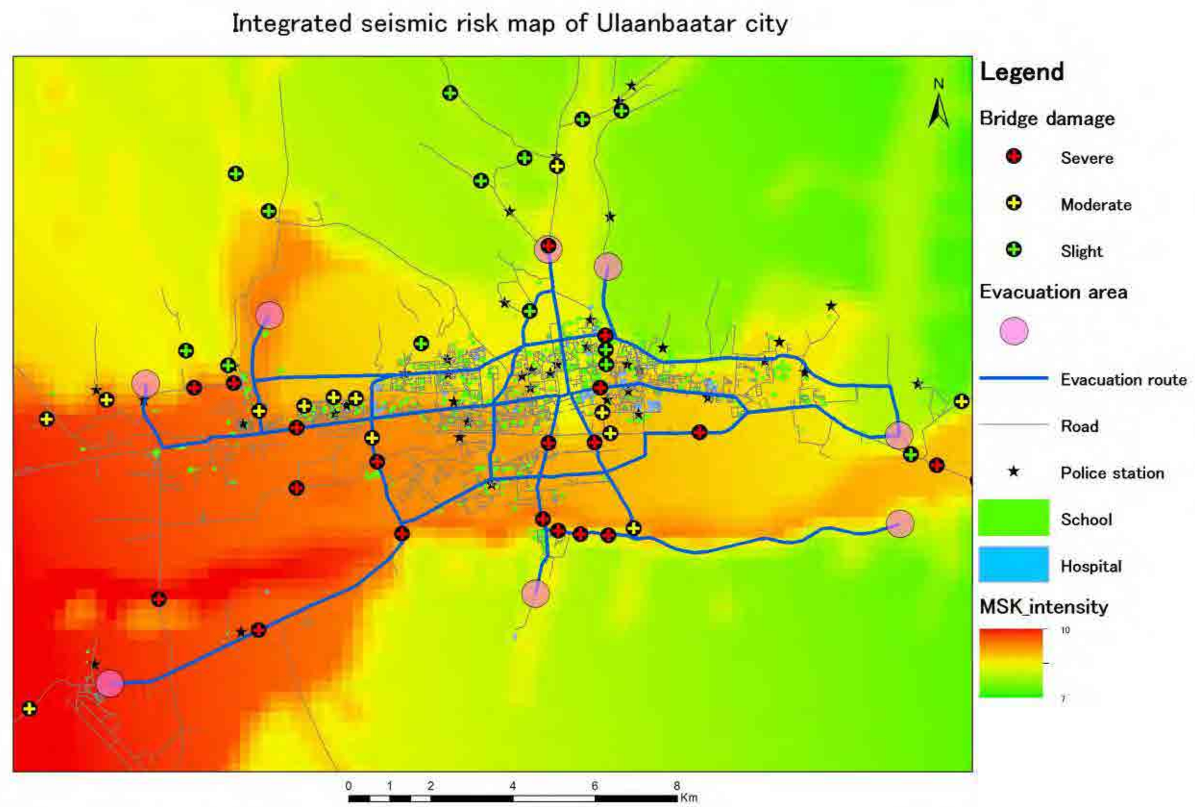



Figure 5.3.3 Comprehensive risk map for UB city (MSK intensity)

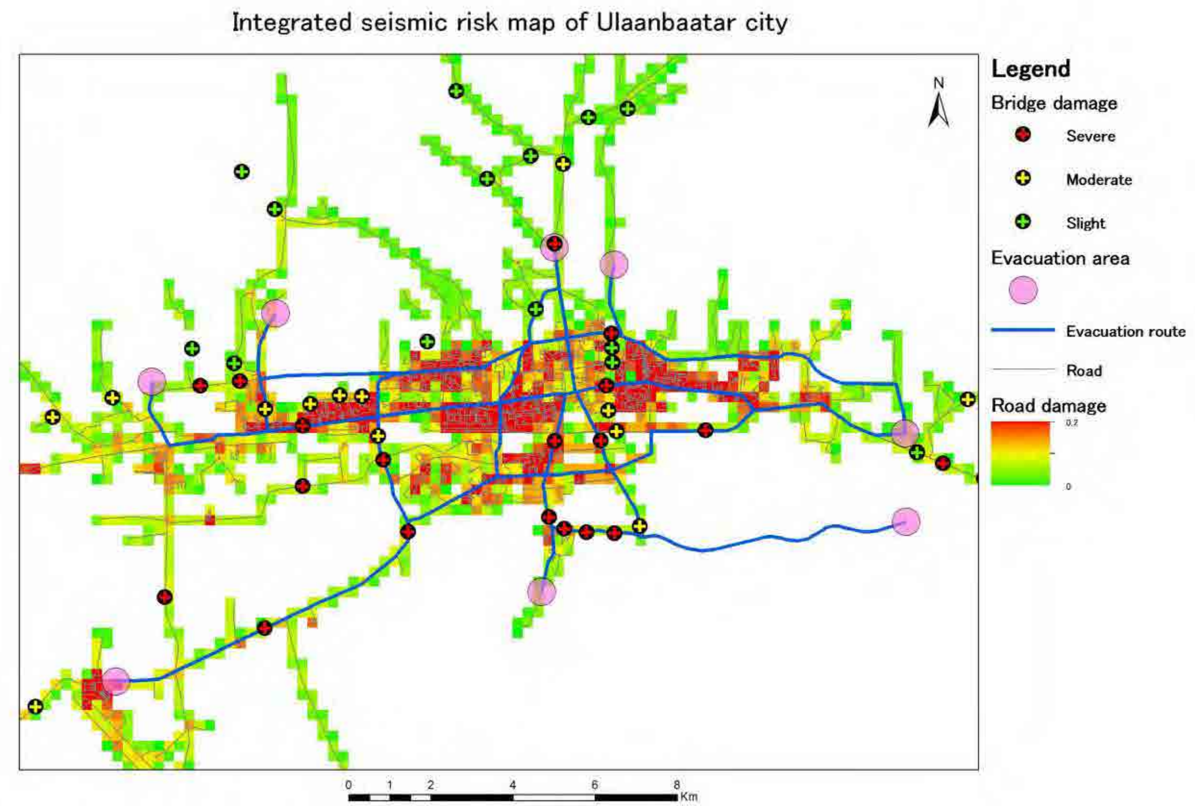



Figure 5.3.4 Comprehensive risk map for UB city (Damage to roads)

# Chapter 6 Priority of Projects Implementation

## 6.1 Concept of priority

It is needed to put first priority to select the project of high possibility of implementation and project of high efficiency to reduce earthquake damage because occurrence of earthquake is not predictable. Priority of Project Implementation is examined for the projects listed on Section 5.1 of Chapter 5 by necessity of Project and Possibility of Implementation.

## 6.2 Project Priority

Table 6.2.1 shows Items, Present Recognition, Needs, Possibility, Financial Load, Total Priority of Projects.

Table6.2.1 List of Project Priority

| ITEMS | | IMPORTANT ITEMS | PRESENT RECOGNITION | NEED | POSSIBILITY | FINANCIAL LOAD | TOTAL PRIORITY |
|---|---|---|---|---|---|---|---|
| Disaster Countermeasures | Seismic Upgrading Measures for Buildings | Important Buildings | ・Many buildings constructed in 1950 are still existing.<br>・Seismic code is not revised much<br>・ It may be not possible to exhibit the function. | Very high | ・ Reinforcement or reconstruction<br>・Decision making is possible in public organization | ・Number of buildings are limited<br>・Public subsidies are needed by political decision | ・Very high<br>・5 years |
| | | Public Buildings | ・Many buildings are masonry constructed in 1950 or precast panel 8-9 floors buildings | High | ・Reinforcement or reconstruction ・Decision making is possible in public organization | ・Number of buildings are limited<br>・ Decision making is possible in public organization | ・High 10 years |
| | | Old apartment houses | ・Many buildings are masonry constructed in 1950 or precast panel 8-9 floors buildings<br><br>・Redevelopment projects are ongoing according Urban Master Plan of UB city | Very high | ・Redevelopment project<br>・Number of subjects is big | ・ Cost burden is high because of private properties | Very high 2030 target |
| | Fire Proof Countermeasures | Building s(houses) in Ger area | ・Ger and wooden houses are existed.<br>・60% of population are in Ger area<br>・Redevelopment projects and land readjustment projects are on going | Very high | ・Reinforcement, Redevelopment project<br>・Number of subjects is big | Cost burden is high because of private properties | Very high 2030 target |
| | Keep of Road function | Road Structures | ・Damages are expected in some bridges along main roads | High | ・Reinforcement or reconstruction | ・・Number of bridges expect to suffer damage are limited | ・High<br>・5 years |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Obstacle from building collapse to road traffic | ・Old buildings constructed along important roads.<br>・Space may remain because of width of roads in UB city<br>・There is high risk of Impassable of the Emergency cars by chronic traffic congestion. | High | ・Designation of Emergency Important roads<br>・Restriction of Illegal extension of buildings<br>Traffic control needed | ・Relocation compensation might be needed for Illegal extension relocation | High<br>10 years |
| | | | ・New airport plan is ongoing | High | | | Follow the new airport plan |
| | Strengthening of Lifeline | Electricity, Water, Heating System | ・Possibility of Supply failure is high in whole area of city<br>・No supply of water, sewage, heating system in Ger area.<br>・Apartment houses are depended on water, sewage, heating system in central area. Even risk of life should be considered in winter season. | High | ・Sequential Replacement of pipeline to Earthquake-proof pipe | ・Cost is depended the length of replacement.<br>・Cost is covered by water, sewage, and heating charge systems. | High<br>2030 target |
| | Disaster Prevention Education | Basic knowledge, Response abilities Preparedness for disasters | ・Basic knowledge earthquake awareness is not high.<br>・Autonomous activities difficult to be expected | Very high | ・Disaster education curriculum<br>・Exercise | ・Cost is low<br>・Continued implementation | Very high Continued implementation |
| | Manuals | Response abilities | ・Items are listed but practical explanation and procedure are needed | High | ・Not difficult<br>・Each division should develop own Manual | ・Low | High<br>1-2 years |
| | Strengthening Information System | Grasping damages | ・There is old system, but does not work now.<br>・Disaster Information System is developed in this spring.<br>・Equipment and system for Information Collection are needed to prepare. | Very high | ・New technology is needed to develop Camera for city view, Speaker for information ・Transmission<br>・Early warning system of Earthquake is needed to develop | Cost is large, but not huge | Very high<br>・Projects are ongoing |
| | | Disaster Medical Care | ・Disaster medical care is not developed.<br>・Support by International Red Cross and Crescent is ongoing | Very high | ・Training of Disaster Medical Experts need | Cost is not large | ・Very high<br>・Project is ongoing |
| | | Architectures | ・Emergency | High | Criteria for | low | High |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Assessment of Damaged Building is not developed | | assessment will be developed in UB city | | 1-2 years |
| | | Recovery of Life line | ・Fear of lack of Contractors for repair and recovery | High | ・Pre Cooperation Agreement | Low | High<br>1-2 years |
| Earthquake Disaster Management Plan | Target of disaster damage reduction<br>The role of government, citizens and private sectors | | ・Systematic Disaster Management Plan was started recently and system for planning and reviewing system are prepared.<br>・Target of disaster damage reduction is not written.<br>・The role of government, citizens and private sectors is not written the Stakeholder of disaster management | High | ・Depends on whether the plan is for government use only or the plan is for stakeholders such as government , citizens and private sectors | Low | High<br>Revise every year |
| Proposal | Concept and Method are shown as Guideline among high priority items | | Concept of Disaster Medical Care | Training of Disaster Medical Experts | | | |
| | | | The role of government, citizens and private sectors | The role of government, citizens and private sectors in the Earthquake Disaster Management Plan | | | |
| | | | Guideline for Urban Planning on Disaster Prevention | The guideline for planning and implement projects to promote In a planned manner | | | |
| | | | Guideline for Emergency Assessment for Damaged Buildings | The Guideline for check the safety of damaged building | | | |
| | | | Aseismic guideline for mid-and high-rise buildings to mitigate earthquake disaster | Guideline for mid-and high-rise buildings to mitigate earthquake disaster | | | |

# Chapter 7 Aseismic Guideline for Mid- and High-rise Buildings to Mitigate Earthquake Disaster

## 7.1 Present state of buildings in UB city and role of the guideline

### 7.1.1 Outline of the seismic capacity evaluation by UB city

(1) Seismic capacity evaluation by UB city

Central UB city has 24650 buildings consisting of residential buildings and official buildings, where 382000 people live their lives. Majority of the buildings in urban area was built in 1970 or earlier. Since those buildings have not been strengthened, they can be causes to increase the disaster risk in case of large earthquake.

Under this situation, establishment of seismicity estimation standard was selected as No. 55 issue in Metropolitan Peoples Representative Council on March 23rd, 2011. The objective of the standard is shown below.

In order to prevent potential earthquake disaster, "seismicity estimation standard" shall evaluate the seismic capacity of the buildings using relevant machines and equipment and shall provide certificate of capacity, for the purposes listed below,
a) to mitigate the disaster by strengthening the existing buildings,
b) to secure the safety of public facilities, residential buildings, civil structures such as roads, bridges, banks and dams, and lifeline structures,
c) to prevent natural disasters

UB city has some public and private organizations to evaluate the capacity of deteriorated buildings. Reconstruction Center and Building Quality and Safety department in Metropolitan planning agency are the examples of the organizations. Quality and Safety department conducted the evaluation for 58 buildings in 2011 and 120 ones in 2012, and is going to examine 150 ones in 2013. It is noted the evaluation is conducted with Mongolian University of Science and Technology.

The main outcomes by the evaluation in 2011-2012 are summarized as follows;

- Seismic capacity of brick masonry buildings constructed in 1970 or earlier is quite low.
- Brick masonry buildings constructed in 1971 or later need strengthening work.
- Precast concrete buildings constructed in 1965-1980 can be utilized after adequate strengthening work.
- Majority of currently constructed reinforced concrete structure possesses enough capacity.

The conclusion above can be applicable to estimate the capacity of similar buildings so that about 800 buildings will be evaluated with in 2013 and be certified.

(2) Quality of buildings

Quality assurance of construction is essential to assure the building's performance under earthquake loading.

It is pointed out that issues are deterioration of brick masonry buildings constructed in 1970 or earlier and erosion of joint of PC panel buildings constructed in 1965-1980.

On the other hand, it must be noted that adequate quality control is not conducted even for the new buildings due to the construction rush caused by rapid population growth. For quality assurance of new buildings both establishment of system and skill up of workers are needed. For the former the relevant standard is provided in Mongolia. For the latter, however, the causes listed below may prevent workers to have enough skills.

- Number of engineer is insufficient for the current construction rush.

- Experts cannot be generated due to the limited workable period.
- Budget for quality assurance is insufficient.

Moreover, some construction companies dare to build buildings with less quality to shorten the construction period and to reduce the construction cost, so that maintaining the moral as well as the technical skill-up has been the important issue.

It is noted that many non-engineered buildings have been constructed in Ger area surrounding the urban area. Especially brick masonry buildings and brick-wooden composite buildings in densely populated area may increase the casualty risk, so that the quality up-grading of buildings in Ger area is also the urgent matter.

### 7.1.2 Seismic risk estimated in this project

(1) Interpretation of result of the seismic risk assessment

Mongolian design earthquake load are based on the probabilistic seismic hazard analysis which gives the MSK intensity map for the given annual probability of exceedance. This map provides the homogeneous intensity from the probabilistic point of view, which may be the minimal earthquake load for each building.

On the other hand, ground motion used in the seismic risk assessment is the deterministically evaluated from the scenario earthquake. Ground motion intensity in each site is conditional. For example large ground motion intensities are obtained in the area near to the fault, and vice versa. Seismic risk assessment shows one occasion in earthquake disaster and its risk map cannot be used to determine the design earthquake load. However, seismic risk assessment can be used to examine the adequacy of the design earthquake load indirectly by the distribution and grade degree of building damage.

For the reasons above, it is concluded that the result of risk assessment is interpreted as a measure to examine the adequacy of current design standard.

(2) Estimated ground motion intensity in UB city

Two scenarios are employed as follows;

Scenario I : Ground motion by the rupture of Hustai fault
Scenario II : The maximum of ground motions by the rupture of Emeelt fault and that of Gunjiin Fault

It is noted that both Scenario I and Scenario II gives the similar ground motion intensity since the former is the large earthquake with long distance and the latter is the small earthquake with short distance. However it is important that in the viewpoint of building damage the former gives the more serious damage due to the larger ground motion components in the longer period range.

(3) Damage to the buildings in UB city

By seismic risk assessment it is concluded that many buildings are damages in both scenarios. Especially Scenario I gives severer damage to buildings.

### 7.1.3 Issues in seismic upgrading

(1) Seismic capacity estimation for existing buildings

UB city is now conducting the seismic capacity estimation for existing buildings. The method employed is based on the design method, and gives the MSK intensity by which the building will reach to the given limit state considering the current situation such as deterioration and modification. The estimation is conducted using the Russian software, which calculates the elastic behavior with finite element model. Input ground motion is also calculated automatically based on the given design conditions.

Current seismic design standard does not mention the behavior after yielding explicitly so that the capacity in case of the large deformation that leads to the severe damage state cannot be assured. Since the difference in ductility due to various structural types cannot be reflected, seismic capacity in case of large deformation may differ largely by structural type. Also since the existing software is current design oriented, the ground motion intensity is set discretely so that it may be difficult to obtain accurate ground motion intensity corresponding to the given limit state. Moreover this method is complicated and time consuming and may not be realistic to be applied to the all the buildings in UB city.

Therefore, in order to estimate the seismic capacity for existing buildings in UB city, the method fulfilling the conditions below is needed;

- Easy to use
- Enable to estimate the seismic capacity in case of large deformation
- Enable to reflect the difference in structural type
- Capacity is given by continuous value

(2) Selection of target buildings for upgrading and prioritization

Though some measures exist to upgrade buildings, such as strengthening, rebuilding, relocation, it is not realistic to apply measures to all the buildings from the viewpoints of cost and period. It is apparent that building with high capacity does not require any measure. Also it may be realistic that building with low operation rate and that with low importance remain as they are.

It is important to prioritize the buildings for upgrading since it is difficult to anticipate the earthquake occurrence and the measure need time to be completed.

Though UB city now provide basis to select target building based on the construction year, more effective basis considering the building's operation rate and importance will be desirable. Basis for prioritization is also needed.

(3) Selection of upgrading measure

As stated above, some measures exist for upgrading. The measure shall be selected considering the technical achievability as well as economic rationality. For example, building with extremely low capacity cannot be strengthened with available method, or can be strengthened with unacceptable cost. Also, building that cannot be relocated, as commercial buildings, has to select strengthening or rebuilding.

(4) Ground motion intensity map

Current Mongolian seismic design standard that is based on the standard of the former Soviet Union was issued in 1992. Basic concept of obtaining the earthquake load is identical in two standards, though some coefficients are different.

Ground motion intensity map referred in the capacity estimation or in the design was established in 1996. It is noted that this map was originally established in 1966. In 2006 RCAG issued the report on the ground motion intensity map based on the probabilistic approach, where the ground motion intensity was given as the one corresponding to the annual probability of exceedance of 1/475. Though this map was planned to be established in 2011 with some modification, it has not been decided when the new map will be issued, as of June 2013.

Ground motion intensity map is essential to determine the seismic capacity of building, and needs to be established with the state-of-the-art knowledge and information.

(5) Ductility regulation

Current and former seismic design standards employ the damage factor $k_1$, which reduces the design seismic load instead of accepting the plasticization of the structure. $k_1$ is 0.25 for ordinary buildings and is unity for important buildings. This shows that the elastic capacity of the important buildings is four times larger of ordinary ones, response reduction effect due to plasticization is considered for ordinary buildings, and, plasticization is not allowed for important buildings.

Namely, the difference between important buildings and ordinary ones are that ductility factor of ordinary ones reaches to 8.5 when important ones reaches to the elastic limit. It is noted that the ductility factor of 8.5 is assumed by the Newmark's formula. However, it is not mentioned if every type of ordinary buildings can maintain their capacity at such large deformation. And the behavior of important buildings after yielding is not stated.

As mentioned above, current standard expresses the importance and structural behavior by one factor, so that the effects of the difference in importance and structural type on seismic capacity in not clear. Also it is not rational to apply same factors to the structures with different structural type, such as steel structure, reinforced concrete structure, brick masonry structure, and so on. Therefore, it can be said that it is better to separate importance and structural type and to establish the factor for each structural type, in order to assign the rational seismic capacity.

(6) Required seismic capacity
As stated above, current seismic standard employs factor $k_1$ to express the difference in building importance, however, the basis of assigning the figure for the factor is not well-explained. It is important to determine how much seismic capacity shall be given to buildings considering their importance or usage.

(7) Quality management
Quality management in constructing buildings in UB is not well-conducted due to the fact that relevant engineers are not sufficient for the current construction rush. Therefore, though they are newly constructed, some buildings are of bad quality. This is also the issue in rebuilding and relocation so that it is very important to examine the policy of quality management in order to assure the efficiency of upgrading measures.

(8) Incentive to promote upgrading measures
The purpose of seismic upgrading is to prevent and/or to reduce the damage to buildings due to earthquake so that the safety of residents in or visitors to buildings can be assured. However it is considered that few people want to make the building safer by their charge since seismic upgrading does not give them monetary benefit.

In the country or region with frequent earthquakes, such as Japan or western Unites States, it has been recognized that the higher seismic capacity is the higher property value is.

On the other hand, peoples in UB city or Mongolia tends not to consider their houses as their property since they had their houses given by government in the era of socialism, so that they think that seismic upgrading shall be done by government. Lack of experiencing large earthquake promotes this tendency. UB city's budget for seismic upgrading, however, is insufficient to conduct the upgrading measures for private buildings.

Therefore, it is an important issue how to give incentive to residents to conduct seismic upgrading.

### 7.1.4 Role of the guideline
Some issues related to seismic upgrading are identified in the previous section. Among these, revision of seismic standard can be regarded as an issue in building administration. Also, the measure to the existing public buildings can be regarded as an issue in public building management administration. So this guideline treats the issues that cannot be mentioned as administrative issues. It is noted that the administrative issues identified above are stated as recommendations for future actions.

## 7.2 Establishment of required seismic capacity

### 7.2.1 Categorization of buildings

Based on the function of buildings in case of disaster, buildings are categorized as shown in Table 7.2.1.

Table 7.2.1 Categorization of buildings by usage

| Importance | Building Usage |
|---|---|
| Important Buildings | Administrative Buildings (Government Office, City Hall, Police Station)<br>Kindergarten, School, Gymnasium<br>Fire Station, Hospital |
| Ordinary Buildings | Others |

### 7.2.2 Required seismic Capacity

In the risk assessment, damage rates for several damage states, such as “slight”, “moderate”, “severe”, and “collapse”, are calculated. If damage state whose damage rate is 50% can be regarded as average damage state, average damage state for Scenario I is “collapse” and that for Scenario II is “severe”, respectively.

The concept above is applied to the important buildings and ordinary buildings. The average damage states are shown in Table 7.2.2, where average damage states for important buildings with larger design seismic load (times 1.25 and times 1.5) are also listed.

From Table 7.2.2, it can be seen that damage to important building is lighter than that to ordinary ones by half rank. Also damage to important building gets lighter by half rank if design seismic load is increased by 25%.

Table 7.2.2 Average damage state

| | Scenario I | Scenario II |
|---|---|---|
| Ordinary Building | Collapse | Severe |
| Important Building | Severe - Collapse | Moderate - Severe |
| Important Building (1.25) | Severe | Moderate |
| Important Building (1.5) | Slight - Moderate | Slight - Moderate |

Note: Figure in parenthesis shows the factor multiplied to design seismic load

Seismic performance matrix shown in Fig. 7.2.1 is derived from Table 7.2.2. Increasing design seismic load by 50% reduce the damage of important buildings considerably. It is quite important to assure the usability of base buildings in case of disaster. For that prevent not only of structural damage but also of functional disorder are highly desired. So it is concluded that important building shall be designed for the seismic load that is greater than one stated in the design standard by 50%.

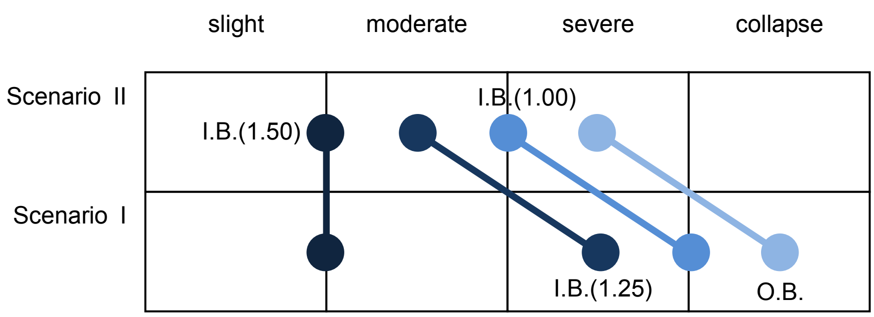



Fig. 7.2.1 Seismic performance matrix

It is also considered that seismic upgrading priority shall be given to the buildings considering their importance.

## 7.3 Seismic capacity estimation for existing buildings

### 7.3.1 Seismic capacity index

Several indices can be used to quantify the seismic capacity. Seismic capacity index shall be selected from the following viewpoints; it is a good estimator of damage state, it can be easily evaluated and it can be easily compared with required capacity.

In case that displacement or drift angle is selected, it requires complicated procedure to obtain possessing capacity though required capacity can easily be determined. Therefore those are not practical in use. Also it is difficult to determine required capacity corresponding to response spectrum, which is a good estimator of damage. Though it may not be a good damage estimator, this guideline employs MSK intensity as seismic capacity index from the reason that it is easy both to evaluate possessing capacity and to determine required capacity.

Table 7.3.1 Index to quantify seismic capacity

| Index | Definition of Index | Note |
|---|---|---|
| Intensity<br>PGA<br>PGV | Peak value of ground motion that gives specified damage | ▪ Not a good damage estimator<br>▪ Easy to estimate a seismic capacity<br>▪ Can be compared with intensity map directly |
| Response Spectrum | Response acceleration that gives specified damage | ▪ Relatively good damage estimator<br>▪ Easy to estimate a seismic capacity<br>▪ Cannot be compared with intensity map |
| Displacement<br>Drift Angle | Building response that gives specified damage | ▪ A good damage estimator<br>▪ Response analysis is needed to Easy to estimate a seismic capacity<br>▪ Cannot be compared with intensity map |

### 7.3.2 Framework of seismic capacity evaluation

(1) Basic consideration

In establishing the framework following considerations were employed.

- Compatible to the existing evaluations conducted by UB city
- Able to handle the numerous buildings
- Able to reflect the effect of inelastic behavior of buildings

Concretely, proposed is the reverse procedure of Limit Strength Method which is used to evaluated the response displacement for given ground motion (see Fig. 7.3.1)

By employing Limit Strength Method, it becomes possible to handle the numerous buildings and to consider the effect of inelastic behavior of buildings. Also by utilizing the result of capacity evaluation by UB city in constructing building model, compatibility between the two methods will be satisfied.

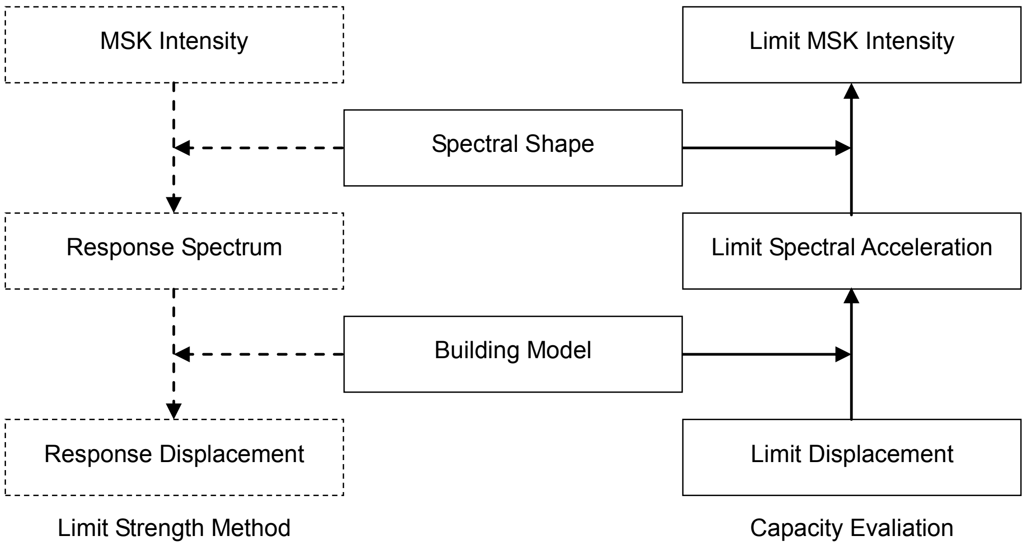



Fig. 7.3.1 Concept of capacity evaluation

(2) Calculation route

Several calculation routes can be taken considering the building size and importance in order to obtain the results for all buildings in UB city within the limited period. Following three routes are proposed to establish building model.

- Route 1: by building material and story number
  -This route does not require calculation to handle many buildings.
- Route 2: by simple calculation with design information
  -This route requires calculation procedure illustrated in this guideline.
- Route 3: by detailed calculation
  -Concrete method can be selected by estimator.

The calculation procedure for each calculation route is illustrated in the Supporting Report.

### 7.3.3 Technical transfer related to capacity evaluation

Explanation of Limit Strength Method was carried out in the activities of WG3 and in the workshop with UB city personnel. Also some spread sheets to make building model were given to counterpart.

## 7.4 Upgrading measures

There are very wide range of upgrading measure from the strengthening conductible by individual or community group to the urban development and revision of standards that require the contributions of enterprises and/or administrations. As described before, this guideline focuses the upgrading measures that are conducted in the present framework, which are the followings;

- Strengthening
- Relocation.
- Rebuilding

It is noted that other measures are summarized as recommendations.

### 7.4.1 Strengthening

In judging if strengthening is adequate or not, the following items shall duly be examined;

- It can increase the capacity of building up to the required level.
- It does not spoil the usability of building.
- It can be economically achievable.

Strengthening work shall be done with the design and construction technology available in the present

Mongol. Also it needs to be checked that the strengthening work does not spoil the performance of the building such as usability, appearance and so on.

Adequacy of the strengthening work also needs to be checked from the economical point of view, so that the following will be examined.

- Cost for the work is appropriate for the remaining value.
- Cost for the work is appropriate for the current usability rate.

### 7.4.2 Relocation

In judging if relocation is adequate or not, the following items shall duly be examined;

- Scheme of relocation is established.
- Performance of building can be maintained.
- Land for relocation is available.

As relocation scheme, the guideline refers to the scheme that is established in UB city master plan.

Performance of building can be examined by the availability of lifeline facilities such as power supply, water supply, sewage, heat supply and so on, connectivity of transportation and access to the commercial and industrial area.

It is noted that if the building loses its value by relocation as commercial building and so on, relocation cannot be the proper measure.

### 7.4.3 Rebuilding

In judging if rebuilding is adequate or not, the following items shall duly be examined;

- Scheme of rebuilding is established.
- Substitutable building is available.

As rebuilding scheme, the guideline refers to the scheme that is established in UB city master plan.

In case of rebuilding residential building, it may not be difficult to obtain the substitutable building if small inconvenience is acceptable. On the contrary, in case that building cannot be temporary relocated, building needs to be rebuild portion by portion.

## 7.5 Promotion of upgrading

### 7.5.1 Example of incentive in Japan

Since it is difficult to ask individuals to upgrade their houses/buildings by their own efforts, public incentive must be given to them in order to realize seismic upgrading. Seismic upgrading contributes not only to secure the safety of owners and users of building but also to secure the safety of citizens by preventing damage to recovery base, to evacuation routes, to emergency access and so on. Namely it is concluded that seismic upgrading can be considered as a public measures from the viewpoint of its effect on public safety.

Table 7.5.1 summarizes the measures following the “law on promotion of renovation for earthquake-resistant structures”.

Table 7.5.1 Incentives to promote seismic upgrading in Japan

| Item | Concrete Measure |
|---|---|
| Promotion of capacity evaluation | ▪ To give financial assistance to building owner who conducts capacity evaluation. Assistance rate varies by local government.<br>ex. Central Government (1/2), Local Government (1/2), Owner (0)<br>Central Government (1/3), Local Government (1/3), Owner (1/3) |
| Promotion of strengthening work | ▪ To give financial assistance to building owner who conducts strengthening. Assistance rate is as follow. |

| | |
|---|---|
| | ex. Central Government (7.6%), Local Government (7.6%), Owner (rest)<br>▪ Assistance rate will be increased if the strengthening is highly desired.<br>ex. Building along the main street needs to be upgraded to prevent blockade. |
| Loaf for strengthening work | ▪ Institutionalize of loan and lowering interest |
| Special tax measures | ▪ Income tax will be exempted based on the balance of loan for strengthening work.<br>ex. 1% of loan balance is exempted from income tax for 10 years.<br>▪ Income tax will be exempted based on the cost to conduct strengthening work.<br>ex. 10% of work cost is exempted from income tax.<br>▪ Real estate tax will be exempted<br>ex. Half of real estate tax is exempted for specified period.<br>▪ Income tax will be exempted based on the balance of loan for purchasing the second-hand house compatible to the current design standard. |

### 7.5.2 Example of urban development

(1) Examples of new development

Upgrading of existing buildings will be done by strengthening work or by new construction (relocating or rebuilding). Since many old buildings that do not possess the required capacity in UB city are facing to rebuilding, urban development renovating buildings can be the effective way.

In UB city 33,982 buildings have been newly constructed from 2004 to 2009 according to forty thousand housing construction project (2009). In this plan the following five items are conducted based on the residence supply strategy.

- New-town development
- High efficient land use in urban area
- Improvement of living environment in Ger area
- Strengthening of housing market and housing financial function
- Promotion of construction industry and material manufacturing industry

It is noted that this plan agree with the objectives in building upgrading.

(2) Examples of redevelopment based on UB master plan

In UB master plan, apartment houses are planned to be arranged utilizing the urban redevelopment business model aiming the high efficient land use in urban area. As model area, one block, east of NOMIN department store (former state department store) and south of the Ministry of Construction and Urban Development, was selected and examined (Ref. UBMPS 3rd Year Report, 2009.10).

On the other hand, Ger area also possesses the issues related to the redevelopment since the risk of building collapse and that of fire following are high in the Ger area surrounding the urban area. Therefore redevelopment of Ger area is mentioned in UB master plan.

(3) Issues

Cost of rebuilding shall be charged to residents. Though the public incentives described above are given, still the charge to residents may remain large enough to give up rebuilding. In case of redevelopment cost for the project can be obtained by selling the excess of floor area that are generated in the project (ex. 4-story building is substituted by 10-story building). Obviously, this procedure requires the excess of floor area be purchased. Therefore, there may be a risk that the excess of floor area is not purchased in the project is done at the improper area with less convenience or less accessibility. Also it must be checked if there is room in floor area ratio in the buildings to assure that enough excess of floor area is obtained.

### 7.5.3 Propose of promotion policy for upgrading

The most basic way to proceed upgrading is to provide proper design standard with new design intensity and to build the new buildings according to the standard with proper quality management. This way gives the buildings with required seismic capacity.

Existing buildings, however, remain as they are. Also importance buildings, such as headquarter buildings, hospitals, schools and so on, may need to be upgraded to be more reliable in case of earthquake disaster, even if they have enough capacity assigned by current standard.

This section proposes the policy to promote to conduct measures from the financial point of view.

(1) Establishment of system for public assistance
Since building upgrading leads to the assurance of safety of UB citizens, provision of public assistance to promote upgrading can be considered as an administrative task. Therefore administrative office is requested to understand the necessity of upgrading, to decide to promote as policy, and to prepare budget to carry out upgrading.

(2) Incentive for upgrading public buildings
In case of promoting upgrading of public building, it is more important to show the basis that responsibility of upgrading to assure the safety is given to the Mongol or UB city than to establish promotion policy such as financial aid. For that purpose, it is required to clarify that the building of concern needs to maintain its function. Following are the reasons that the public building shall be upgraded.

- In case fire stations are damaged, the fire engines or other vehicles cannot be dispatched.
- In case hospitals are damaged, necessary treatment for victims cannot be carried out.
- In case school buildings are damaged, they cannot be used as temporary refuges.

(3) Incentive for upgrading private buildings possessing public role in case of disaster
As same as public building, some private ones need to be upgraded if they have public roles, so that the effort to convince building owners to conduct upgrading. However financial support is highly required since buildings are privately owned. Listed below are the policies of financial supports.

a) Incentive for capacity assessment
Capacity assessment is the first step to proceed upgrading. Some assessment method are conducted by building owner by themselves with no charge, some are by experts with relevant fee.

So public financial support system needs to be established by which entire or partial cost for capacity assessment will be covered. The charge rate will be optional.

b) Incentive for strengthening
As for capacity assessment, financial assist for capacity strengthening is important to proceed upgrading. Since the cost for capacity strengthening is high, the maximum financial assist rate shall be duly determined. The financial assist rate may be increased in case of strengthening important buildings by the political treatment.

Both capacity assessment and strengthening require budgetary provision to conduct public support, so that it is necessary to anticipate annual number of supports. In case cost of support activity reaches the budgetary limit, the rest will be done in the next fiscal year.

c) Loan system for strengthening
Loan system will be established in the public organization so that loan with lower rate than standard rate will be available in case of fundraising for strengthening work.

d) Tax benefit
Table 7.5.2 proposes the feasible tax benefits.

Table 7.5.2 Feasible tax benefit

| Item | Concrete Measure |
|---|---|
| Exemption from income tax | ▪ Income tax will be exempted based on the balance of loan for strengthening work.<br>ex. 1% of loan balance is exempted from income tax for 10 years.<br>▪ Income tax will be exempted based on the cost to conduct strengthening work.<br>ex. 10% of work cost is exempted from income tax.<br>▪ Income tax will be exempted based on the balance of loan for purchasing the second-hand house compatible to the current design standard. |
| Exemption from real estate tax | ▪ Real estate tax will be exempted<br>ex. Half of real estate tax is exempted for specified period. |

e) Reduction in insurance premium rate
In Mongolia nonlife insurance covers the loss due to the damage by earthquake. Reduction in premium for the upgraded building is rational and attractive for insurance companies in the aspect of production development, since earthquake risk is decreased for such building.

Administrative office should require insurance companies consider the feasibility of reduction in premium.

## 7.6 Establishment of “Aseismic Guideline for Mid- and High-rise Buildings to Mitigate Earthquake Disaster”

The guideline has been established by the collaboration of project team and counterpart. Concretely, situation of existing buildings and capacity evaluation conducted in UB city were described by counterpart. On the contrary, project team described result of risk assessment, illustration of Limit Strength Method, and upgrading measures in Japan. Both parties contributed in categorization of building and determination of importance factors.

Table 7.6.1 shows the contents of draft guideline.

Table 7.6.1 Draft contents of the guideline

| Chapter | Section | Paragraph |
|---|---|---|
| 1 Preface | 1.1 Target buildings | |
| | 1.2 Contents of the guideline | |
| 2 Current issues in UB city | 2.1 Situation of buildings in UB city | 2.1.1 Overview of buildings in UB city |
| | | 2.1.2 Earthquake risk assessment |
| | 2.2 Issues in seismic upgrading | 2.2.1 Issues in existing buildings |
| | | 2.2.2 Issues in aseismic design |
| | | 2.2.3 Issues in upgrading measures |
| | 1.3 Correspondence for the issues in the guideline | 2.3.1 Selection of target buildings |
| | | 2.3.2 Items reflected in the guideline |
| 3 Target seismic performance level of buildings | 3.1 Concept to determine target seismic performance level | |
| | 3.2 Determination of target seismic performance level | 3.2.1 Categorization of buildings |
| | | 3.2.2 Target seismic performance level |
| 4 Seismic capacity evaluation of existing buildings | 4.1 Outline of the evaluation | 4.1.1 Index of capacity |
| | | 4.1.2 Outline of the evaluation |
| | 4.2 Modeling of buildings | 4.2.1 Establishment of elastic limit by simplified method |
| | | 4.2.2 Establishment of elastic limit by semi-simplified method |
| | | 4.2.3 Establishment of elastic limit by detailed method |
| | | 4.2.4 Establishment of skeleton curve |

| | | |
|---|---|---|
| | 4.3 Seismic capacity evaluation method | 4.3.1 Flowchart of seismic capacity evaluation |
| | | 4.3.1 Concrete procedure of seismic capacity evaluation |
| 5 Upgrading | 5.1 Selection of buildings to be upgraded | 5.1.1 Important notice in selection of buildings to be upgraded |
| | 5.2 Strengthening | 5.2.1 Measures of strengthening |
| | | 5.2.1 Important notice in strengthening |
| | 5.3 Relocation and rebuilding | 5.3.1 Important notice in relocation and rebuilding |
| 6 Promotion of upgrading | 6.1 Incentives to promote upgrading | 6.1.1 Necessity of incentives to promote upgrading |
| | | 6.1.2 Example of incentives for upgrading in Japan |
| | 6.2 Examples of plans for new-developed and developed area | 6.2.1 Example of urban develop plan in UB city according to UB master plan |
| | | 6.2.2 Issues in urban development aiming seismic upgrading |
| | 6.3Proposal of promotion of upgrading | 6.3.1 Establishment of public support system |
| | | 6.3.2 Incentive of upgrading for public buildings |
| | | 6.3.3 Incentive of upgrading for buildings with public function |
| 7 Proposal | 7.1 Newly constructed buildings in urban area | |
| | 7.2 Existing buildings in urban area | |

# Chapter 8 Environmental and Social Consideration

## 8.1 Disaster Scenario Disposal of Rubble

(1) Waste Disposal System of UB

- Public corporation of UB City operates 4 municipal waste disposal plant. Collection and transportation of waste is conducted by private corporations of each district.
- All the waste excluding hazardous waste is landfilled without separating flammables and nonflammables. Construction waste is also treated as general waste.
- Most of the waste in UB City is landfilled at Narangiin Enger Disposal Site which was granted by the Japanese Government and started its operation in 2009.. The plant is located 10km northwest of urban area having design capacity of approximately 27.8 ha or 272ｍ3 and life of 11 years.
- Since the landfills are not soil-covered, fire often breaks out and strong wind scatters waste.
- Illegal dumping is common especially in Ger area and arise environmental issues.
- There are waste-pickers who pick up valuables in the landfills.

(2) Issues on Disposal of Rubbles after Earthquake

As shown in Table 8.1.1, the estimated volume of rubbles due to Scenario I Earthquake is 12.14 million m3. Dominant source of the rubbles are structures built of stone-masonry, reinforced concrete and bricks. 2.43 million 10ton-dumptrucks are required to transport the total rubbles.

Table 8.1.1 Estimated Volume of Rubbles due to Scenario I Earthquake

| | District | Volume of Rubbles(m3) |
|---|---|---|
| 1 | Bayanzurh | 2,703,075 |
| 2 | Songinohairhan | 2,575,282 |
| 3 | Bayangol | 2,389,881 |
| 4 | Hun Uur | 1,753,198 |
| 5 | Chingeltei | 1,468,810 |
| 6 | Suhbaatar | 1,256,678 |
| 7 | Nalaih | 981 |
| | Bayangol | - |
| | Bayanzurkh | - |
| | Total | 12,147,904 |

While prompt and systematic disposal of large amount of rubbles will be required, the following issues are thought to emerge.

- Since waste disposal is conducted by private corporations, removal of rubbles and regular waste collection will not work effectively.
- Residents will disorderly start moving rubbles to vacant lot or river area without permission.
- It is assumed that some rubbles be urgently landfilled at Narangiin Enger Disposal Site, however, additional plant will be needed since the total volume of the rubbles is much larger than its capacity.
- Hazardous substance will cause health problems of workers and nearby residents.

(3) Proactive Measures and Program for Restoration/recovery Period

Taking the above into consideration, the following measures should be taken.

- In addition to the prior conclusion of cooperation agreement with private waste disposer, UB City should assign roles of organizations concerned such as Road Bureau in advance. UB City should also conclude cooperation agreement on regional rubble disposal with each district as well as surrounding cities.

- Temporary rubble storage site should be selected in advance and will be informed through the media/cellphone properly during restoration period. Observation of illegal damping will be also necessary.
- Prior selection of candidate site for landfill of rubbles should be done considering restriction of possible waste, method, impact to surrounding such as fire, offensive odors, soil pollution, groundwater pollution, scattering, noise and vibration to transportation road and involuntary resettlement. Obtaining prior consent of neighboring residents is necessary.
- Sprinkling watering to temporary rubble storage site is required for anti-scattering of hazardous substance of rubbles. UB City should provide masks to workers and neighboring residents to prevent health problem.
- Recycling wood materials, rebards and others will be done by utilizing waste-pickers systematically in order for reuse of rubbles.

## 8.2 Human-waste Treatment

(1) Current Situation of Human-waste
Sewage in UB City is treated in one treatment plant, i.e. Central Sewage Treatment Plant, and discharged to Tull River. In Ger area, untreated domestic wastewater is discharged to soil and people use simple pit latrine.

(2) Issues of Human-waste Treatment after Earthquake
It is thought that large number of apartment buildings will collapse and water and sewerage system will not function properly. This would disable the uses of most toilets in the affected apartment area. Evacuated people and residents of undamaged area are supposed to use toilets nearby ger area or install simple pit latrine in yard to use. Envisaged issue would be difficulties in excavating ground due to frozen top soil in winter. In summer, residual urine in the damaged apartments would cause serious offensive odor as well as health problem.

(3) Possible Measures
- UB City should in advance grasp the number of potential portable toilets which normally are used for event and conclude corporative agreement with other owners. UB City also promotes utilization of practice bags as portable toilet.
- Urgent public toilet can be provided by installing stilt toilet above riverbed to directory discharge to river flows or drop urine to sewerage manholes and such.
- Establishment of mutual-aid based favorable community is necessary in borrowing toilets in ger area.

## 8.3 Dangerous Facilities and Hazardous Substance Disposal

(1) Current Situation
- Major dangerous facilities in UB City are thermal power stations, chemical factories, metal processing factories, leather factories, gas stations and so others.
- There is no integrated facility to dispose hazardous substance. No waste disposal plant in UB City accepts hazardous substance. Despite that designated hazardous substances are to be properly disposed based entrepreneur-pays-principle, illegal disposal of hazardous industrial and medical waste is found commonly.

(2) Concerns during Earthquake Disaster
- Due to insufficient seismicity of dangerous facilities, there is fear that fire and environmental pollution caused by leakage of hazardous substance.
- Post earthquake confusion would complicate issues on hazardous waste disposal, i.e. dumping into illegal area, temporal rubble storage area and waste disposal plant.

(3) Necessary Measures

- Establishment of rules stipulating dangerous facilities to possess certain level of seismicity as well as mandatory daily/regular inspection is required in order to minimize pollution of surrounding soil and groundwater. It is also necessary to maintain soundness of storage tanks of gas station close to ger area to avoid occurrence of fire and fire spreading.
- It is needed to ensure emitter's proper disposal and strict controls on illegal disposal/dumping.

## 8.4 Asbestos Issue

(1) Usage of Asbestos and Related Laws

- As asbestos is easily obtainable in Mongolia, people's awareness to its risk seems low.
- Asbestos is used as heat insulating materials in blast furnance at thermal power stations, heating hot water pipelines and others.
- In general houses, asbestos is used as sealing materials of window flame against cold. Some families put asbestos plate on stoves for heat insulation.
- While Mongolia had no restrictive law on asbestos until July 2010 when the Government issued order number 192 to restrict use of asbestos, it was canceled in the following year, June 2010.

(2) Issues after Earthquake

- Inproper usage of asbestos contained in rubbles would put people at risk of inhaling powder dust.
- It is concerned that affected residents would make inproper use of asbestos when they lose their home due to collation of apartment buildings and relocate to gers or construct temporary housings.

(3) Countermeasures

- UB City should provide education to residents on awareness of the risk of asbestos, appropriate usage of asbestos exposed by demolition of housings and strong possibility of health hazard to be occurred due to deteriorated/damaged asbestos used for building materials.
- When disposing rubbles, assuming that rubbles contain asbestos, water sprinkling and use of masks are necessary.

## 8.5 Issues on Resettlement in Recovery Stage

(1) Anticipated Resettlement

UB City would encounter to plan resettlement of residents in order to:

- Implement antiearthquake urban planning such as road-expansion program,
- Execution of restriction of inhabitable area and improvement plan of ger area in order for accomplishment of recovery program.
- Enforce evacuation from partially-collapsed housings/apartments.
- Avoid significant adverse environmental impact due to hazoudaous substance leaked from surrounding facilities.
- Regulate disorder expansion of ger area due to relocation of homeless sufferers.

(2) Considerations in Resettlement Program

When involuntary resettlement is necessary due to above situation, UB City should implement the program taking consideration of the following items.

- Ensuring proper information disclosure on resettlement program to residents.
- Sufficient consultation with stakeholders such as affected residents and communities.
- Execution of prior survey and study corresponding to the items in Table 8.5.1 complying with laws and regulations of Mongolia and UB City.

Table 8.5.1 Items to be considered in survey and study for resettlement program

| | | | |
|---|---|---|---|
| (1) | Air pollution | (14) | Involuntary resettlement |
| (2) | Water pollution | (15) | Local economies, such as employment, livelihood, etc. |
| (3) | Soil pollution | (16) | Land use and utilization of local resources |
| (4) | Waste | (17) | Social institutions such as social infrastructure and local decision-making institutions |
| (5) | Noise and vibrations | (18) | Existing social infrastructures and services |
| (6) | Ground subsidence | (19) | Poor, indigenous, or ethnic people |
| (7) | Offensive odors | (20) | Misdistribution of benefits and damages |
| (8) | Geographical features | (21) | Local conflicts of interest |
| (9) | Bottom sediment | (22) | Gender |
| (10) | Biota and ecosystems | (23) | Children's rights |
| (11) | Water usage | (24) | Cultural heritage |
| (12) | Accidents | (25) | Infectious diseases such as HIV/AIDS |
| (13) | Global warming | | |

Source: JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS, April 2010

[List of References]

- Basic design study report on the project for improvement of waste management in Ulaanbaatar City, JICA, 2007.5
- Preparatory survey report on the Ulaanbaatar water supply development project in Gachuurt in Mongolia, JICA, 2010.3
- Strengthening the capacity for solid waste management in Ulaanbaatar city final report, JICA, 2012.9
- JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS, April 2010

# Chapter 9 Disaster Education and Capacity Development

In the Project, following capacity development activities were conducted, and materials and programs used in those activities are arranged for future capacity development in Mongolia. In formulating capacity development plan, keep in mind for further additional components of knowledge and techniques after the project.

## 9.1 Capacity Development of the training course in Japan

As part of supporting capacity building of relevant organizations, training for persons involved in the Project to be conducted in Japan was conducted. The objective of the training course in Japan is that trainees obtain understandings for Japanese seismic disaster management so that smooth implementation of the Project will be achieved. Also it is paid attention that the techniques and knowledge are utilized in the Project, therefore all participants should be selected from WG members of this project or direct staffs of WG members.

Furthermore, implementation period of the training course was set that the trainees can attend the relevant events including the Great Hanshin-Awaji earthquake memorial event to be held on January 17, and also visit Hokkaido to learn seismic disaster management during midwinter. The detail plan was not decided by only WG4 in charge of disaster education, so that the letter of intent and draft schedule are distributed to all WG member, then the training contents was fixed.
The implementation period of training, field, contents, and organization in charge is as follows.

Table 9.1.1 Training course in Japan

| Organization | Field | Contents |
|---|---|---|
| ADRC | Administration in Disaster Management | Law and policy related to earthquake<br>Disaster management<br>Cooperation of government, community and citizens |
| NHK | Earthquake Bulletin<br>Disaster Awareness | Lecture of earthquake bulletin and development of disaster educational programs |
| Disaster Reduction and Human Renovation Center | Cultures in disaster management | Visit to the facility transmitting the Kobe earthquake disaster |
| Disaster reduction exhibition by Kyoto city | Education regarding Disaster reduction | Visit to the facility where emergency drill is held |
| Asahikawa City | Education regarding Disaster reduction | Disaster reduction activity in the cold area<br>Measures for heavy snow and cold wave<br>Experience of staying refuge in winter |
| Northern Regional Building Research Institute | Disaster management planning | Lecture of disaster management plan and challenges in the cold area |
| Takenaka | Building code of quakeproof | Lecture of seismic isolation/resistant building, and visit existing case |
| Hakusan | Personal Earthquake Simulator | Experience-based lecture of portable and personal earthquake simulator |
| TOA | Disaster Information Distribution | Visit the latest model of disaster information distribution system |
| Hanshin Expressway | Road and bridges | Visit earthquake library of road and bridge. |
| Plus-arts | Emergency Drill | Emergency Drill for children |
| Fire Dept. in Kobe City | Emergency Drill | Emergency Drill for medical welfare community |

Source: JICA project team

Table 9.1.2 Schedule of Training Course in Japan

| Date | Fields | Contents |
|---|---|---|
| 2013/1/15, Tue | Arrival | |
| 2013/1/16, Wed | AM JICA Kansai<br>13:00-15:00 ADRC<br>15:30-17:00 Hanshin Expressway | Orientation<br>Disaster Countermeasures of Japan<br>Damage of Road and Bridge |
| 2013/1/17. Thu | 10:00-12:30 Memorial walk<br>15:30-17:00 E-Defense | Transfer earthquake experiences<br>3 dimensional shaking table |
| 2013/1/18, Fri | 10:00-12:00 NHK<br>14:00-16:00 Plus Arts | Disaster news, earthquake bulletin<br>Pre-lecture of Kaeru Caravan |
| 2013/1/19, Sat | 10:10-12:00 Disaster Reduction and Human Renovation Center | Taking over experiences and technologies |
| 2013/1/20, Sun | AM Fire Dept. in Kobe City<br>PM Kobe -> Asahikawa | Emergency Drill for medical welfare community |
| 2013/1/21, Mon | AM Asahikawa City<br>PM Disaster relation places | Disaster Countermeasure at Municipality Level |
| 2013/1/22, Tue | ALL Northern Regional Building Research Institute | Disaster management plan and challenges in the cold area |
| 2013/1/23, Wed | Asahikawa -> Kobe | |
| 2013/1/24. Thu | 10:00-12:00 Takenaka<br>13:30-15:00 Takenaka<br>16:00-17:30 Hakusan | Lecture of seismic isolation/resistant building, visiting existing building<br>Portable Earthquake Simulator |
| 2013/1/25, Fri | AM Making Action plan report<br>PM TOA | New technology for disaster information distribution |
| 2013/1/26, Sat | 09:40-11:10 Kyoto City Disaster Prevention Center<br>12:30-14:00 Traditional housing<br>14:30-15:30 Kinkakuji Temple | DRR learning facilities for citizens<br><br>DRR for cultural and historical heritage |
| 2013/1/27, Sun | 13:00-16:00 Plus Arts | Kaeru Caravan, new type Disaster Drill |
| 2013/1/28, Mon | AM Presentation of action plan<br>PM Evaluation and Closing | |
| 2013/1/29,Tue | Return | |

Source: JICA project team

The training course in Japan planed at 9.1 was conducted on Jan. 2013. Members are basically selected from WG members (see Table 9.1.3). Since the general election on Jun. 2012, most of members who had participated the training course in Japan on Feb. 2012, left or retired, JICA and the project team asked to nominate new Mayer, Deputy Mayer, and Chief of NEMA as trainee of the training course in Japan. However, their schedule couldn’t be arranged with training period, therefore their represents participated.

Table 9.1.3 Members of the Training in Japan

| No. | Name | Organization | Position | Reference |
|---|---|---|---|---|
| 1 | Togtuun ERDENETUYA **(Cancelled)** | Construction, Urban development and Planning Agency of UB | General engineer | Leader of WG1 |
| 2 | Mijid SUKHBAATAR | Disaster management department, NEMA | Head of Infrastructure and earthquake risk reduction unit | Advisor of WG2 and 4 |
| 3 | Medekhgui NYAM-OCHIR | Metropolitan Specialized Inspection Agency of UB | Deputy Head | Member of WG3 |
| 4 | Chantsal NAMSRAIJAV | EMDC | Vice principle | Leader of WG4 |
| 5 | Bakhit ARDABYEK | Construction, Urban development and planning agency of UB | Specialist, Quality and safety division | Member of WG1<br>In charge of earthquake risk in master plan of UB |
| 6 | Dandar TULGA | Construction, Urban development and planning agency of UB | Senior Specialist, Quality and safety division | Member of WG3 |
| 7 | Minjuurdorj BATSAIKHAN | Land Agency of UB | Chief | Advisor of WG2 (on behalf of deputy Mayer) |

| | | | | |
|---|---|---|---|---|
| | **(Cancelled)** | | | |
| 8 | Demberelsuren BAYASGALAN | Road department of UB | Deputy chairman | On behalf of chairman (WG1) |
| 9 | Tserenpil BATSAIKHAN | RCAG | Head of research and development laboratory, Seismological department | Supporter of mapping team of the project |
| 10 | Tsedendamba OTGONBAGANA | Education department of UB | Director general | Drill and educational program (WG4) |
| 11 | Tsegeedei TURMANDAKH | EMDC | Head of rescue team | Plan, Education, Drill, Campaign (WG4) |
| | Total 11 persons | | | |

Source: JICA project team

According to the structure of WGs, four groups made presentations as of the results of the training course on 28th January, the last day of training in Japan.
Each group has expressed to utilize the contents of this training course for further WG activities and UB City Disaster Prevention plan.

## 9.2 Capacity Development throughout WG activities

In this project, 4 WG are activated. Each WG has held study meetings for capacity development not only for WG member but also other persons who has interested in the special knowledge and techniques.

The study meetings of earthquake hazard, building risk evaluation, road and bridge risk evaluation, lifeline risk evaluation, fire risk, earthquake disaster management plan, disaster education have been held.

Table 9.2.1 Study Meetings

| Date | Title | Contents |
|---|---|---|
| 2012/10/25, Thu | Earthquake hazard | Targeted active faults and hazard estimation method |
| 2012/11/02, Fri | Disaster Education | Disaster education system in Japan |
| 2012/11/08, Thu | road and bridge risk evaluation, lifeline risk evaluation | Each risk evaluation method |
| 2012/11/15, Thu | Building Risk Evaluation | History and philosophy of aseismic design in Japan, risk evaluation method of building |
| 2012/11/29, Wed | Fire Risk | Methods of fire risk and fire spread prediction |
| 2012/12/11, Tue | Earthquake Disaster Management Plan | Exchange of opinions for earthquake disaster issues of UB city |

Source: JICA project team

## 9.3 Study Meeting for EMDC staffs

Furthermore, according to the agreement with the EMDC general affairs director, the new study meetings of earthquake risk and measures for EMDC staffs were held in 2013. The objective, period, content are as follows;

１． Objective

It is expected the big earthquake will occur, and UB city will be damaged. The capacities against earthquake disaster in personnel and organization level shall be enhanced by preparation in advance against the earthquake, with learning earthquake mechanism, expected damages, and impacts

２． Period and expected dates

(1) 4th April, Tuesday
(2) 11nd April, Tuesday

(3) 21th May, Tuesday

３． Expected Contents

（１） What is Earthquake?

- Mechanism of earthquake
- World historical earthquake records and damages
- Historical earthquake records in Mongolia

（２） What kinds of damage are expected?

- Expected earthquake to occur at UB city
- Expected property damages (Building, Fire, Road and Bridge, Lifeline)

（３） Effects on daily life

- Scenario from occurring earthquake, response, and rehabilitation
- Daily life as evacuee
- Disaster medical care
- Traffic system
- Economic growth

４． In order to ensure the sustainability of outcomes

- To award a certificate to those who attended all lecture.
- Taking video of lectures, then utilize for e-education for other staffs in remote places and new staffs.

## 9.4 Technology transfer of public awareness activity on DRR

By the president order, the efforts of earthquake disaster response have been strengthened in nationwide from 2010. NEMA and EMDC conduct evacuation drills regularly (last week of March (28 March 2013), international day for DRR (12 October 2012)). Also EMDC conducts evacuation drill and response training at school in cooperation with Red Cross and Educational sector of UB city.

On the other hand, present activity mainly focuses disaster response such as evacuation drill, rescure,first aid, fire fighting so far, and basic knowledge of earthquake and preparation activities are not enough conducted due to lack of instructors' knowledge and experiences, and lack of materials. Furthermore, most of UB citizens have never experienced massive earthquake with damage in past, therefore they couldn't participate activities with concrete image of earthquake risk and the situation after earthquake.

### 9.4.1 Capacity Building throughout Public Awareness WS

The Project planned to conduct public awareness activity via WG4 activity. At first, the public awareness WS on earthquake DRR was held on 21-22 September 2012 with disaster related organizations (government, educational sector, mass media, NGO, international organizations, etc.). At the WS, following three kinds of activities in Fig 9.4.1 were done.

| | |
|---|---|
| To catch up earthquake damage throughout pictures and videos of past earthquake in Japan and Armenia | To try ro image what will be happened in case of earthquake in UB city ("Meguromaki") |
| To try to examine what actions will be taken in chronological order if the earthquake occurs. (“Namazu no Gakko”) | To learn and discuss for what kinds of preparation is needed. (Emergency kit, Fixing Furniture, Aseismic Reinforcement) |
| To learn public awareness activities on DRR in Japan (From various good practices) | To discuss about knowledge and techniques what UB residents should have for reduce earthquake damages. |

Fig 9.4.1 Activities of Public Awareness WS

Furthermore, a meeting for discussing on the implementation of the Campaign was conducted on 10 December 2012. As a result of discussion, date, venue, programs to be implemented in the Campaign was proposed.

### 9.4.2 Promotion of understanding of public awareness activities on DRR by Japan training

Training course in Japan on 16-28 January 2013 is conducted, trainees visited various DRR educational activities in Japan, they deepened the understanding.


Fig 9.4.2 Participation to Training Course in Japan

In February to March 2013, each person in charge of activity of the campaign planed detail and prepared based on the brief campaign plan. Also the leaflet for DRR, created by NEMA, is revised based on discussion between EMDC and JICA project team.


Fig 9.4.3 Leaflet for DRR

### 9.4.3 Implementation of the Public Awareness Campaign on Seismic Disaster Risk Reduction

The campaign was eventually conducted on 29-30 May 2013 at "Victory Square" in Ulaanbaatar for Ulaanbaatar citizens, Officials involved in DRM. Organizers are EMDC, UB city, and JICA Project Team. Co-organizers are Mongolia Red Cross, Mongolian Academy of Sciences, UB City Health Department, UB City Education Department, and National Audit Office. And cooperative organizations are Nomin HD Co., Mongolia Insurance Company, and Utilis.Sas (Open Mongolia).
The four kinds of programs, i.e., “Competition”, “Experience”, “Exhibition”, and “Seminar” were conducted in the Campaign.

Preliminary round was conducted in each of the 4 target districts, Sukhbaatar district, Bayangoru district, Chingeltei district, and Songinohairhan district. Then, one school selected from each district participated in the final round on 29 May. Four programs; Bucket brigade, jack-up rescue race, blanket stretcher transportation competition and memory competition of emergency bag goods are conducted.


Fig 9.4.4 Bucket brigade

The campaign provided the various experience programs, such as "shaking table" experimentally developed by the EMDC for the campaign, firefighting training used water extinguisher, making paper dishes, dice games, vibration education teaching material "Paper Bururu", leaning of furniture fall prevention, first aid practice in case of emergency including artificial respiration, and rope works to help in the event of a disaster. The developed "shaking table" needs further improvement for simulating the real earthquake shake, however, helped to generate participants’ interest in earthquake shake.

Furthermore, as one of the experience programs, self-propelled earthquake simulator, "Jishin The Vuton" was brought from Japan and provided opportunity for experiencing ground motion with simulation video in accordance with the earthquake data recorded in the past. In total, 290 people (178 males, 112 females) experienced the simulator. Some of them felt scary wondering “what we can do if we have this kind of shakes?” or expressed the needs for the improvement of measures for earthquake with the comments like “the current buildings in UB city are not seismic resistant. More experiments of the buildings for earthquake resistance and development of guideline for safe building are required.

Fig 9.4.5 EMDC Shaking Table and Japanese "Jishin The Vuton"

As the exhibition program, emergency items and equipment are introduced. They included emergency response first aid set, first aid supplies, sample disaster prevention goods in Japan, survival food, emergency food, emergency response vehicles, search and rescue equipment, and various fire extinguishers. Also pull-tab canned beef and dried meat, unique emergency food in Mongolia which was discussed in the preparatory meetings were introduced. In JICA Project team booth, many people interested in portable radio with hand-cranked power generator and windup LED light as disaster prevention goods of Japan.

Besides, in the exhibition booths in EMDC, Mongolian Academy of Sciences, Education Department and JICA Project team, introduction of their DRR activities and/or explanation of the earthquake and possible damages in UB city were provided. In the booth of Mongolian Academy of Sciences, technical explanation of the earthquake with the exhibition of the observation equipment was provided. Not only the general public but also the staff members of the organizations involved in the campaign could enhance their knowledge on earthquake by the explanation.


Fig 9.4.6 Emergency kit and Survival Food

Further, the picture and essay contest on earthquake disaster risk reduction was conducted along with the campaign activities for getting more participation and involvement in the event. The awarded pictures (refer to the table) were exhibited at the venue. Also awarded ceremony was conducted for the prize winners for the picture and the essay contest at the closing ceremony.


Fig 9.4.7 Awarded Pictures of the Picture Contest

As one of the campaign activities, a seminar for seismic disaster risk reduction was conducted aiming at enhancing DRR knowledge and sharing outcomes of the Project. Also, it was considered the implementation of seminar could help getting more participants of the campaign. The target participants of the seminar were the school teachers and district officers in charge of disaster risk management and total 300 persons were attended.

In the seminar, a lecture on the technical knowledge of the earthquake was provided by a representative from Mongolian Academy of Science at the beginning. Then, lectures on the estimated earthquake damage in UB city and impact to the life of the people were made by the project team members based on the outcomes of the Project activities.

From 11:00 a.m. on 31 May 2013, the next day of the Campaign, a review meeting of the Campaign was conducted among 40 representatives of the implementing organizations and agencies including of WG 4 members. The following comments were expressed on the pros and cons and recommendation for future improvement.

- To update the awareness program in the context of the actual situation of Mongolia based on this experience and conduct it on a regular basis
- To utilize the video recorded the event activities for further expanding of the event nation wide
- To report the result of the event activities to the UB City for further understanding of the high officials of the UB city and getting more budget allocation for conducting this kind of events
- To take advantage of the organizations' network that has strengthened in this activity, and promote disaster awareness activities
- To make effective use of the awarded pictures in the contest such as using them in posters and calendars of EMDC
- To introduce the selected essays in the government radio program
- To utilize the posters developed by JICA project team for the campaign event in their own activity (Mongolian Red Cross)
- To improve the "shaking table" for simulating real earthquake shake and enhancing safety, and then use it in the activities in the regions

# Chapter 10 Proposal for Earthquake Disaster Management

## 10.1 Disaster reduction related Laws, System and organizations

### 10.1.1 The state and subjects of Laws, System and organizations

Disaster reduction related Laws, System and organizations of Mongolia are shown in Figure 10.1.1. The Disaster Prevention Standing Committee is under the National Security Council which members are only President of Mongolia, Prime Minister of Mongolia and Chairman of Parliament. National Emergency Management Agency (NEMA) in national level and Emergency Management Agency of Capital (EMDC) in UB city are established as the implementation organization respectively the role of disaster related policy in each organization is decided. The Disaster Prevention Standing Committee is in the Cabinet which chairman is the 1st vice minister and other members are from related ministries and organizations. The secretariat of the committee is in National Emergency Management Agency (NEMA). This committee is corresponding to National Disaster Prevention Committee in Japan. Red Cross, Mass media and people of experience or academic standing are not included in the Committee in comparison of Japanese case. Also there are no sub committees to survey specific topics.

National Emergency Management Authority which National Defense Committee, Fire Agency and National Storage Agency were unified was established according National Resolution No 1. (Issued on 7th of January, 2002). In local governments (21 prefectures and UB city).

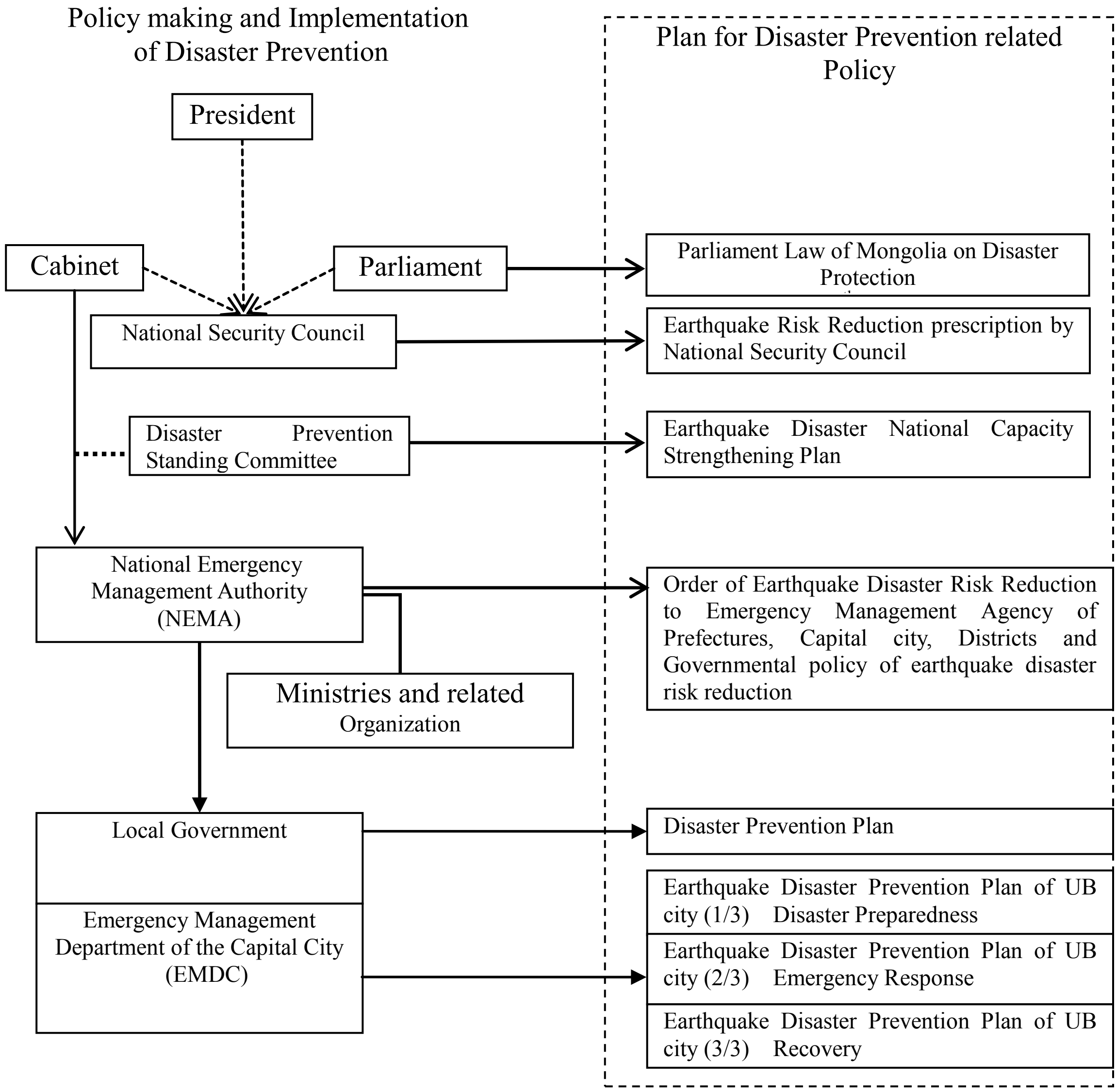



Figure10.1.1 Disaster reduction related Laws, System and organizations of Mongolia

Basic law related earthquake disaster countermeasures is "Parliament Law of Mongolia on Disaster Protection" issued on 20th of June 2001. Disaster. As the date of issued indicates, Disaster related law and organizations has become in present system in more less 10 years, it is the period to keep and enrich present system.

10.1.2 Proposal for Disaster reduction related Laws, System and organizations

The cooperation of Mass Media, Red Cross, Academia Society and also Economic are necessary in national level disaster management. In this view point, these representative from respective society become member of the Disaster Prevention Standing Committee. Also it is recommended that sub committees to make advice disaster policy making under the Disaster Prevention Standing Committee such as "Earthquake Disaster Research Council" or "Academic Research Sub Committee". Member of the Council or Sub Committee, not only seismologist but also experts from Geology, Civil Engineering , Architecture, Mechanical Engineering in Engineering field, Sociology, Economics, Law in field of Arts, Disaster Medical and Education are recommended to participate to cover the fields which may suffer earthquake damage to promote holistic countermeasures in disaster management.

## 10.2 Earthquake Disaster Management Plan in Local Level

### 10.2.1 Subjects of Earthquake Disaster Management Plan in Local Level

UB city is the capital and top of local governments in Mongolia. Citizens and Private Sectors are also stake holder of disaster management of UB city. Earthquake Disaster Management Plan is not only how to response to the disaster after its occurrence but also how to reduce the estimated damage may occur in future and to establish the cooperative system with who concerned. Standing in this view, it is important to describe the role of stake holders in the plan. This point is added in 2013 revised plan referring the imput from JICA project.

As process of reviewing the plan, EMDC coordinates as secretariat and related sections of UB city government prepare the draft of the plan. Final plan consists of 27 separate chapters.

The schedule and priority of implementation of issues contain in the plan is not written until the plan of 2012. In 2013 revised the schedule has the list of targeted period with short time and longtime range.

### 10.2.2 Proposal for Earthquake Disaster Management Plan

- It is necessary to show the target of damage reduction. It becomes the common object to be reached among the stakeholders and it makes the direction of disaster reduction.
- It is desirable to describe as government, residents and private sectors are the stakeholders and they shoulder their responsibility implement for target of disaster reduction.
- It is necessary that representative of citizens and private sectors to the process of reviewing the plan as the stakeholders of disaster management of UB city.
- It is strongly recommended that to open the plan for public to have common understanding to implement the issues indicated in the plan.
- It is necessary to examine the schedule and priority of implementation of the plan. By showing the schedule and priority, it becomes understanding of stakeholders.
- It is also needed the checking procedures of progress of the plan.

## 10.3 Financial actions, enactment of disaster related laws and regulations for implementation of the plan

### 10.3.1 The state and subjects of implementation of the plan

(1) Financial actions and enactment of disaster related laws and regulations

The national security council issued order of the financial actions and enactment of disaster related laws and regulations (it is listed in governmental policy of earthquake disaster risk reduction settled by National Security Council). In this policy, the order to the Parliament of Mongolia, to order to Cabinet of Mongolia, policy of earthquake disaster reduction are indicated and consist of order to the Parliament, Cabinet, Minutes of the Council.

Order to Parliament of Mongolia

- Ensure drastic Legal arrangement to promote cooperation and holistic management among related organizations which engage earthquake disaster risk reduction and disaster prevention and engage national security
- Regal environment and necessary fund to reconstruct and ensure safety of building

Order to Parliament of Mongolia

Agreements between Ministries and Organizations

- Prepare funding resource for geophysical survey in and around of capital city and construct geophysical observation base in assumed epicenter area. [relevant organization; Ministry of finance, Academy of Science (RCAG)]
- Prepare funding resource for geophysical survey in and around of capital city and construct geophysical observation base in assumed epicenter area. [relevant organization; Ministry of finance, Academy of Science (RCAG)]
- Implement seismic-capacity evaluation for residential houses, public facilities, industrial and

service facilities and inventory survey for all buildings and complete building database. Implement earthquake disaster risk evaluation in Capital and major cities and prepare cost for the evaluation. Legal arrangement to cooperate among related organization to promote plan should be prepared. [relevant organization; Ministry of Finance, Ministry of Justice, Prefectural Governor, UB city Mayor]

- Prepare emergency warning system and early warning system to transfer disaster information rapidly from epicenter such as Siren. Implement search and rescue, damage reduction, evacuation exercise more than once a year. [relevant organization; Ministry of Finance, NEMA, UB city Mayor, Academy of Science (RCAG)]
- Promote to set up business continuity plan for private sectors and give necessary guide. [relevant organization; EMDC]
- Set up high-rise building planning standard which indicate suitable number of floors of buildings in Earthquake Disaster Risk Zone in respect prefectures and UB city and keep this rule. (Ministry of Roads, Transport, Construction and Urban Development)

Earthquake Disaster National Capacity Strengthening Plan by National Security Council
There are also items related financial actions, enactment of disaster related laws and regulations in Earthquake Disaster National Capacity Strengthening Plan by National Security Council authorized on 30th of March, 2011this plan.

Table 10.3.1 Earthquake Disaster National Capacity Strengthening Plan

| | Project | Period | Organizations |
|---|---|---|---|
| 1 | Hazard Map in UB city, budget allocation of procurement of necessary equipment | 2011-2012 | UB city,<br>Academy of Science (RCAG) |
| 2-11 | omittion | | |
| 12 | Budgetting for the activities of National Disaster Prjects Coordination Permanent Committee | 2011 | Earthquake Disaster Standing Committee |
| 13 | Reflect Disaster Prevention,Air Pollution, Reduction of over congested central area, new town construction and issue about Infrastructure to draft of Urban Redevelopment Law.<br>Draft should be submitted National Congress of spring,2011 | 2011 | MRTCUD,<br>UB city, |
| 14 | Introdue draft of Emergency Management Law | 2011-2012 | Official Residence of the President 、National Security Council, NEMA |
| 15 | Enact legal system of reconstruction on old apartment houses | 2011-2012 | MRTCUD, UB city, |
| 16 | Revision of Building Code and international level of building inspection system | 2011-2014 | MRTCUD, General Agency for Specialized Inspection |
| 17 | Budgetting of 2011 government budget to stock of food for 100000peoples for 1 month and its storege buildinds | 2011 | Ministry of Finance ,UB city, NEMA |
| 18 | Omision | | |
| 19 | Budgetting for capacity building of experts in Earthquake Disaster field | 2011 | NEMA, Ministry of Finance Ministry of Education and Culture |
| 20-21 | Omission | | |
| 22 | Budget allocation of earthquake observation equipment in Dundgobi, Selenge and Bayanhongor | 2011 | Ministry of Education and Culture |
| 23 | Extention work of Military Hospital,<br>Formation of Portable Hospital of 5000 to 10000 victims of earthquake disaster | 2012-2013 | Ministry of Defense、Ministry of Finance,<br>NEMA |
| 24 | Creat Search and Resque Dog | 2011-2012 | NEMA, Ministry of Finance |
| 25 | Budget allocation of 4 sets of temporaty buridge, Earthquake Experience Mobile. | 2011-2012 | UB city, Ministry of Finance ,NEMA |
| 26 | Strengthening of brood stock and construction of unti-seismic brood bank center | 2011-2012 | Ministry of Health、Ministry of Finance ,NEMA、UB city, |
| 27 | Budget allocation for regional medical center in Khovd, Uvurkhangai, Orkhon and Dornod<br>Extention work of brood center in Garkhanuul General | 2011-2012 | NEMA, Ministry of Finance |

| | Project | Period | Organizations |
|---|---|---|---|
| | Hospital<br>Budget allocation for renewal of blood center machinary in Sukhbaatar, Khentii and Tuv General Hospitals | | |

Ref : Earthquake Disaster National Capacity Strengthening Plan

As shown above, financial actions and enactment of disaster related laws and regulations in national level were issued. Based on these orders, practical and detailed financial actions and enactment of disaster related regulations are needed to implement each countermeasure.

(2) Publicity of the Plan

The Plan is not opened now. Most of the contents are designated as the National Secret and public servants have the duty of confidentiality.

Therefore the Earthquake Disaster Management Plan is not known to the citizens and private sectors also the role of citizens and private sectors for disaster management is not knower. The plan or at least concept and aims must be opened to public or at least to designated stakeholders to let them to involve and participate to the disaster management.

### 10.3.2 Proposal for promoting he Earthquake Disaster Management Plan

(1) Financial actions

- Based on these orders, effort for financial request for implementation of individual countermeasures should be done.
- Considering necessity of projects for disaster mitigation, priority of the projects and schedule of projects plan should be made to obtain the project budget allocation.

(2) enactment of disaster related laws and regulations

- Disaster related laws should be enacting as soon as possible according to the order by National Security Council.
- Regulations and standards need for implementation of project should be enacted such as public subsidy or grant-in-aid for reconstruction of old buildings. Based on these orders, practical and detailed financial actions and enactment of disaster related regulations are needed to implement each countermeasures

(3) Publicity of the Plan

- The Earthquake Disaster Management Plan is opened as much as possible to let stakeholders to understand and have common recognition to play the role of stakeholders for disaster reduction.
- Publication of the plan is needed to citizens to understand the limitation of assistance from government that what assistants will be able to get or may difficult to get when disaster occurs and to understand that citizens have own role against disaster without having over expectation to government.
- Publication of the plan is needed to citizens to understand the role of community and importance of preparedness for disaster.

## 10.4 Disaster Information Distribution System

### 10.4.1 Current Situation of Disaster Information Distribution

The governments of Mongolia and UB city formulate the development plan of disaster information distribution system for the response of earthquake disaster since 2012. Current situation of the disaster information distribution system is clarified as follows;

(1) Current disaster distribution system is aged

The defense alarm system developed in UB city during 1970-80 is aged without maintenance and no spare parts, therefore the system is not working well now.

(2) No specific channel of information exchange and sharing for disaster related organizations

Due to no specific channel between disaster related organizations such as NEMA, EMDC, RCAG, etc., emergency communication is insecure.

(3) Undeveloped legal system

Legal system for disaster information, implementing organization, investigation and check systems are not developed

(4) Emergency information is not distributed immediately

Emergency information is distributed with document of telephone from NEMA and Mongolian Metrological Agency to Mass Media. Information value is abused with slowed transmission.

(5) Undeveloped emergency disaster information distribution tower

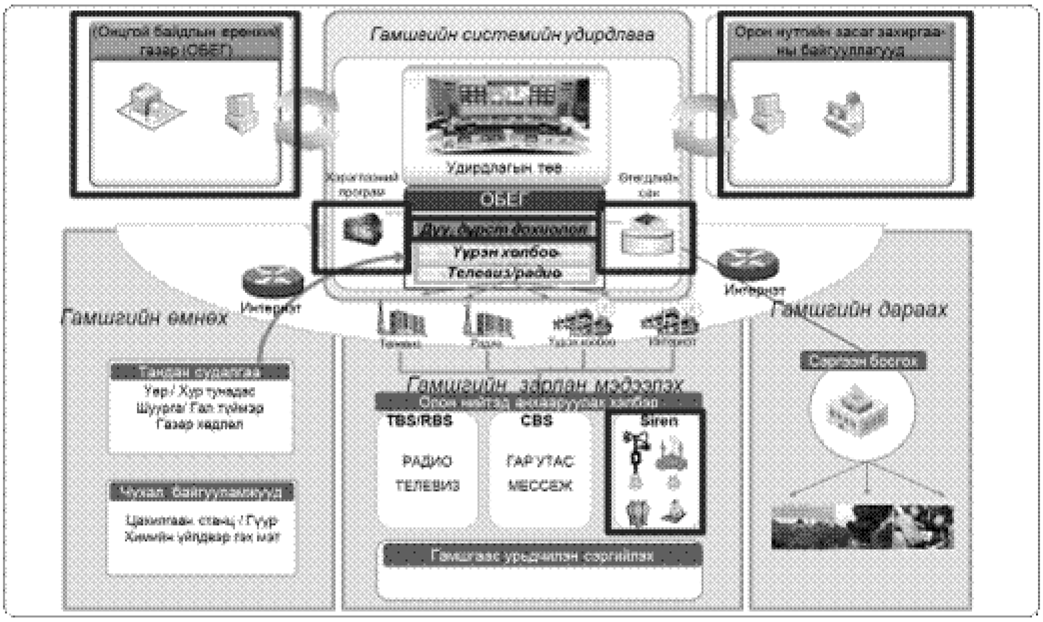
There is no emergency disaster information distribution tower in population concentrated UB city.

10.4.2 Development policy of disaster information distribution system

Following two (2) objectives are set as the early warning system.

(1) National Alert System for earthquake disaster
(2) Development of Disaster Information Accumulation and Disaster Exchange System

Figure 10.6.1 is whole system image, and Figure 10.6.2 is layout image of Emergency Disaster Information Distribution Tower.




Source: Development of Early Warning System, ICTPA

Fig10.4.1 Concept of UB city Disaster Information Distribution System


Source: Development of Early Warning System, ICTPA

Fig10.4.2 Layout image of Emergency Disaster Information Distribution Tower

This project has been published in major newspapers for one month from the 12th April 2012. KT (Korean Technology) won a bid, and signed a contract until October 2014. And following four (4) items are expected to develop in the project

(1) Establishment of disaster alert system management center in NEMA, and mobile sub center as an alternative
(2) Installation of 60 units of emergency disaster information distribution tower in UB city (40 in 2013, 20 in 2014)
(3) Installation of seismometers in assumed source region
(4) Development of disaster information network utilizing four mobile phone companies (with CBS), TV, and Radio

### 10.4.3 Structure of operation and maintenance of disaster information distribution system

The system redundancy for earthquake disaster such as main/sub operation center and basic/alternative network is considered in the development plan. However, there are no mention about quakeproof level of buildings and networks.

During visiting the disaster warning system management center under construction on the second floor of NEMA, the following issues were seen;

- Because of out range of the contract of the system development, seismic reinforcement of NEMA building is not executed.
- The possibilities and countermeasures of black out, water failure and heating cut are not taken into account.
- Interior is included in agreement, but because the door of each room does not consider the quakeproof, there is a possibility that the door will not open if the building is deformed by massive earthquake.
- Server room has openable windows facing the courtyard, and not considers the fixed rack and thermal runaway measures.
- Description of quakeproof is less in the specifications of ICTPA. (KT engineer’s comment)

### 10.4.4 Recommendations for disaster information distribution system

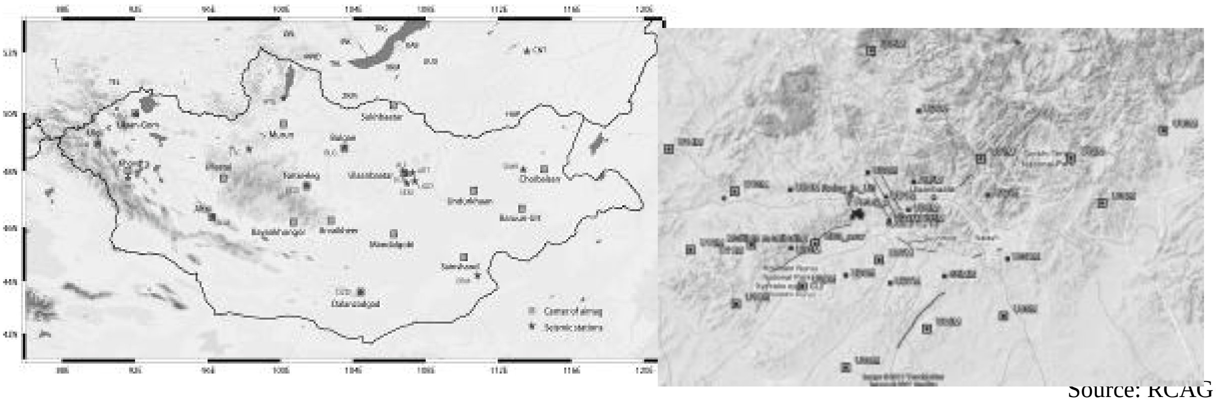
The lecture and visiting of new public address system and alert tower was conducted as a part of the training course in Japan on January 2013, and also technical lectures to ICTPA and NEMA were done in Mongolia. Because the development with KT is in the process, exchange of opinions with NEMA and ICTPA has done for possible future support and measures.

(1) The external evaluation of the system developing, particularly BCP and quakeproof evaluation are necessary. Furthermore, the next plan of improvement due to the evaluation is needed.
(2) It is necessary to develop awareness materials such as brochure and video for UB citizens to inform the functions of the system, then lectures and trainings by utilizing the materials.
(3) It is necessary to incorporate a comparative advantage technology of modulation mechanism for voice transmission, to modify the system more effective.
(4) For the introduction of EWS throughout the country as well as UB City, new proposal of EWS for local city is required.

## 10.5 Seismic observation system

### 10.5.1 Challenge of current seismic observation system

RCAG has set up a seismograph, and observes nationwide earthquake in Mongolia. RCAG has established geomagnetic meter, inclinometer, strain gauge, and GPS, especially, they are placed centrally around the known active faults and Ulaanbaatar city, however some of them are not transferred in real time.



Source: RCAG

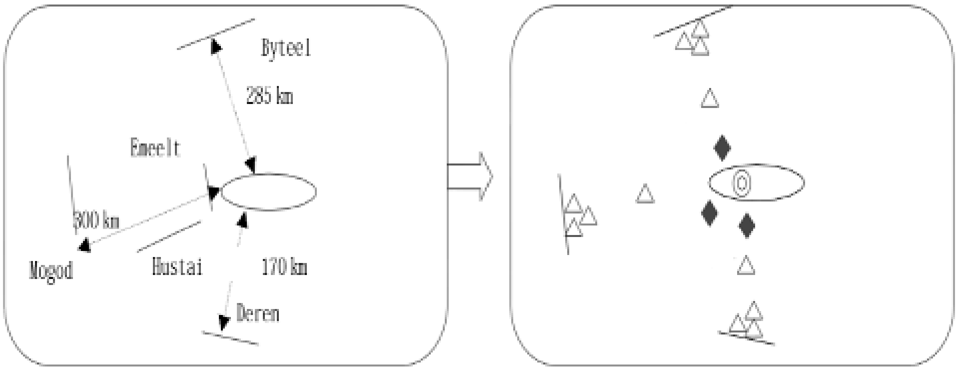
Figure 10.5.1 Seismic stations in Ulaanbaatar city and surrounding Mongolia throughout

### 10.5.2 Challenge on the development of the Earthquake Early Warning System(EEWS)

In order to develop EEWS shown in 10.4, the earthquake early warning that JMA operational serve as a reference as similar cases. In this case, automatic observation technology of seismograph nationwide, real-time high-speed communication technology, waveform analysis technology, and calculation technology of the time of occurrence, hypocenter, magnitude, seismic intensity, and automatic breaking technology of calculation results are necessary.

### 10.5.3 Recommendations for earthquake observation system sophistication

JMA had set about 220 earthquake observation centers in Japan before the Great East Japan Earthquake, and increased to 400 centers for simultaneous multiple earthquake and massive earthquake, furthermore data from external organizations is included. In consideration of the frequency of occurrence of earthquake, it is not necessary to install as same level as Japan in Mongolia, however, installation of the system and various devices for the realization of the earthquake early warning system (EEWS) to estimate quickly the earthquake size via observing the movement of the targeted fault is required.




Source: RCAG

Figure10.5.2 The plan of the target faults and monitoring sets of EEWS

## 10.6 Emergency Response in case of Disaster

### 10.6.1 Damage Estimation Result

(1) Number of damaged buildings is large. There are many old buildings still using for Police and Fire fighting that must be functional in case of disaster. Therefore possibility that the function is inhibited high.

Proposal 1: Promotion of anti-earthquake reinforcement of important buildings in case of disaster

(2) Damage of bridges located on main road are estimated to be damaged even road damage itself is low. Therefore there are risks of delay of Emergency vehicle and delay of emergency supply to the affected site.

Proposal 2: Anti-earthquake reinforcement of bridges

(3) There is high risk of road Impassable by buildings collapse and over road facilities. Emergency activities suffer severe effect by road impassable.

Proposal 3: Promotion of anti-earthquake reinforcement of road side buildings and over road facilities

(4) There is high risk to be suffered by fire damage. Therefore Undeveloped road for fire-fighting, Lack of water for fire-fighting and unreachable of fire engine due to impassable road or traffic jam causes difficulties of fire-fighting activates in Ger area where mostly high risk of fire break out and fire spread.

Proposal 4: Construction of firefighting water tank in UB city including Ger area.
Proposal 5: Designation of important roads in case of disaster
Proposal 6: Emergency traffic control system of important roads in case of disaster (such as shout out of car entering to UB city from outside)

### 10.6.2 Construction of emergency experts network

There is necessary to establish disaster medical system to organize huge number of injured.

Proposal 7：Wide area disaster medical system (Transportation of injured by Helicopter, Installation of heliport)
Proposal 8: Information communication system for hospital network
Proposal 9： Development of emergency medical care such as Triage

### 10.6.3 Safety assessment of damaged buildings

Proposal 10: Emergency assessment system for affected buildings (Guideline is prepared already)

### 10.6.4 Network of professional for Emergency recovery

Life line such as Water, Sewage, Heating and other which is essential for urban life is constructed underground and its distance is long. It is not sufficient to do by pipeline contractor in UB city

Proposal 11: Disaster assistance agreement is recommended to agree among the whole of pipe contractors in Mongolia for complete repair in short period.

### 10.6.5 Schools

There are several issued to be considered in school disaster management. Response manuals for School hour and other are need to be prepared. Also manual for management of school as an evacuation place and to be trained.

## 10.7 Land use and Urban development control

### 10.7.1 State of the art of land use and urban development

Category of land use in Land law and urban development law is as follow shown in Table 10.9.1.

Table 10.7.1 Category of land use in Land law and urban development law

| law of Mongolia on land | | Urban Development law | |
|---|---|---|---|
| Aglicaltural land | Grazing land, Agriculture land | Agriculture | Grazing land, Agriculture land |
| w | Urban, Village, other Settlements, Mining and Industrial | Residential and public zone | Settlments・Urban Facilities |
| | | Industrial zone | Industrial, Utilities, Warehouses |
| | | Greenary recreational and tourism zone | Greennary of urban suburbs, recreational facilities, natural conservation area, national park, histrical heritages, tourism zone |
| | | Summer housing zone | Summer housing without Infrastructures |
| Land under roads and network | Transportation, Power, Heating, Water Supply, Information Network | Engineering supply network, road and transportation zone | Transportation, Infrastructures, Utilities ( Power supply, Heating, Water supply, Sewage, Waste, Information Network) |
| Land with forest resources | Forest | Greenary recreational and tourism zone | Greennary of urban suburbs, recreational facilities, natural conservation area, national park, histrical heritages, tourism zone |
| Land with water resources | Water surface (Lake, Marsh, Pond, River) | Greenary recreational and tourism zone | Greennary of urban suburbs, recreational facilities, natural conservation area, national park, histrical heritages, tourism zone |
| Land for special use | Cemetery, Funeral Hall, Refuse Dump | Special purpose zone | National Defence, Deplomacy |
| | | | |

Ref : UBMPS Final Report

In 1992, Mongolia shifted from socialism to market economy and land use reformation to permit transferable land ownership since 2003. But urban planning and urban development system arrangement was remained. As built-up area of UB city could not absorb population increase which UB population was 650 thousand became 1220 thousands in 2012, 40% of population lives in Ger area without urban infrastructures. Ger area is still expanding from central area to suburbs.

Apartment houses that major buildings in built-up area of UB city were mostly constructed during era of

socialism from 1921 to 1992 and these buildings are getting old.
Major road network in central area of UB city was constructed with sufficient width but sub road network is not sufficient in central area. For street level road network, it seems not designed based on urban planning. Especially in Ger area, there is no road in side of Ger area and only between wooden fences of houses used as road without any pavement.

Based on these observations, it is very important and urgent to implement the planned improvement. Newtown planning, reconstruction of old apartment houses, land readjustment of Ger area with promoting to rebuild Ger to permanent houses and road network plan. These problems are also important as Disaster Prevention Urban Planning to promote anti-seismic retrofitting of buildings, ensuring of evacuation place an evacuation road, earthquake fire countermeasures and earthquake countermeasures.

### 10.7.2 Promotion of Deliberate land use and control in Ger area

Disaster vulnerability is high. Not only risk of building collapse, fire break out and spread but also no water supply, road, undeveloped road reduce tremendously capability of disaster response. Still population in Ger area is increasing. Not only from disaster management view point but also living environment, deliberate land use control and implements of urban redevelopment projects, urban readjustment projects are highly needed. Unregulated spreading of Ger area will be continued unless these control and project is implemented.

### 10.7.3 Need of Redevelopment of old buildings and Incentives

Seismic diagnosis of existing old buildings is undergoing and reconstruction projects by urban redevelopment projects are also ongoing now. Cost of reconstruction of apartment houses for seismic reinforcement shouldered by apartment building owners. In case of redevelopment project, some of redevelopment cost is compensated by expenses resulting from the sold extra housing units but in some case extra housing units cannot be sold. When old buildings already constructed full floor-area ratio designated in urban planning, no extra housing units cannot be constructed. Because of these reasons, it is needed to prepare some Incentives from public side such as follow.

- Incentives for seismic diagnosis
- Incentives for seismic reinforcement
- Financing facility for seismic reinforcement
- Incentive by preferential tax
  - Deduction of tax by Loan balance for seismic reinforcement
  - Deduction of tax of seismic reinforcement cost
  - Reduction of property tax for seismic reinforced buildings
  - Loan tax cut the purchase of second-hand housing that conformed seismic standard

UB city urban master plan targeting on 2020 is ongoing and UB city urban master plan targeting 2030 is proposed 2013. As land use projects and urban redevelopment projects are closely related to urban planning. Urban planning on Disaster which aimed to realize UB city as disaster-resistant city is proposed. Guideline for urban planning on Disaster is prepared

## 10.8 Policy to upgrade seismic capacity of buildings and infra-structures

### 10.8.1 Current issues in UB city

Factors of vulnerability of buildings and infrastructures in UB city (or Mongolia) are summarized as follows;

- Seismic capacity required in current design standard is not sufficient,
- Construction quality is poor,
- Consciousness for seismic upgrading in citizens is low,
- Budget for seismic upgrading is limited, and
- Seismic capacity of important buildings is still low.

Proposals for the issues mentioned above are explained in the following sections.

### 10.8.2 Revision of the current seismic design requirement

Current Mongolian seismic design standard is based on the former Soviet Union's one with a little modification. Though activity to revise the design basis ground motion exists under RCAG and other organization, design basis ground motion shall be determined with the adequate limit state. On the other hand, current limit state is set as elastic limit because of the design standard and relevant design software, so that it may be concluded that current standard cannot assure the performance or safety in case of large deformation of the buildings.

In order to solve such a situation, it is necessary to introduce the ultimate capacity calculation into the design standard and to transfer the knowledge and software need for the method.
Concretely, the followings are identified to be transferred; push-over analysis, non-linear dynamic analysis and ground motion generation. One of the efficient drivers for technical transfer is establish license, with which engineers can design buildings and can ask for higher design fee.

### 10.8.3 Upgrading construction quality

Insufficient quality control engineers and lack of experts are factors to yield the low quality in construction. The fact that construction period is limited due to the climate condition, is the cause to prevent experts be brought up.

In order to bring up experts, supporting the training course by nation or UB city can be effective. Support will include the dispatching the trainers as well as financial aid.
If the construction companies are obligated to employ certain number (or rate) of experts by law, supports from the company may be expected.

### 10.8.4 Promotion of consciousness for seismic upgrading

As stated in Chapter 7, it is hard to rapidly increase the consciousness of each citizen for the seismic upgrading. Campaign for disaster risk management described in Chapter 9 was the great opportunity to experience earthquake and to learn the necessity of upgrading with joy. Also it is important to periodically conduct the enlightening activity such as education for students as well as evacuation training, so that the importance of upgrading is aware, and modification and reconstruction of buildings will be of concern.

### 10.8.5 Framework to draw the budget for upgrading from citizen

UB's current budget is not sufficient to upgrade all the buildings in UB including private ones. Urban develop planning by private sector also possesses issues that it takes a lot of time and it is often hard to establish adequate project.

Therefore, it is realistic to collect budget from residents. Prof Meguro of University of Tokyo proposes one measure to collect budget, which gives larger aid to the owners of upgraded buildings, in case they are damaged. This is the system that only the building owners whose buildings possess sufficient seismic capacity will have priority to be supported by the government.
In Japan, tax incentives and reduction on insurance cost are also effective incentives.
In addition, financial system based on the public support aiming seismic upgrading shall also be considered, since upgrading requires a large amount of budget.

### 10.8.6 Prioritization in upgrading

Not only upgrading aged apartment houses and conducting urban planning but important buildings such as police stations, fire stations, local government offices, hospitals, school buildings and kindergartens shall be upgraded prior to other buildings, from viewpoint of the functions in case of disaster.

## 10.9 Disaster risk reduction communication, School disaster risk reduction, Community based disaster risk reduction

### 10.9.1 Necessity of capacity development in disaster related organizations

- Since governmental official, NGO etc. involved in disaster prevention have no experience of big size earthquake in UB City so far, knowledge on earthquakes is insufficient. In order to continue to spread the correct knowledge, it is necessary to rise up for these staff of relevant organizations.

- Information and knowledge on earthquakes can be provided by RCAG is not shared enough, it is necessary to provide a program to acquire the knowledge of earthquake disaster prevention in collaboration with RCAG.
- It is also effective that adding knowledge earthquake disaster prevention in the requirements of promotion system of EMDC.

10.9.2 Dissemination of disaster prevention education activities

- EMDC has sufficient mobilization of residents for disaster drills, etc. Community based activities in Mongolia is not enough active, however it is possible to enhance the knowledge of earthquake disaster prevention of the entire community by leveraging the mobilization. And it would be effective as next step that the development of the efforts to raise awareness about the importance of cooperation of local residents for damage mitigation.
- Participants said that the campaign including the preparation process is very useful and good experience, therefore spreading to a wider range at the national level would be effective.

10.9.3 To share the results of training in Japan

- Many of the trainees said that they were able to learn many skills and knowledge in Japan. Even making the prototype vibration table, there is a willingness to try to develop based on the knowledge gained in Japan. Providing training opportunities in Japan in the future would be effective.
-

10.9.4 Promotion of school disaster education

- The school tournament that was carried out this time is effective as a mechanism to encourage their students' attention. Establish a system that can be performed on a regular basis as a program of school earthquake disaster prevention education is expected.

10.9.5 Promotion of educational activities that utilize the mass media

- In the Public Awareness Campaign, many mass media participated and it was featured on TV, radio, and newspaper. The second day of the Campaign, there is also a participant who visited by the news of the mass media, so activities such as awareness campaign is also effective as a means of disaster education.
- On the other hand, a material that may be related to earthquake disaster prevention is still limited. It is required to develop video materials that are utilized via the mass media.

10.9.6 Promotion of educational activities in collaboration with private sectors

- In the Public Awareness Campaign for Seismic Disaster Risk Reduction, Mongolia insurance company sponsored the disaster prevention painting contest, and Nomin HD exhibited and sold disaster prevention goods. Thus, some private sectors highly have interest in disaster prevention. To promote initiatives that utilize private sectors and the NGO/NPO widely not only "support agreement in case of disaster", but also the disaster prevention awareness activities in peacetime proceeds is expected.

10.9.7 Promotion of experience menu

- So far, most of activities for residents were such as the implementation of evacuation drills, exhibition and demonstration of emergency response equipment. In this project, we were able to convey the knowledge of earthquake through earthquake experience programs such as vibration table and “Jishin The Vuton”. Mongolian side hopes to continue these activities, therefore technical assistance (Provision of shaking table technology improvement, etc.) in order to provide a better program is needed.

10.9.8 To collect earthquake experience records in Mongolia

- Earthquake survivors in 1957 visited the disaster prevention campaign venue. It would be possible to summarize the earthquake experience stories of past Mongolia during their alive. This is useful as disaster prevention materials in the future.