September 2016

JICA ERAKV NEWS No.2

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

Contents

INTRODUCTION

The project “The study on Earthquake Disaster Mitigation”, conducted by JICA in 2002, estimated the damage with several scenario earthquakes. More than ten years have passed since the project, and population and the number of buildings have increased without enough countermeasures against the earthquake disaster. In this circumstance, the Government of Nepal (GoN) requested the assistance from the Government of Japan, and this project was formulated.

On April 25, 2015, just before the commencement of the project, the Gorkha Earthquake of Mw7.8 (USGS) occurred. The experts from this project urgently visited Kathmandu from 6th May as on Page 2. During the visit, the team investigated the damage of buildings, the needs from the GoN for recovery and reconstruction, and had series of discussions with the counterparts.

Though the Gorkha Earthquake caused heavy damages both in and out of Kathmandu Valley, the damage was relatively small compared with other earthquakes having similar magnitude. It was recognized by both JICA and GoN that the quick recovery and reconstruction with the concept of Build Back Better (BBB) is an urgent issue and, in the meantime, it is necessary to promote the Disaster Risk Reduction and Management (DRRM) for the future earthquake. This project modified its contents as shown on Contents 3 so as to achieve above concept, and has been proceeding.


1


2

TEAM MEMBER


Ryoji TAKAHASHI
Team Leader / DM Administration


Toshio DOI
Soil Survey


Katsu KATO
Regional DM Planning/ Reconstruction Planning


Akira INOUE
Earthquake Disaster Risk Assessment (Building)


Akihiro FURUTA
GIS and Mapping


Kenpei KOJIKA
Deputy Team Leader/ DM Administration/ Risk Assessment/ DRR Planning


Koichi HASEGAWA
Seismic Hazard Assessment (Ground motion)


Makoto IKEDA
Emergency response Planning


Akio HAYASHI
Earthquake Disaster Risk Assessment (Infrastructure)


Abilash POKHREL
Damage Survey Organization Coordination


Fumio KANEKO
Seismic Hazard Assessment (Earthquake)


Shukyo Segawa
Seismic Hazard Assessment (Ground motion)


Junya UMEMURA
Urban Design and Planning


Hiroshi IMAIZUMI
Earthquake Disaster Risk Assessment (Economic and Social Analysis)


Yasuhiro KAWASOE
Project Coordinator / Associate Regional DM Planning


Jun MATSUO
Seismic Hazard Assessment (Ground Modelling)


Michio MORINO
Seismic Hazard Assessment (Topography)


Kanako IUCHI
Land Use Planning


Miki KODAMA
Community Based Disaster Risk Management

3


4

-Caption of Photos-
1. 2nd Counterpart Training in Japan at JICA
2. Providing the result of the hazard assessment to DMG
3. In JCC Meeting
4. Bridge Survey for Risk Assessment


Deepak Raj PAGENI
Civil Engineer


Nirdesh SHRESTHA
GIS Engineer


Subhechha SHARMA
Interpreter / Civil Engineer


Sangita ADHIKARI
Secretary

Overall Gaol

To reduce the earthquake disaster risk through effective and sustainable measures to be taken based on the disaster risk assessment.

Project Purpose

To implement the earthquake risk assessment for future scenario earthquakes considering the earthquake environment after the Gorkha Earthquake, and to develop the DRRM plan for concrete and effective promotion of disaster risk management for future earthquakes.

Project Output

• Output 1

Seismic hazard assessment based on scenario earthquakes utilizing the latest knowledge and creation of detailed ground model for Kathmandu Valley.

• Output 2

Seismic risk assessment based on the results of seismic hazard assessment (Output 1), and summarize as damage estimation by considering several occurrence scenes (time, date, etc.) for buildings and infrastructure damage, and human and economic loss.

• Output 3

Enhancement of technical skills for updating risk assessment results in accordance with the social environment change in the future.

• Output 4

To formulate BBB recovery and reconstruction plan utilizing the results of hazard assessment, and DRRM plan based on the results of seismic risk assessment for the pilot municipalities.

Implementing Agencies

MoUD, MoHA, MoFALD, and DMG

Pilot Municipalities

1) Lalitpur Sub-Metropolitan City
2) Bhaktapur Municipality,
3) Budhanilkantha Municipality

Duration

Approx. 3 Years
(from May 2015 to April 2018)

Gorkha Earthquake and Emergency Survey

The JICA Project Team carried out an urgent damage survey after the Gorkha Earthquake in order to understand seismic damage and the needs of GoN for recovery and reconstruction. The damage survey was carried out in the Kathmandu Valley and in Sindhupalchowk District which suffered the most severe damage due to the earthquake. Damage to the buildings built of adobe, bricks or RC frame, high rise buildings, and roads were investigated. A detailed damage survey was carried out in Sankhu and Bhaktapur.


1


2

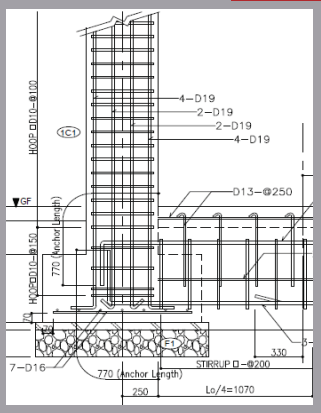

3


4

1. Damage Survey in Sankhu
2. Survey of collapsed RC Buildings
3. Discussion for modification of the project with JS of MoUD
4. 1st JCC Meeting

Quick Response Activities after the Gorkha Earthquake

Construction of Cut Model from June to August 2015



Example of the Section


Image of the Cut Models


Constructed RC Model

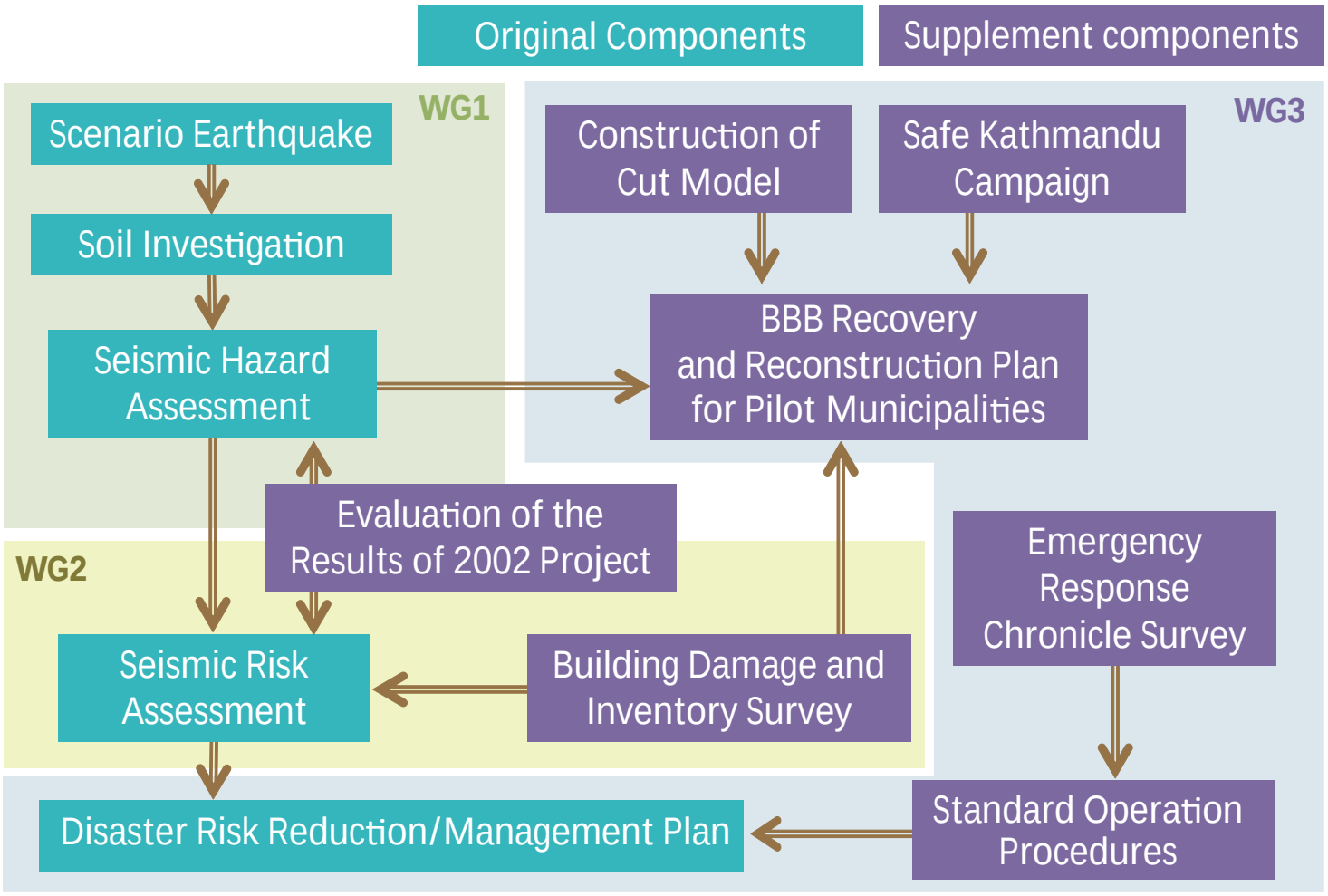
The JICA Project Team members provided explanation about the quake-resistant model houses, Japanese earthquake resistant method and its technical history with Cut Models.

More than 800 people including Secretary of MoUD, President of JICA visited the site on the 2 days event. After the event, Himani Shah, Former Crown Princess also visited the site, and many Nepali News published about the model.

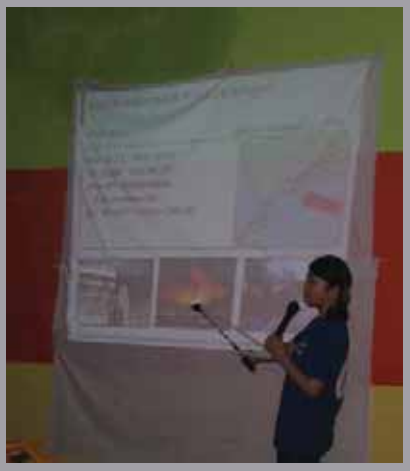

2 days Event
(24, 25 June 2015)

Modification of Project Components

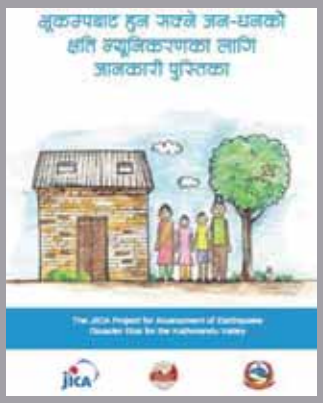
Originally, this project was planned for Seismic Hazard Assessment, Seismic Risk Assessment and DM plan based on the Risk Assessment. However, in order to correspond to the needs after the Gorkha Earthquake, following activities were added in the 1st Joint Coordinating Committee (JCC) meeting held on 18th June, 2015.



Safe Kathmandu Campaign in August 2015



Explanation of the Earthquakes Mechanism



Cover of the Brochure

"The Safe Kathmandu Campaign", which is for enhancing community awareness for Disaster Risk Reduction, was conducted in the middle of August with approx.200 participants in three pilot municipalities. Necessity of retrofitting and issue for cost, lack of information, request of support from the government, and so on were among the topics widely discussed in these WSs. Also, "The Radio program" and distribution of "the Brochure of the earhquake resistance" were conducted.

Workshop in Lalitpur Sub-Metropolitan City

Activities of 3 WGs

WG1

Seismic Hazard Assessment

1st Meeting on 7th Aug 2015

The Outline and Framework for the activities were discussed.
The progress of the Microtremor measurement was introduced.

2nd Meeting on 9th Nov 2015

The progress including Scenario Earthquake and Soil Modelling was explained. The importance of technical transfer was shared among participants.

3rd Meeting on 11 Sep 2016

Scheduled.

WG2

Seismic Risk Assessment

1st Meeting on 27th July 2015

The Outline and Framework for the activities were explained from the JICA Project Team and discussed among participants.

2nd Meeting on 8th Feb 2016

The progress of Data collection for Buildings, Infrastructures, Lifelines, social economic situation was explained
The necessity of more detail data was shared among participants.

3rd Meeting on 4th Aug 2016

The risk assessment approaches for building and infrastructure damage and human and economic loss are discussed.

WG3

Pilot Activities

1st Meeting on 5th Aug 2015

The Outline and Framework of the Recovery and Reconstruction plan was explained. The schedule, image of plan was discussed, as some recovery works has already started.

2nd Meeting on 1st Mar 2016

(Draft) BBB Recovery and Reconstruction Plan was introduced.
The implementation method and budget were recognized as the main issue to be further discussed.

3rd Meeting on 6th May 2016

The contents of BBB Recovery and Reconstruction Plan was discussed.

JCC and Joint Working Group Meetings

1st JCC Meeting on 18th June 2015

The Project component was modified (Contents 3), and 3 pilot municipalities were determined.




1st JWG Meeting on 6th Dec 2015

1st Joint Working Group (JWG) meeting was organized to share the works of each working group before the 2nd JCC meeting. The Development Commissioner of KVDA chaired the meeting. The presentation was prepared by the JICA Project Team, and the comprehensive ideas including the themes of 3 WGs were discussed.




2nd JCC Meeting on 16th Dec 2015

The activities of the three WGs were presented by Nepali representative of each WG. Scenario Earthquakes were determined. The framework for Recovery and Reconstruction Plan was confirmed.




2nd JWG Meeting on 11th April 2016

2nd JWG meeting focused on the progress of Seismic Hazard Assessment, especially for calculation of PGA (Peak Ground Acceleration of seismic motion at ground surface) for the Scenario Earthquakes. The importance of PGA for Risk Assessment and Disaster Management was shared among the participants.




3rd JCC Meeting on May 10th 2016

Result of Hazard Assessment (the Scenario Earthquakes and Seismic motion) and Finalization of the Recovery and Reconstruction Plans in Pilot Municipalities were discussed and confirmed.



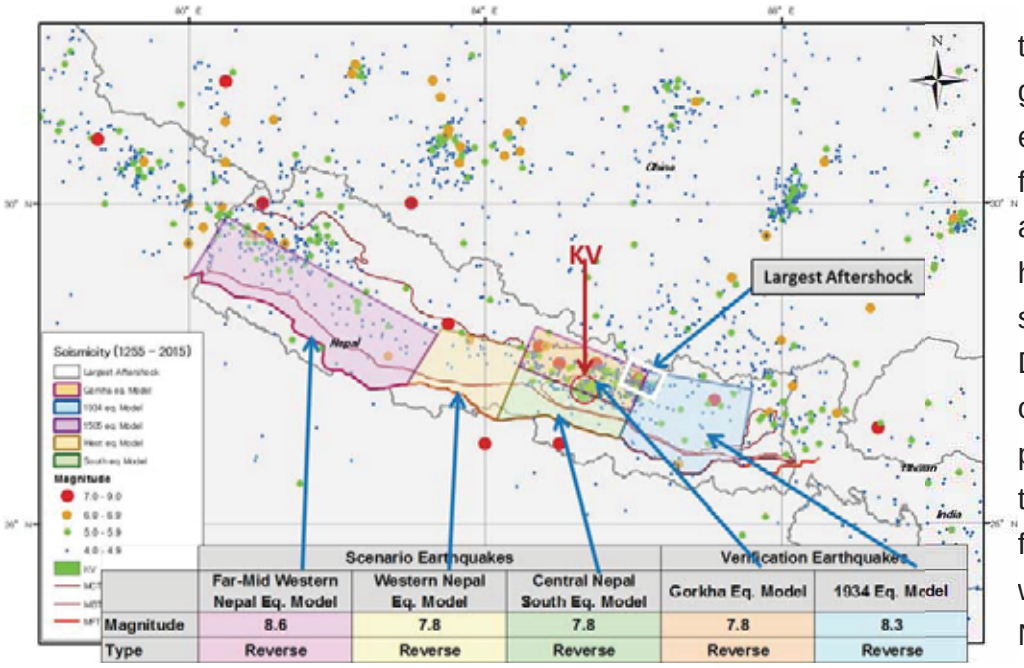

4th JCC Meeting on September 14th 2016 (Scheduled)

Final Result of the Hazard Assessment and Coverage items for the Risk Assessment, etc. will be discussed.

Result of the Seismic Hazard Assessment

As the resource information for reducing the damage due to future earthquakes to the Kathmandu Valley, “Seismic Hazard Assessment” has been conducted. Firstly, the scenario earthquakes were set. Secondly, the seismic motions due to the scenario earthquakes were calculated by considering the propagation of the seismic waves from the epicentre to the bottom rock of the Valley. Then, the change of earthquake motions within the sub-surface soil ground of the Valley was analysed. Finally, the earthquake shaking at the ground surface and collateral hazards like liquefaction and slope failure were investigated.

Scenario Earthquake



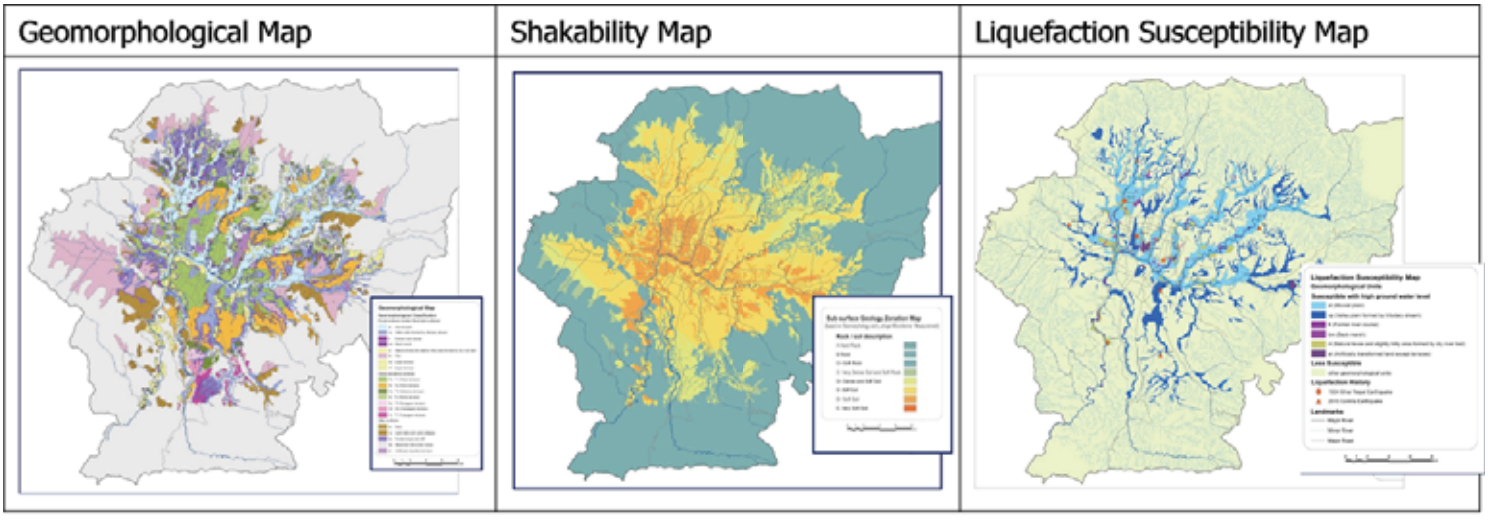
	Scenario Earthquakes			Verification Earthquakes	
	Far-Mid Western Nepal Eq. Model	Western Nepal Eq. Model	Central Nepal South Eq. Model	Gorkha Eq. Model	1934 Eq. Model
Magnitude	8.6	7.8	7.8	7.8	8.3
Type	Reverse	Reverse	Reverse	Reverse	Reverse

The possible earthquakes affecting the Kathmandu valley were investigated in order to prepare for future earthquakes. They were derived from the following information; active faults, crustal movement, historical earthquakes and current seismic activity.

During the process, the opinions of national and international experts including that of DMG were taken into account. As a result, the following 3 scenario earthquakes were set; 1) Far- Mid Western Nepal Scenario Eq., 2) Western Nepal Scenario Eq., and 3) Central Nepal South Scenario Eq. In addition, the information of the past earthquakes is effective for verification. Therefore, the information due to the 1934 Nepal-Bihar Earthquake, as well as the main shock and the largest aftershock of the 2015 Gorkha Earthquake were used.

Seismic Microzonation Maps

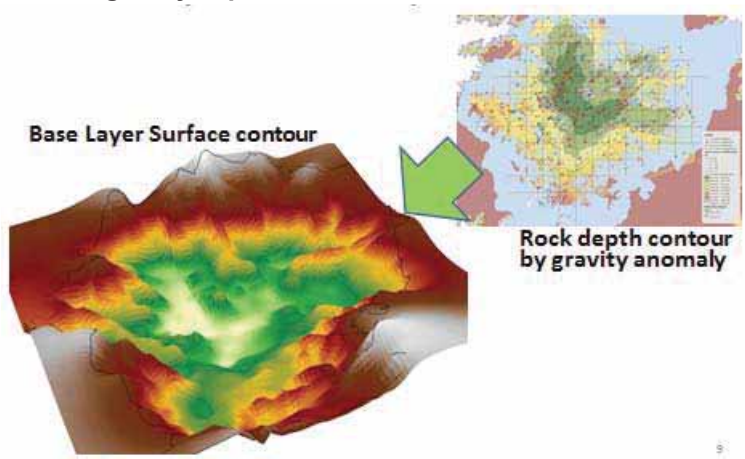
Several ground condition maps were developed, which represent the characteristics of the ground condition in the Kathmandu Valley with respect to ground shaking caused by earthquakes. First, Geomorphology Map after examining the topography and sedimentary environment was newly prepared. Based on the Geomorphology Map and the results of the Array Microtremor Surveys, the Soil Softness (Shakability) Map, and the Susceptibility Maps for Liquefaction and Slope Failure were developed.



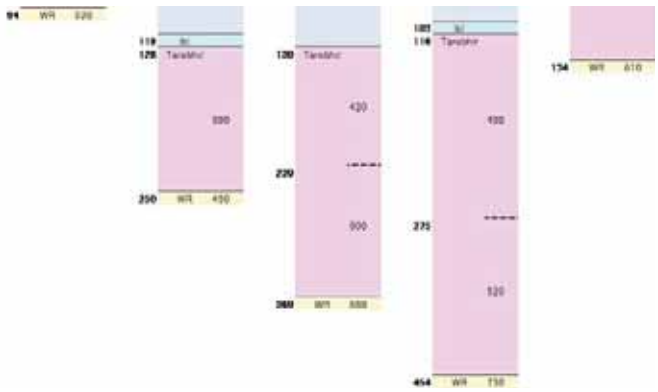
Ground Modelling

Since the sub-surface ground remarkably affects the strength of the ground motion, its structure and physical properties should be identified in order to assume the seismic hazard. For the Kathmandu Valley, maximum depth to rock layer is more than 550 m. Prior to this project, the details of the characteristics of the sub-surface ground had not been sufficiently investigated. The following are the main portion of the investigation of this project. First of all, based on around 449 bore-hole data and the gravity exploration result data, 25 geological cross-sections estimating the situation in the direction of the depth of the geology were produced. Simultaneously, the Microtremor Survey at 518 Single Points, including existing 210 points, 74 points of L-Shape Array, 39 points of 3-point Array and 5 points of Tripartite Array, gave the S-wave velocities for the geologic structure. Based on the above information and survey results, a detailed ground model (structure and properties) for each 250 m x 250 m grid (total 11,934 grids) was set.

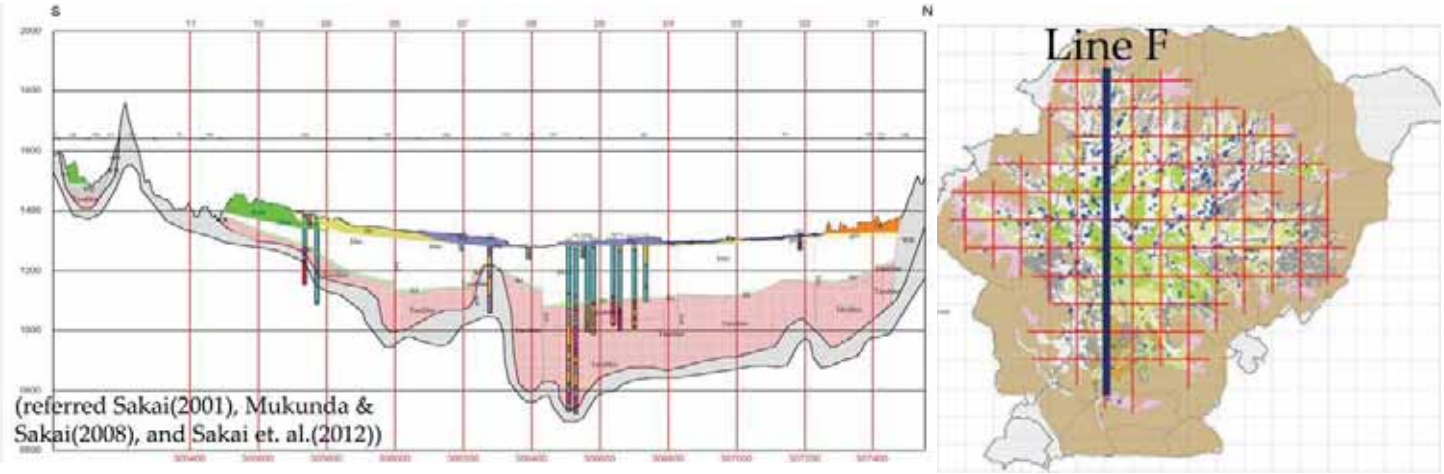
Rock Depth distribution based on the boring data and gravity exploration results



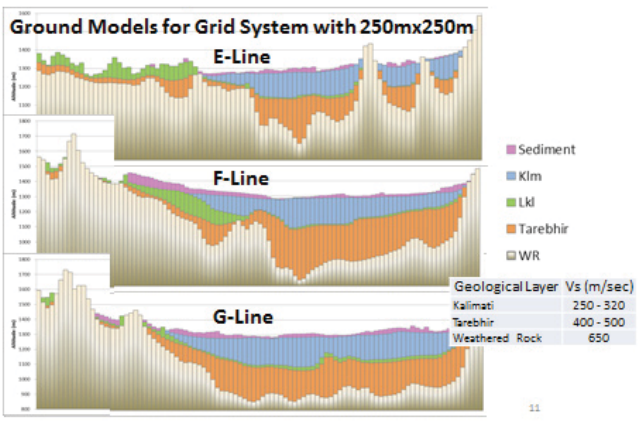
S-wave velocity setting for the geological layers based on the Tripartite Array Microtremor Survey

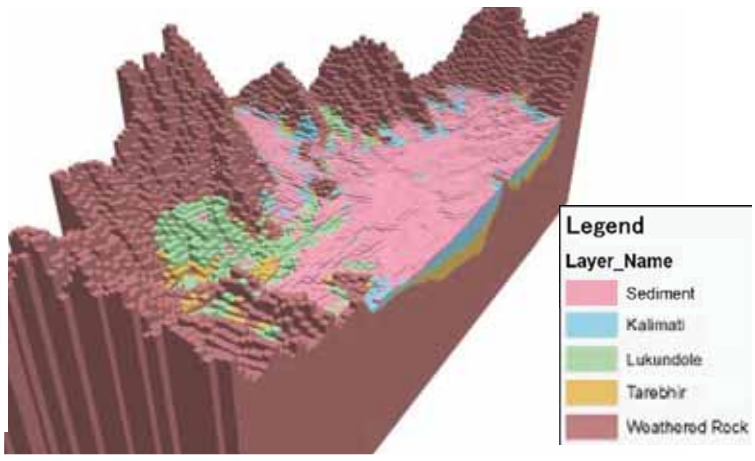


Geological cross-section based on the ground and the survey data, totally 25 cross sections, for E-W &N-S



Ground model for each 250m grid (left: a cross-sectional view, right: a three-dimensional view)

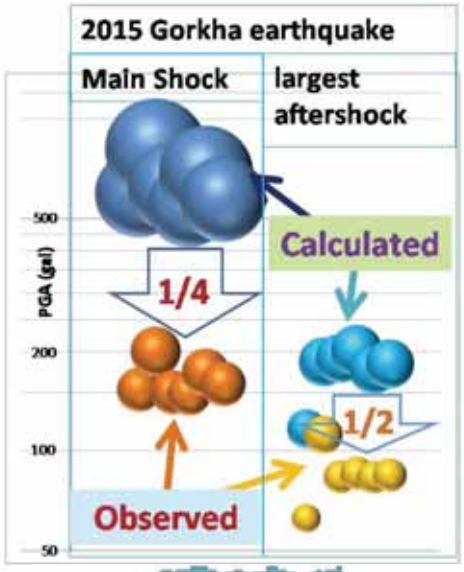




Seismic Ground Motion Estimation

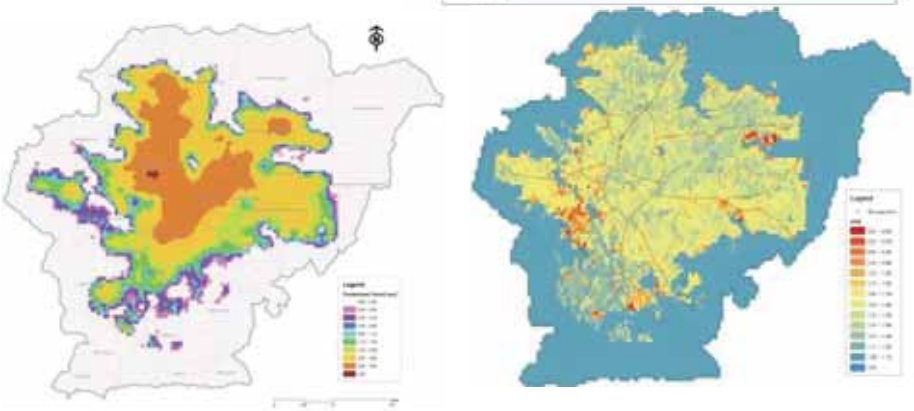
Singularity of Seismic Motion by the Gorkha earthquake

Singularity of ground motion was observed in the Gorkha earthquake. Recorded seismic motion values due to main shock (7.8) were about quarter of those calculated for the same magnitude earthquake, and about half due to the largest aftershock (M7.3) . The reason for such phenomena is still under consideration in seismology. Therefore, the project decided to use a correction factors (x1/3 to x1/1) for The Central Nepal South Scenario earthquake, whose source area is close to that of the Gorkha earthquake.



Amplification of seismic motion in the sub-surface ground of the Kathmandu Valley

Kathmandu Valley shows complicated features, as the sub-surface ground is covered by the strata deposited at the time of the Paleo-Kathmandu Lake, river and terrace deposits. Features of the amplification and the predominant period calculated from the ground models greatly influence ground motion distribution. Depending on the level of the input ground motion, a nature of nonlinearity of soil appears.



Predominant Period (left), Amplification (right) of sub-surface ground

PGA by Scenario and Verification Earthquakes

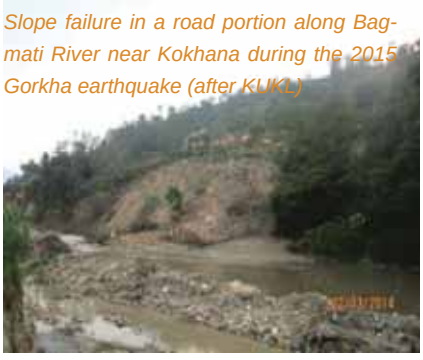
Using the ground models for sub-surface of the Kathmandu Valley, the peak ground acceleration (PGA) by 3 scenario earthquakes and verification earthquakes were calculated by response analysis. PGAs are: 150-200gals for Gorkha earthquake and Western Nepal Scenario earthquake, 100-150gals for Far-Mid Western Nepal Scenario earthquake and the largest aftershock, and 200-300gals for Central Nepal South Scenario earthquake with correction factor x1/3 and 1934 Bihar-Nepal earthquake, and PGAs increase along correction factors and Central Nepal South Scenario earthquakes with x1/1 become PGA 400-800gals.

Liquefaction and Earthquake induced Slope Failure

Liquefaction at Tundhikel during the 1934 Bihar-Nepal earthquake (Rana, 1935)

As very less information for assessment of liquefaction and slope failure is available in Kathmandu Valley, this project decided to understand their overall trend for scenario earthquakes by referring to the history. Considering the utilization of the result in disaster management, some assumptions were adapted to be in safer side.

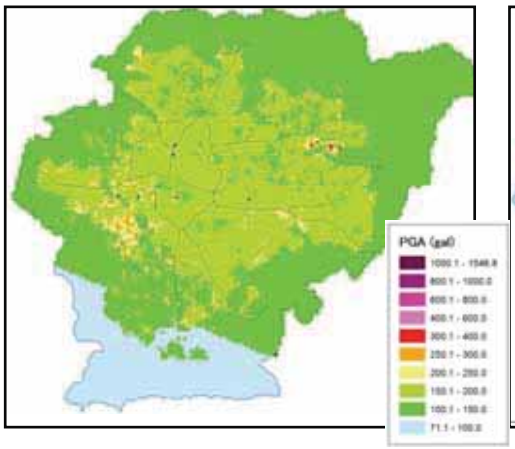
For the largest aftershock and the main shock of the 2015 Gorkha earthquake, Far-Mid Western Nepal, and Western Nepal Scenario earthquake, liquefaction and slope failure are assumed as rare occurrence. Some occurrences of liquefaction and slope failure caused by the Gorkha earthquake did not bring real damage. For the 1934 Bihar-Nepal earthquake and Central Nepal South Scenario earthquake with correction factor of x1/3, the possibility of liquefaction and slope failure were assumed at some parts of Kathmandu Valley. The assumed results were confirmed with the actual history information of the 1934 earthquake. For other cases (x1/2, x2/3, x1/1) of the Central Nepal South Scenario earthquake, the possibility of liquefaction and slope failure were assumed to gradually spread toward the peripheral region of the Kathmandu Valley, as the correction factor gets larger.



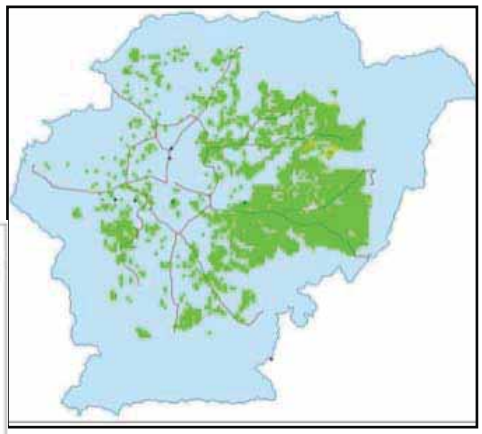
Slope failure in a road portion along Bagmati River near Kokhana during the 2015 Gorkha earthquake (after KUKL)

PGA (verification earthquakes)

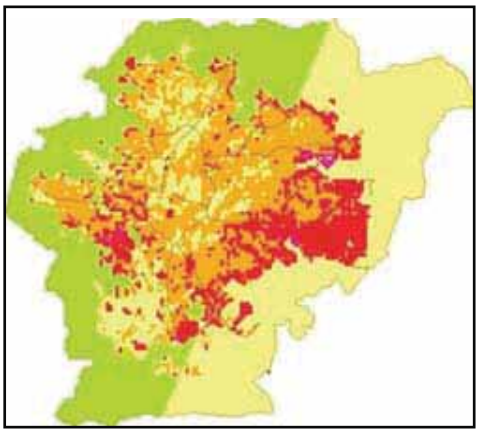
Gorkha EQ (x1/5)



Largest Aftershock of Gorkha EQ (x1/2)

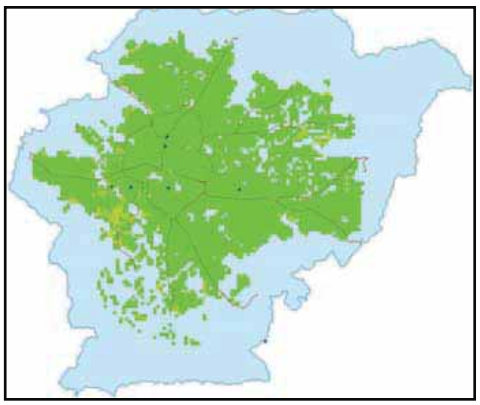


1934 Bihar-Nepal EQ (x1/1)

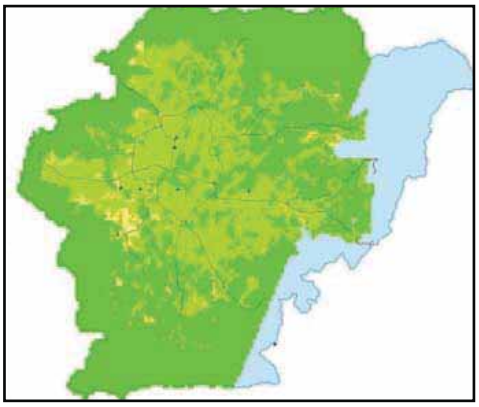


PGA (Scenario earthquakes)

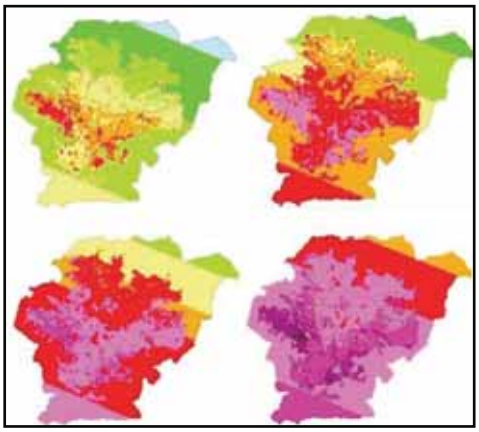
Far-Mid Western Scenario EQ (x1/1)



Western Nepal Scenario EQ (x1/1)

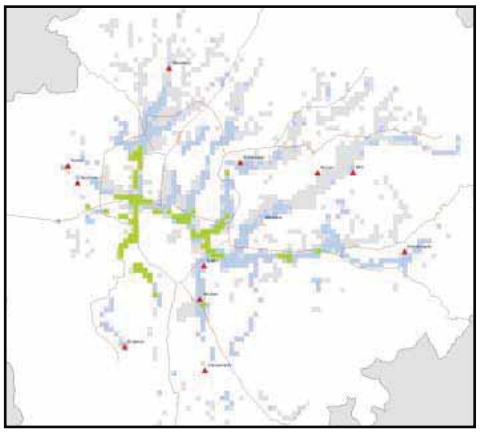


Central Nepal South Scenario EQ (x1/3. x1/2) and (x2/3, x1/1)

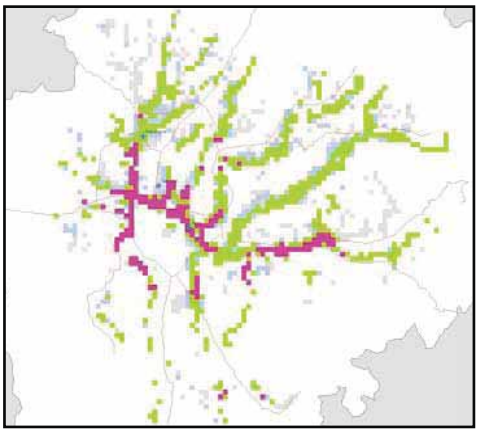


Liquefaction

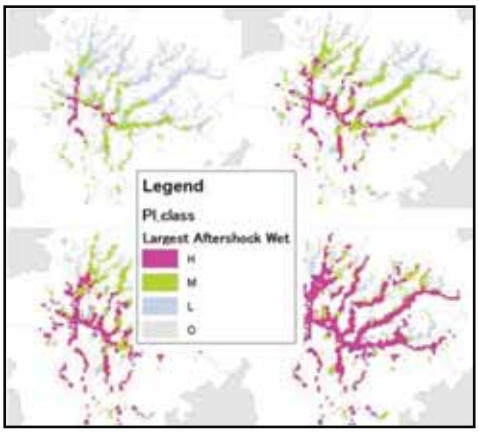
Far-Mid Western Scenario EQ (x1/1)



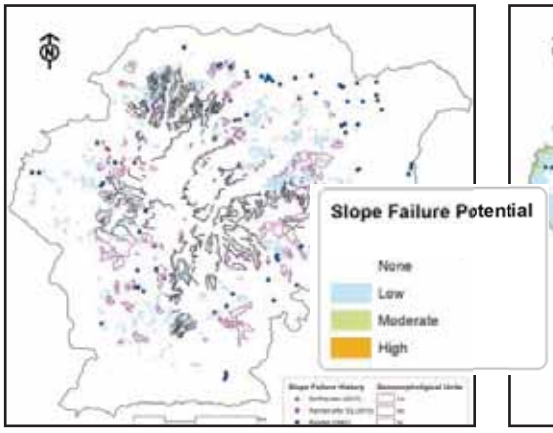
Western Nepal Scenario EQ (x1/1)

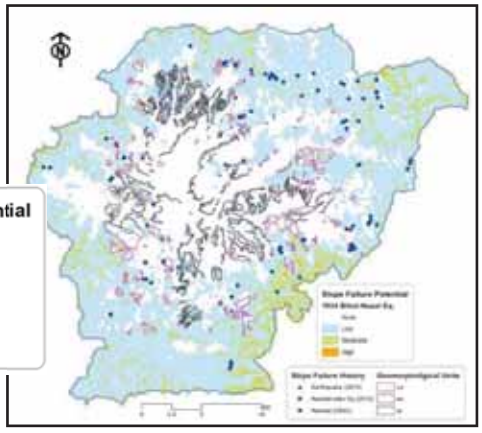


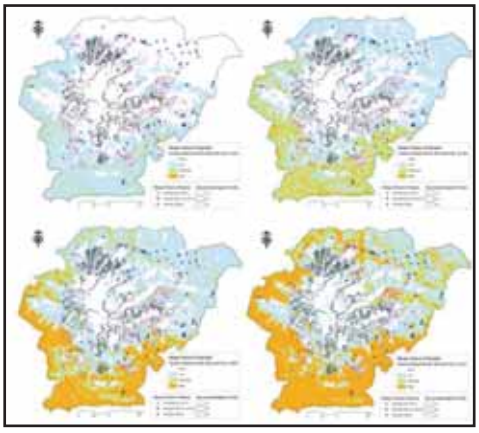
Central Nepal South Scenario EQ (x1/3. x1/2) and (x2/3, x1/1)



Earthquake induced Slope Failure





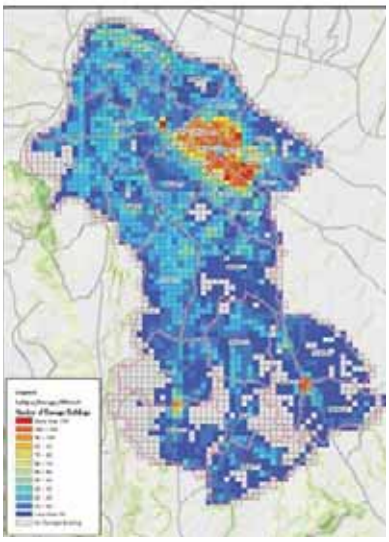


Progress of the Seismic Risk Assessment

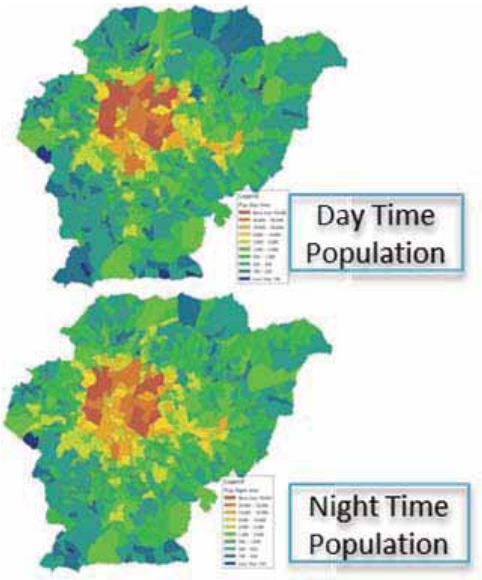
WG2 performs the seismic risk assessment based on the diverse information collected in the activity now under way and the result of seismic hazard assessment prepared by WG1. The major targets of the assessment are buildings, road network, bridges, water supply and sewage pipelines, electricity system and telecommunication system. The results will be summarized in maps by each sector such as building, infrastructure, lifelines, human damage and economic losses.

Data collection and Geo-Database Development

The Team is collecting necessary data for earthquake risk assessment, and modifying them by comparing with data from the 2002 JICA Project. The survey for the building inventory and damage from the Gorkha Earthquake is completed. Data collection for infrastructure and lifeline damages, human damage and economic loss are almost completed.



100m-grid number of damage buildings

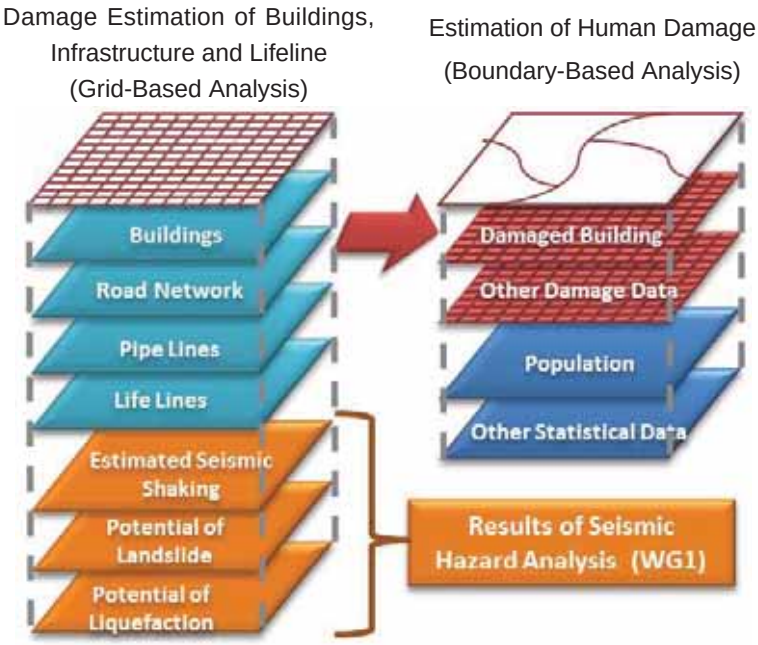


Day-Night Time Population Up to Ward Level

Approach of Seismic Risk Assessment

Damage Assessment of Building, Infrastructure and Lifeline

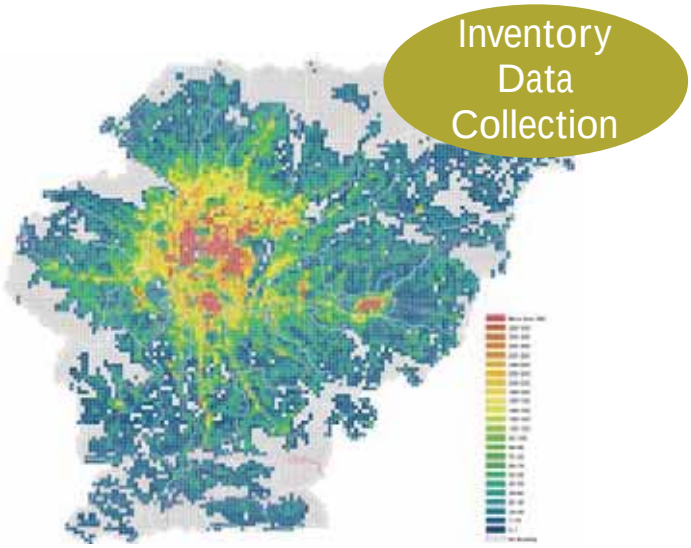
The damage of buildings, infrastructure and lifeline are estimated quantitatively based on the results of seismic hazard assessment prepared by WG1 using GIS (Geographical Information System).
Basically, the damage assessment is conducted using 250m-mesh grid as the minimum segment for analysis. For the human damage assessment, boundary-based analysis will be applied.



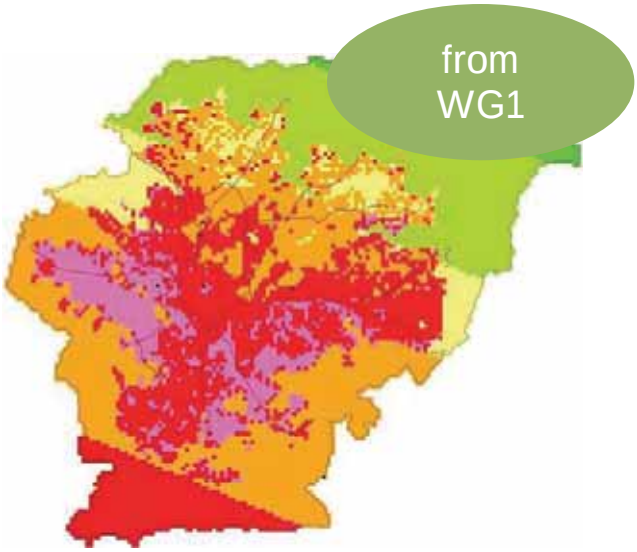
Human Damage and Economic Loss assessment based on Earthquake Occurrence Scene

The occurrence time of earthquake, such as weekday, weekend, daytime, night, will be considered subjected to the availability of data. For the purpose of Disaster Management plan, risk assessment will be carried out for 2016 and 2036. The estimation of 2036 is further divided into two cases: one with countermeasures taken during the period and another without the countermeasures.

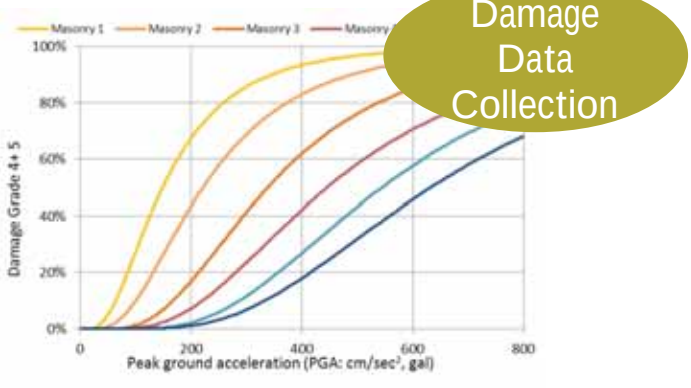
Damage Assessment Flow (Draft)
- Case of Building Damage & Human Damage -



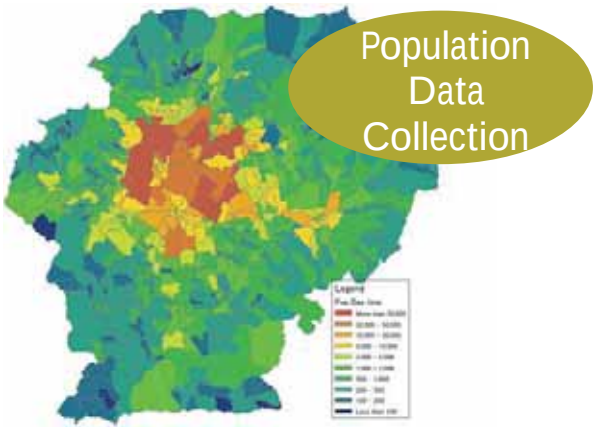
Building Inventory



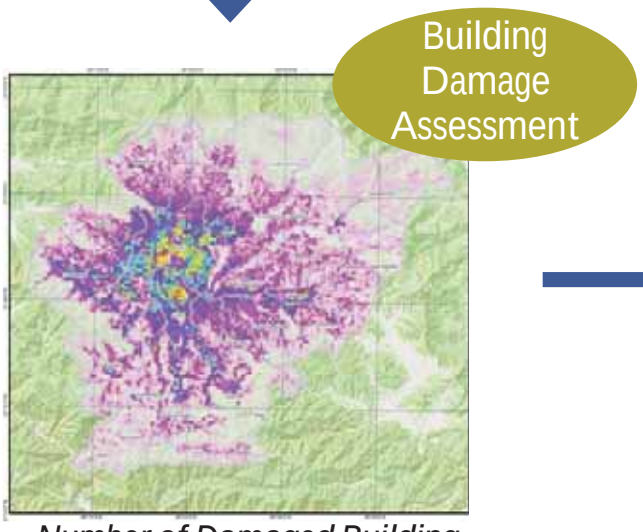
Peak Ground Acceleration



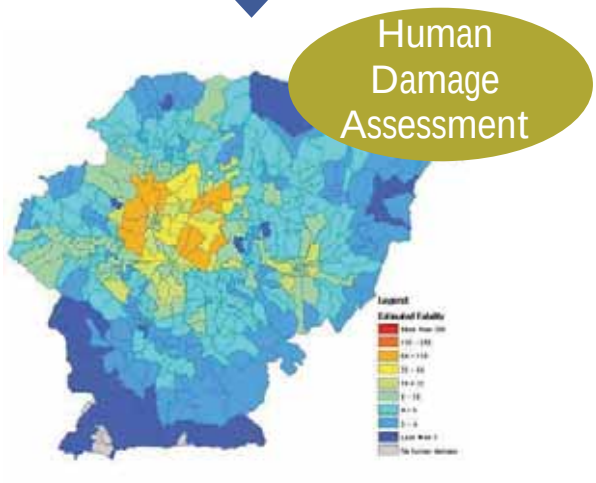
Building Damage Function
(Fragility Curve)



Population Distribution



Number of Damaged Building



Number of Death

Note: All of the above figures are still in draft form, and have not been finalized yet.

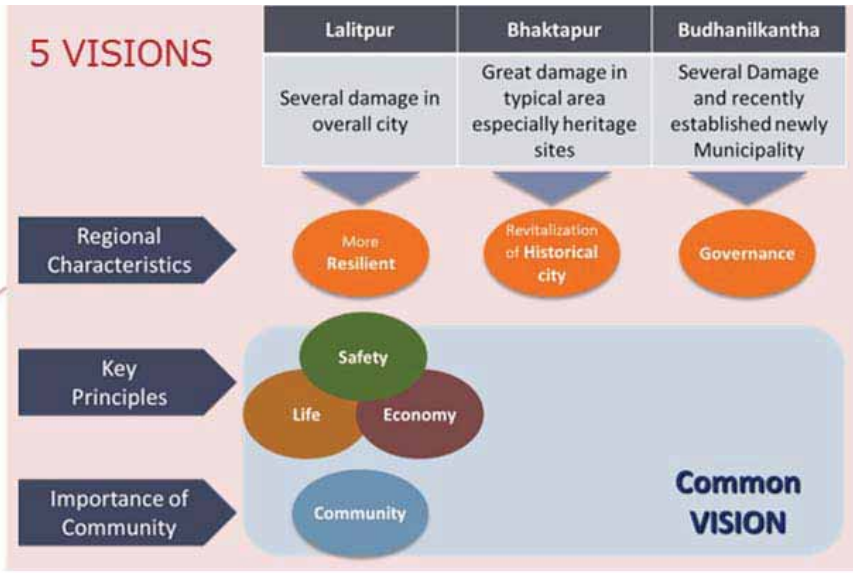
BBB Recovery and Reconstruction Plan

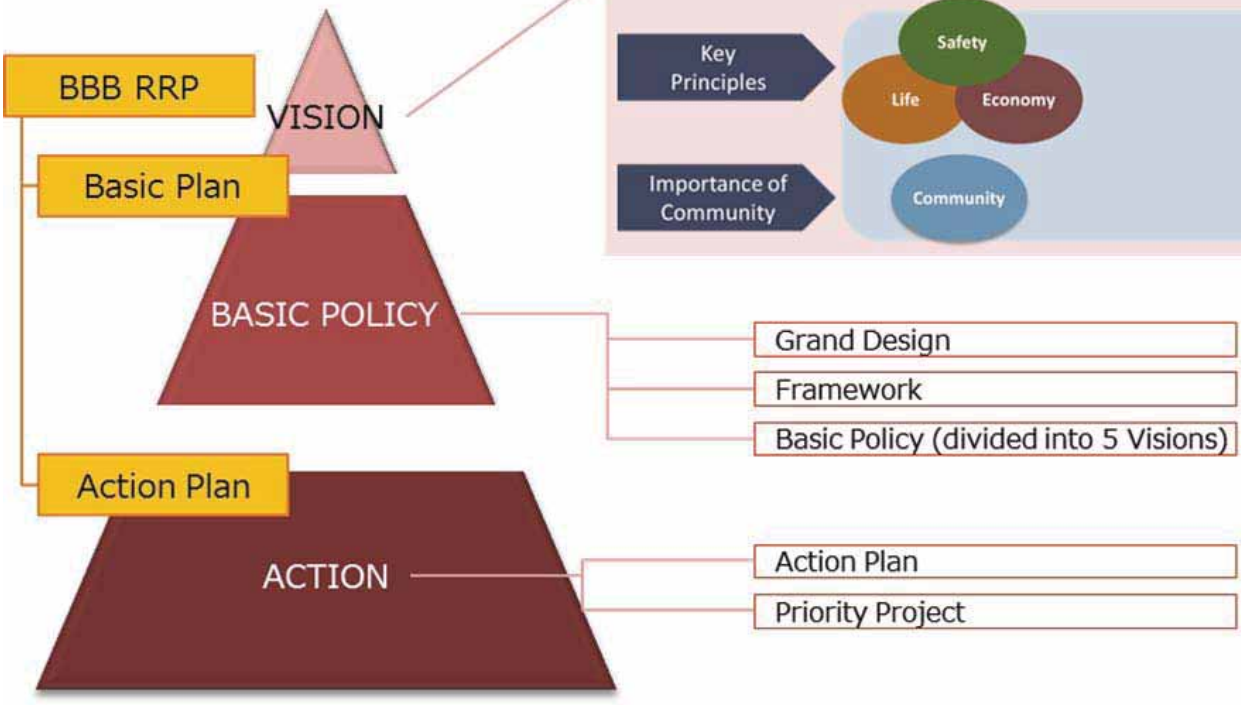
for 3 pilot municipalities

Municipalities affected by the Gorkha earthquake must conduct the actions that are necessary for their recovery. To build more resilient society, the concept of "BBB" is essential. The BBB Recovery and Reconstruction plan (RRP) shall contribute as the Master plan with necessary measures and actions including integration of DRRM into development in order to implement reconstruction smoothly and quickly for Lives of victims, industry and Economy, and urban planning for Safety and resilience. Furthermore, this plan shall contribute to clarify the role and responsibilities, and to accelerate the coordination among all stakeholders. The Project has supported formulation of the RRP for 3 Pilot Municipalities (Shown on the Right Map) and the plans were finalized.

Structure of BBB RRP

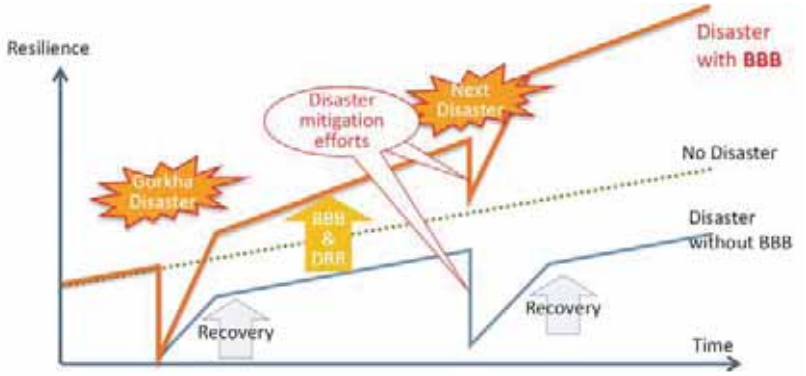
The RRP consists of the Basic Policy and Action Plan based on the Vision. The basic plan shows the entire image of the reconstruction such as vision and grand design based on the damage status and direction for future development. Each Vision is divided into several policies, and each policy includes the list of necessary countermeasures and actions for detail Action Plans. In order to achieve the policies, the Action Plan includes the responsible organizations in the municipality in consideration with the National or District organizations.



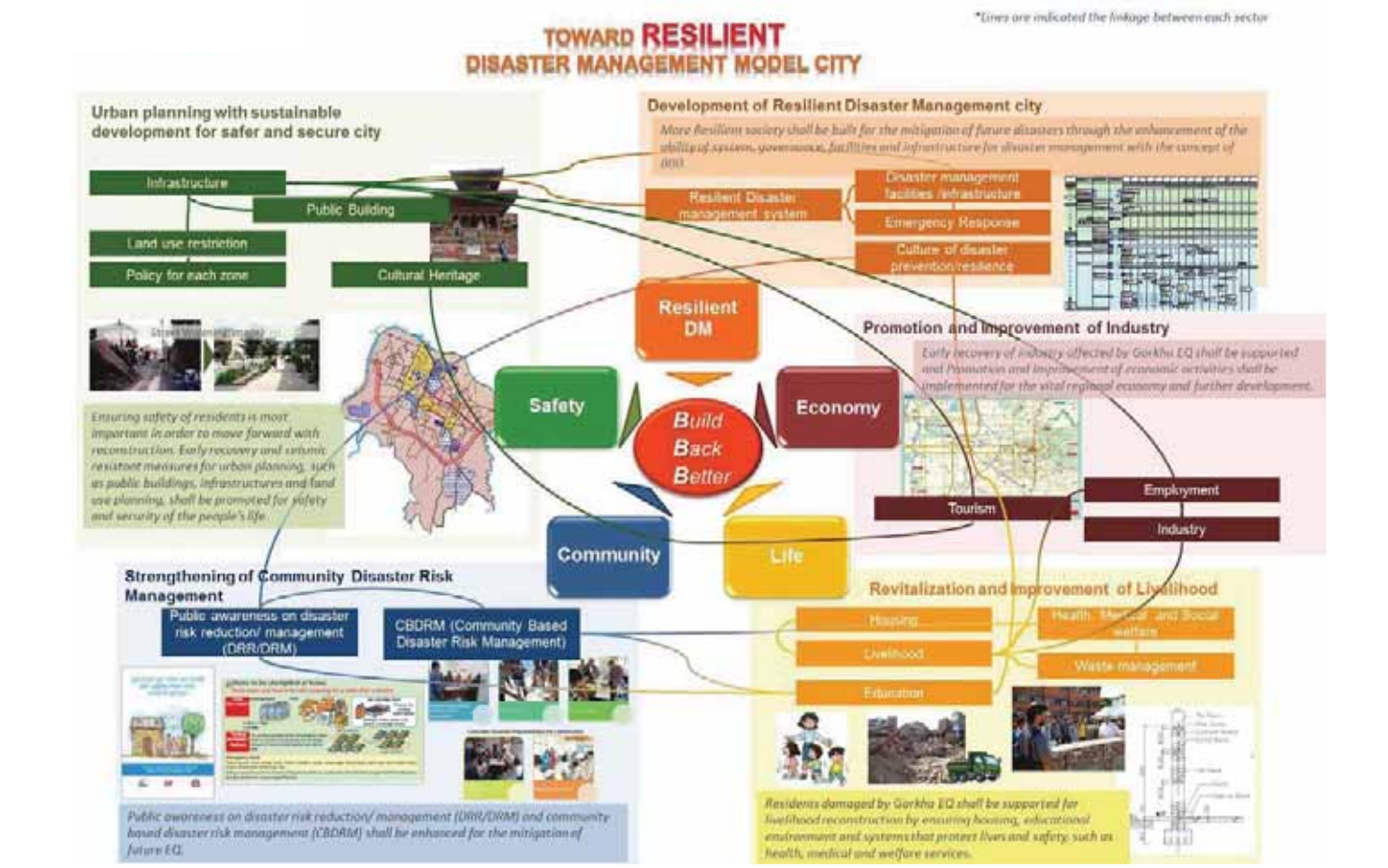


Primary Vision "Build Back Better (BBB)"

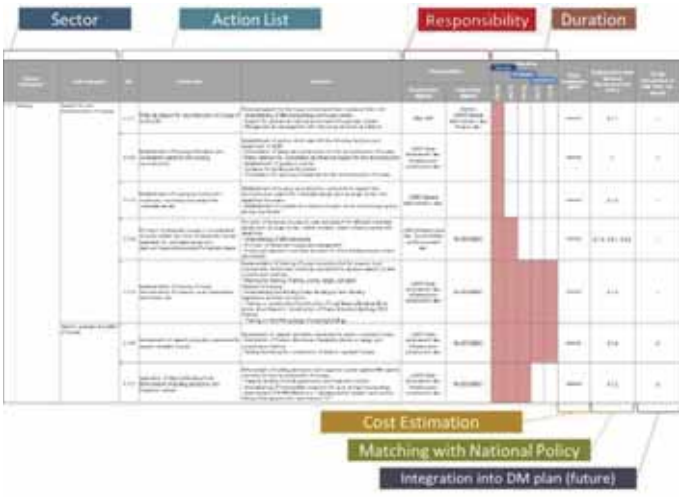
The "BBB" concept is an approach to build more resilient society during the reconstruction phase, including physical restoration of infrastructure, revitalization of livelihood, industry and economy, and the restoration of local culture and environment. With lessons learned from the disaster experiences, "BBB" concept is recognized as one of the four priorities for action of the "Sendai Framework for Disaster Risk Reduction (2015-2030, SFDRR) ", adopted in Sendai, Japan 2015.



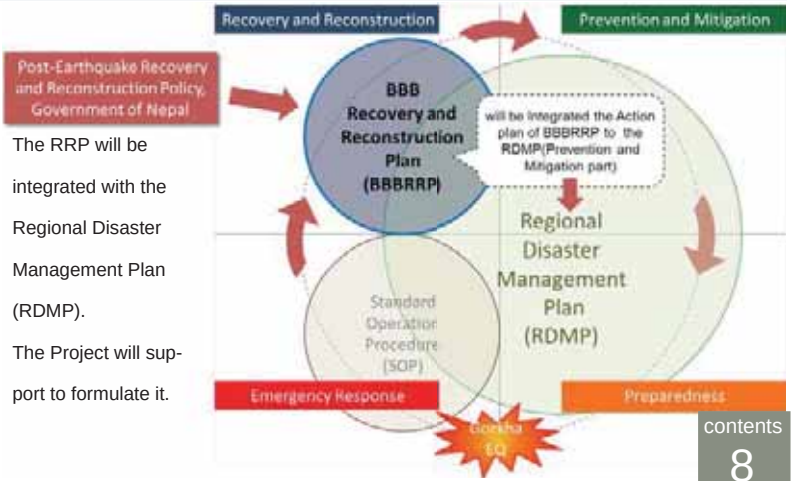
Grand Design (e.g. Lalitpur Sub-Metropolitan City)



Framework of Action Plan



Integration to DM plan (What's the Next)



The RRP will be integrated with the Regional Disaster Management Plan (RDMP).

The Project will support to formulate it.

WSs for dissemination and public comments of the BBB RR Plan

Workshops (WS) were held in each pilot municipality for the introduction, dissemination and getting the public comments for the BBB RR Plan. Municipal council members, municipal officials, ward secretaries and leaders of community disaster management committee, etc. were invited and most of them participated. They attentively followed the explanation and were actively involved in the discussion. In the question-and-answer session, in particular, the importance of implementation of the plan was focused, and also the participants mentioned that there still are areas where the reconstruction works have not started yet.

Lalitpur Sub-Metropolitan City May 8, 2016



Budhanilkantha Municipality May 11, 2016



Bhaktapur Municipality July 20, 2016



Official approval of BBB RR plan from municipal council

The JICA Project Team is supporting the official approval of BBB RR plan from the municipal council towards the comprehensive implementation of the plan. For the process of the official approval, the executive officer of the municipality consults with the municipal council,and then the plan will be the official document of the municipality with the official approval. As of September 2016, the BBB RR Plan for the Lalitpur Sub-Metropolitan City has already been officially approved by the municipal council.

Counterpart Training in Japan

Counterpart training in Japan is scheduled to be held three times, out of which two have already completed as shown below.

1st Counterpart Training

(24 Oct 2015 - 8 Nov 2015)

BBB Recovery and Reconstruction and Disaster Management System

11 participants from MoUD, MoFALD including 2 participants from Pilot municipalities, MoHA and DUDBC

1. Seminar at GRIPs (University)
2. Ministry of Land, Infrastructure, Transport and Tourism
3. Miyagi Prefecture (Tohoku)
4. National Research Institute for Earth Science and Disaster Prevention

<Objectives>

1) To become able to propose measures for recovery and reconstruction planning and disaster management planning in each level of government

2) To become able to propose measures for Strengthening the cooperation among organizations in Kathmandu Valley

3) To become able to propose measures for Concrete initiatives, activities for recovery, reconstruction and DM Planning

2nd Counterpart Training

(15 Mar 2016 - 27 Mar 2016)

Seismic Hazard and Risk Assessment

12 participants from MoUD, MoFALD, MoHA, DMG and DUDBC

1. Tokyo Rinkai Disaster Prevention Park
2. Japan Meteorological Agency
3. Damaged area due to the Earthquake in 2011 in Sendai (Tohoku)
4. Honjo life safety learning centre

<Objectives>

1) To become able to propose measures for "Seismic Hazard Analysis" of the future earthquake in Kathmandu Valley.

2) To become able to propose measures for "Seismic Risk Assessment" based on the Hazard analysis in Kathmandu Valley.

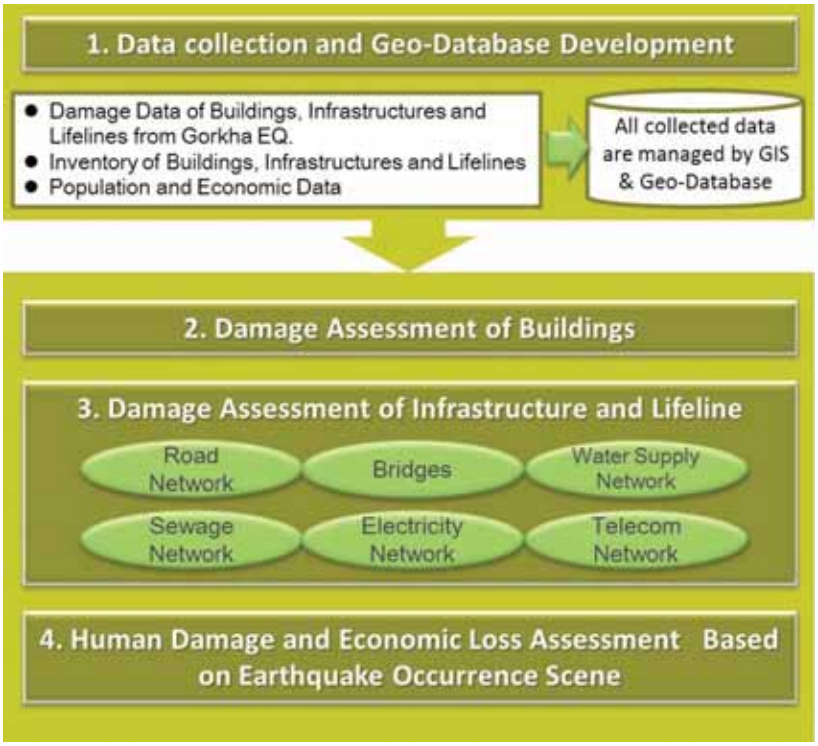
3) To increase knowledge on "total disaster risk management", and become able to propose measures for utilizing the result of Seismic risk assessment into the BBB reconstruction from the Gorkha Earthquake and disaster risk management.

Further Schedule

Result of Seismic Hazard Assessment (Contents 6)

BBB Recovery and Reconstruction Plan (Contents 8)

Seismic Risk Assessment for Buildings, Infrastructure Lifeline, and Social and Economic Impact (Contents 7)



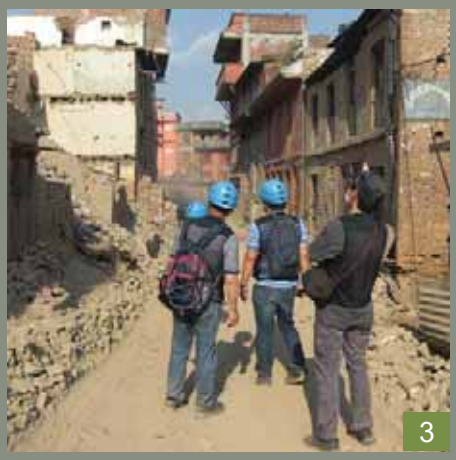
Formulation of Disaster Risk Management (DRM) Plan Guideline, DRM plans for the three Pilot Municipalities, Community based Disaster Risk Management (CBDRM) Activities, and Standard Operation Procedure (SOP)

Image of Guideline for DM Plan

Image of SOP

1


2


3


4


5


6

Title Page

7

8

9

10

-Caption of Photos-

1. One year seminar in April 25 2016
2. Bridge Survey for risk assessment
3. Damage Survey in Bhaktapur
4. Construction of Cut Model in TU
5. First Meeting with new Secretary of MoUD
6. Regular Meeting with Counter-parts

7,8 . Dissemination WS in Budhanil-kantha Municipality

9. Sharing the data of Hazard Assess-ment with DMG.
10. Technical Transfer for Building Risk assessment to DUDBC

JICA PROJECT

ERAKV

NEPAL - JAPAN

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

https://www.facebook.com/JICA-Earthquake-Risk-Assessment-PJ-in-KV-Nepal-Community-690728411055174/