Nepal Earthquake 2015 Loss Assessment:
on the Perspective of China

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Academy of Disaster Reduction and Emergency Management,
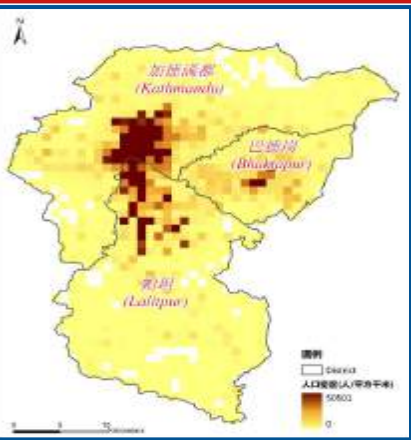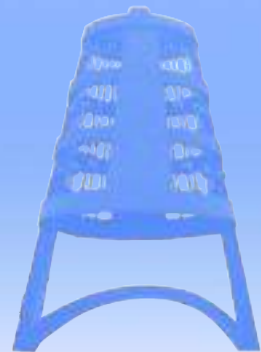Ministry of Civil Affairs & Ministry of Education

Beijing Normal University

Outline

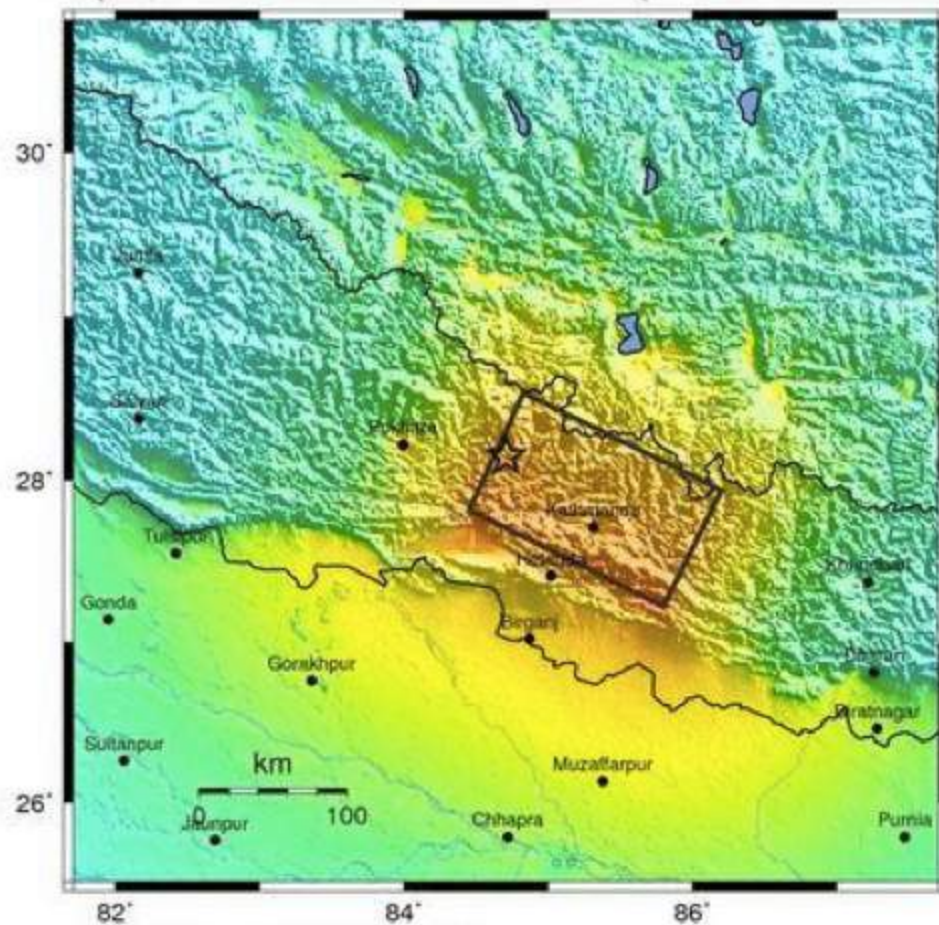# 1. Introduction

Shaking Intensity

The Modified Mercalli Intensity (MMI) scale depicts shaking severity. The area nearest Katmandu experienced very strong to severe shaking.

Modified Mercalli Intensity	Perceived Shaking
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II–III	Weak
I	Not Felt

Image courtesy of the US Geological Survey

USGS Estimated shaking Intensity from M 7.8 Earthquake

1) Team building

2) Preparation

3) Data collection

4) Field Survey in Nepal

5) Report Writing

Preparation Meeting before departure for field work in Nepal

Team Members

- 18 members
- 7 Institutes

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Yunfei Qiao	Chinese Academy of Cultural Heritage, State Administration of Cultural Heritage, Institute of Engineering Planning，Director/Senior Engineer
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Tiehua Shi	China Academy of Building Research. Researcher
Li Yang	Building General Municipal Engineering Design & Research Institute Co., Ltd., Senior Engineer
Qi Li	Building General Municipal Engineering Design & Research Institute Co., Ltd. , Senior Engineer

Collection of Dataset
(hazard, statistics, remote sensing imagery, modeling parameters, etc.)

Category	Data name	Data content	Time	Data sources
Fundamental geographic	Administrative division	Development area, Prefecture, City, County, City Point, Administrative area code	2014	HDX
	Natural environment	Terrain elevation, Hydrographic net, etc.	——	HDX
	Traffic data	Airport, Road	2015	HDX
Socio-economic	Nepal Statistical Yearbook	Nepalese Population, GDP, etc.	2013	Central Bureau of Statistics (CBS)
	Nepalese population census data	Nepalese administrative units, Households, etc.	2011	Central Bureau of Statistics (CBS)
	Nepalese county level statistics data	Nepalese county level socio-economic statistics data, population, households, number of enterprises, etc.	2014/2015	Central Bureau of Statistics (CBS)
Thematic elements	Housing data	House number, House structure type	2011	Nepalese statistics departments
	Cultural heritage maps	Heritage place plans, individual building dimensions, Heritage composition maps	2015	Nepal archaeological bureau
Remote sensing data	Satellite remote sensing data before disaster	High-resolution satellite images	November 13, 2014	Google Earth
	Satellite remote sensing data before disaster	High-resolution satellite images	May 14, 2015	Google Earth
	UAV remote sensing data after the disaster	UAV remote sensing data	In May 2015	Domestic sharing mechanism
Casualty loss	Loss data	Death and missing population, Damaged buildings, Relocated population	2015	Nepal Ministry of the interior

Field work: -- 3 cities (Kathmandu, Lalitpur and Bhaktapur)
-- detailed survey at 29 locations in the above 3 cities
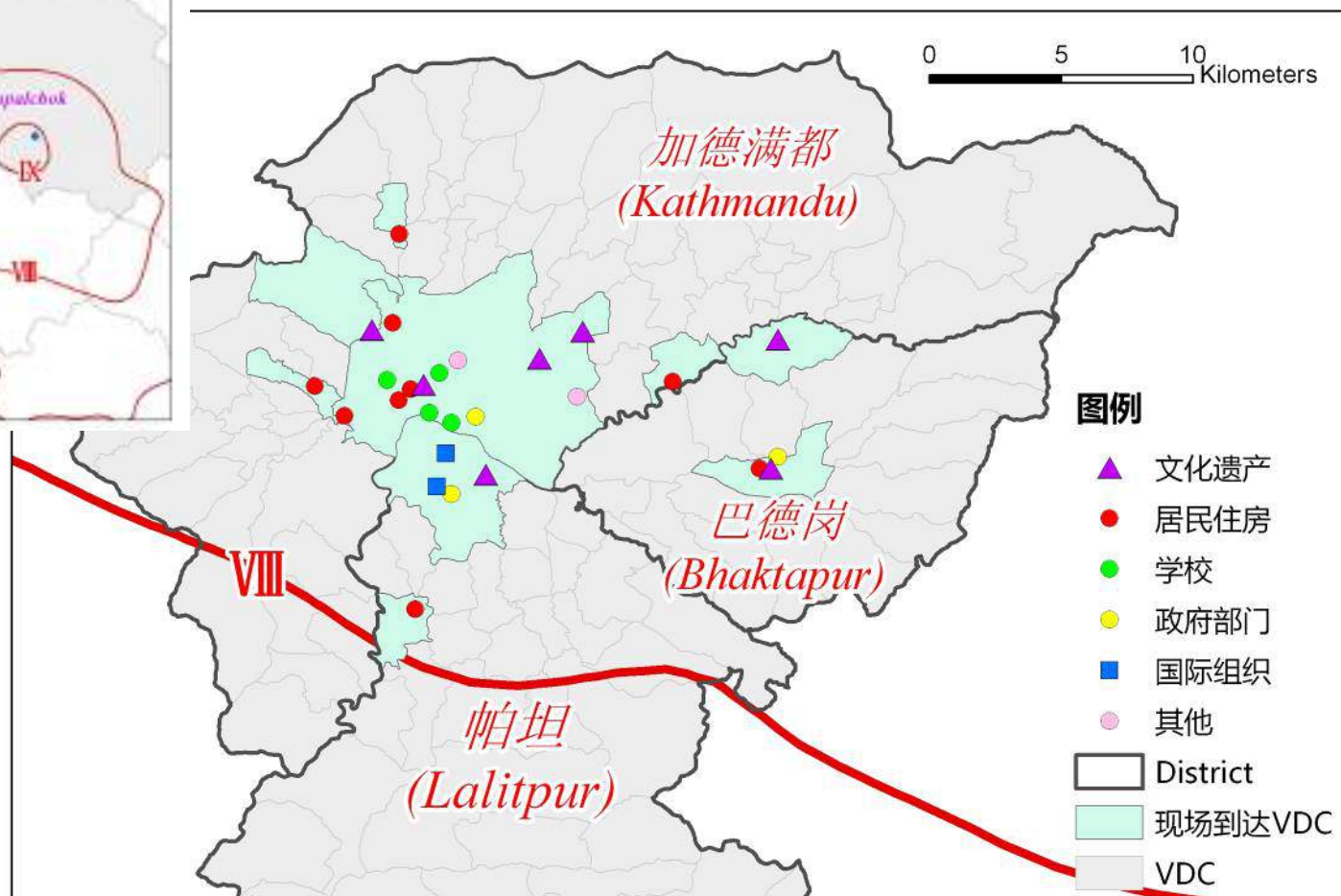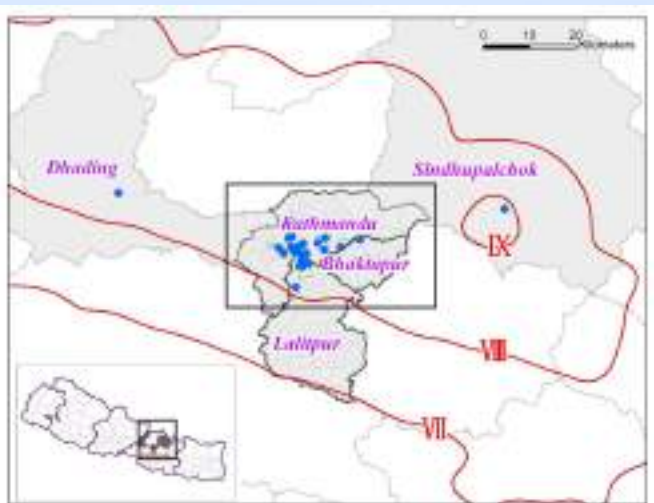
Meeting with National Planning Commission of Nepal (June 6)

Meeting with Mayer of Lalitpur (June11)

Survey in temporal shelter (June 11)
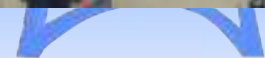
Meeting with Economic and Commercial Counselor (June 12)
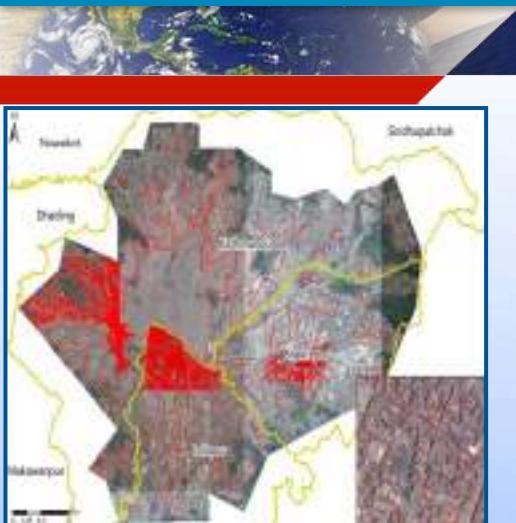
Field survey at Kathmandu, June 9

Changu Narayan Temple, May 10

Field survey at School, Kathmandu, June 10

Lalitpur, June 11

Scope of Assessment

1. Nepal

- Total Direct Economic Loss

2. Three Cities (Kathmandu, Lalitpur Bhaktapur)

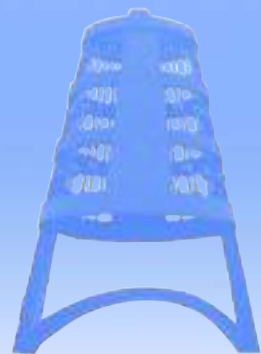- Building
- Infrastructure
- Heritage

Data and Methods for Assessment

1) Hazard maps: China Earthquake Administration, USGS

2) Field Survey: data by Assessment Team in Nepal

3) Satellite Imagery: obtained by NDRCC, China, and UN-Charter

4) Exposure data: Population, Building, Socio-economic from intl. Org.

5) Loss Statistics: casualty, and building damages by Nepal Gov. (by June 20)

6) Others: Rapid loss assessment results by other international organizations

2. Direct Economic Loss

Direct economic loss

loss caused by physical damage induced by earthquakes, such as physical damages of buildings, infrastructure, equipment and other fixed assets while the cultural value of buildings, the value of non-moving cultural relics, land resources and other natural resources are not considered.

Loss rate of fixed asset

Direct Economic Loss = Fixed Asset Stock × Fixed Asset loss rate
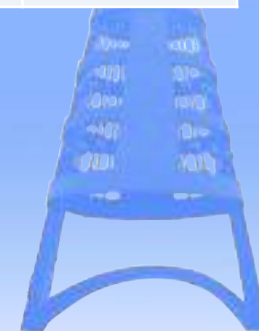
Fixed Asset Stock: the total number of buildings, infrastructures, equipment and other fixed asset from historical investment. It is the upper limit of direct economic loss caused by a disaster. The calculation fixed asset stock is mainly based on historical fixed asset, rice index, depreciation rate, GDP and other indicators.

Loss Rate of Fixed Asset: classified into high, medium and low 3 types. The calculation of 3 types of loss rate is mainly based on the estimated "complete damage rate" and "partial damage rate "of private buildings in affected area.

Direct Economic Loss of Nepal and 3 Cities

(unit: 0.1bn)

Unit	GDP	Assets	Damage Ratio (%)			Direct Economic Loss		
			low	moderate	high	low	moderate	high
Nepal	198.82	731.66	6.5	7.3	8.1	47.6	53.6	59.5
-Kathmandu	31.33	115.28	6.9	7.8	8.7	8.0	9.0	10.0
-Lalitpur	2.73	10.05	18.8	21.2	23.5	1.9	2.1	2.4
-Bhaktapur	5.76	21.19	10.8	12.2	13.5	2.3	2.6	2.9
-Sum of 3 cities	39.82	146.53	/	/	/	12.2	13.7	15.2

NEPAL EARTHQUAKE 2015

Post Disaster Needs Assessment

VOL. A: KEY FINDINGS

GOVERNMENT OF NEPAL
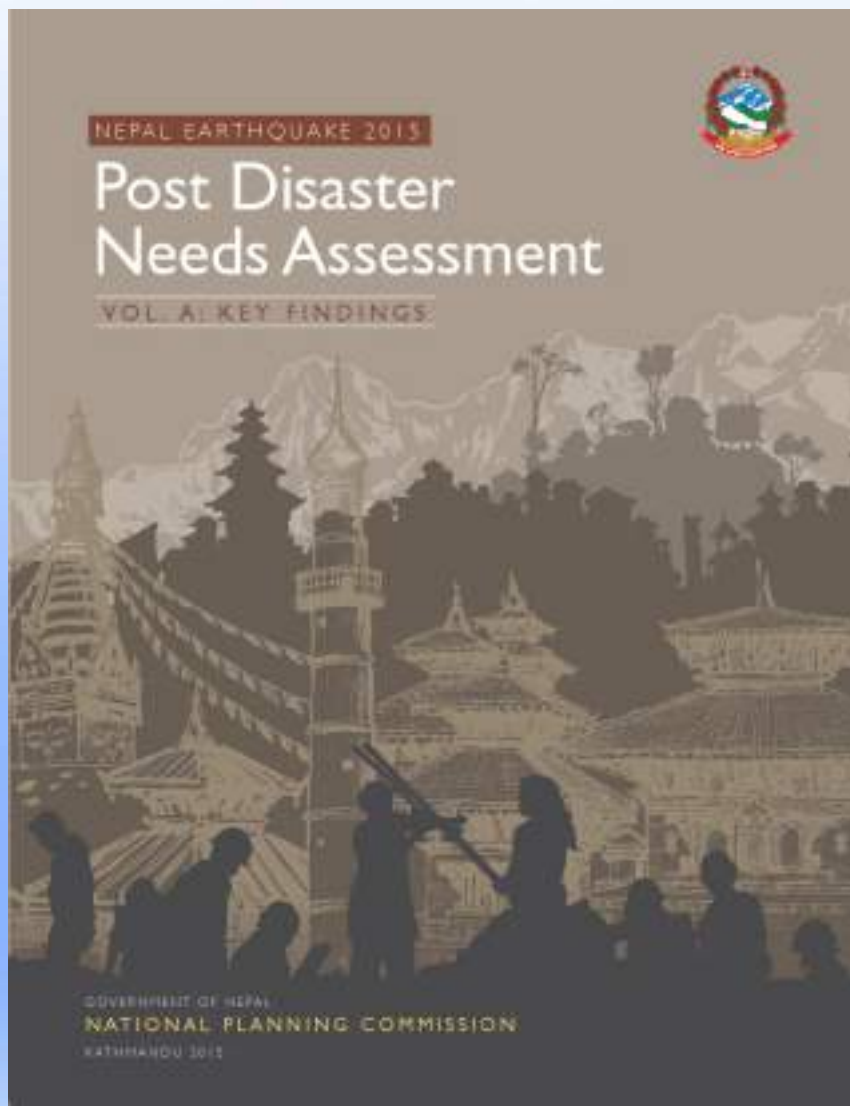NATIONAL PLANNING COMMISSION
KATHMANDU 2015

TABLE 1. SUMMARY OF DISASTER EFFECTS

	Disaster Effects (NPR million)			Distribution of Disaster Effects (NPR million)		Losses in personal income (NPR million)
	Damages	Losses	Total	Private	Public	
Social Sectors	355,028	53,597	408,625	363,248	45,377	–
Housing and Human Settlements	303,632	46,908	350,540	350,540		–
Health	6,422	1,122	7,544	1,394	6,150	–
Education	28,064	3,254	31,318	2,365	28,953	–
Cultural Heritage	16,910	2,315	19,225	8,948	10,274	
Productive Sectors	58,474	120,646	179,121	156,079	20,043	17,124
Agriculture	16,405	11,962	28,366	25,813	2,553	4,980
Irrigation	383	–	385	–	385	
Commerce	9,015	7,938	16,953	16,953	–	2,667
Industry	8,394	10,877	19,271	19,271	–	3,654
Tourism	18,863	62,379	81,242	75,105	6,137	6,200
Finance	5,013	26,890	31,905	20,937	10,069	–
Infrastructure Sectors	52,460	14,323	66,783	17,281	46,502	
Electricity	17,807	3,435	21,242	15,589	5,673	–
Communications	3,610	5,085	8,695	1,712	6,983	
Community Infrastructure	3,349	–	3,349		3,349	–
Transport	17,188	4,930	22,118	–	22,118	
Water and Sanitation	10,506	873	11,379	–	11,379	–
Cross-Cutting Issues	51,872	1,061	52,955	1,755	51,178	–
Governance	18,757		18,757		18,757	–
Disaster Risk Reduction	155	–	155	–	155	–
Environment and Forestry	32,900	1,061	34,021	1,755	32,267	–
Total	517,434	189,027	706,461	540,362	166,100	17,124
Total (US$ million)	$5,174	$1,890	$7,065	$5,404	$1,661	$171

Source: Estimation by PDNA Team

Total	517,434
Total (US$ million)	$5,174

Comparison with PDNA of Nepal Earthquake 2015

3. Building Loss

Field Survey

1. Relatively old residential buildings: 1-2 stories, Masonry or wooden.
Majority of them are severe damaged or collapsed; a few old residential
buildings are brick or masonry structure, damage state severer than
moderate are nearly 50%, a few are severe damaged or collapsed.

Field Survey

2. Multi-story residential or commercial buildings

Relatively new, masonry or frame structure, majority of which are 3-5 stories. The damage degree is relatively slight, damage state severer than medium are less than 30%, very few are collapsed.
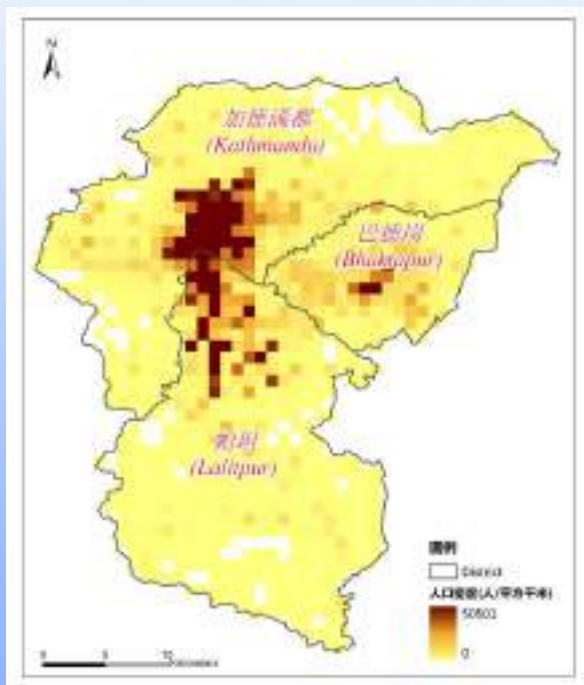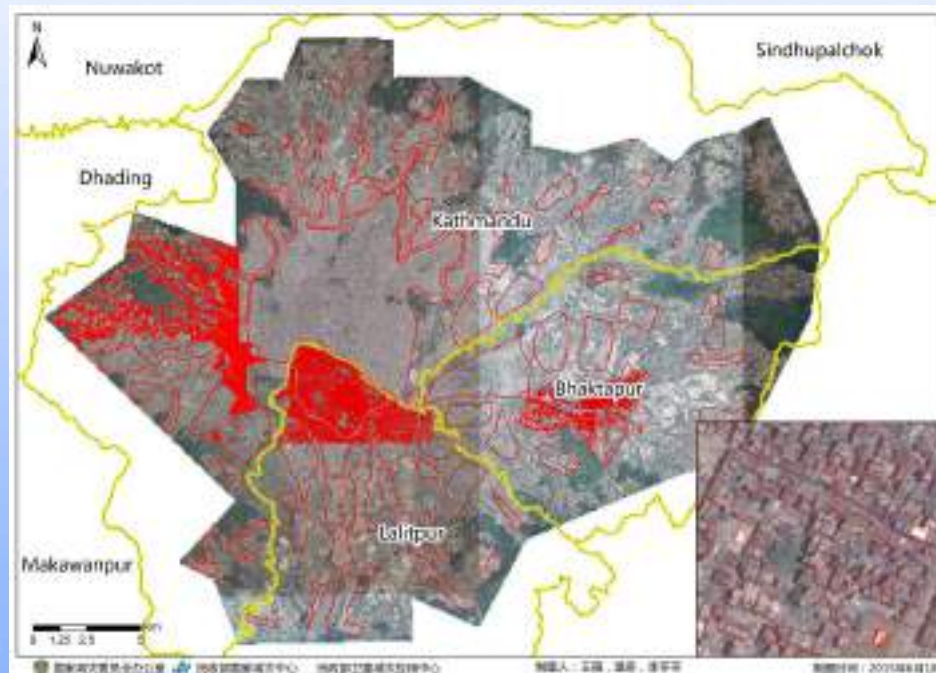

3. High-rise residential buildings:

reinforced concrete frame or shear wall structure, brick filled wall, the damage state is under medium from appearance, no severe damage.
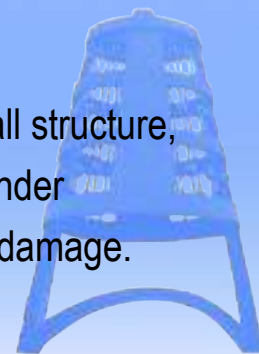
Population (1km grid)

Building Stock Estimation with high-resolution Imagery
(data source: NDRCC, China)

Population and building statistics (Data source: Nepal statistics depart.)

Area	Population	Building	Building structure type%		
			Frame	Masonry	Wooden
Kathmandu	1,744,240	436,344	20	75	5
Bhaktapur	304,651	68,636	10	85	5
Lalitpur	468,132	109,797	15	75	10
Total	2,517,023	614,777	—	—	—
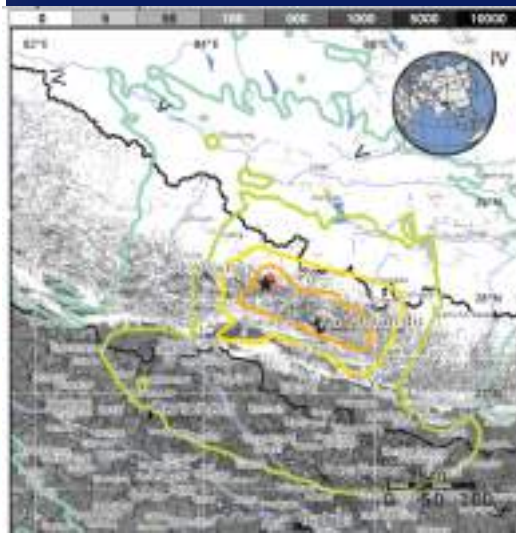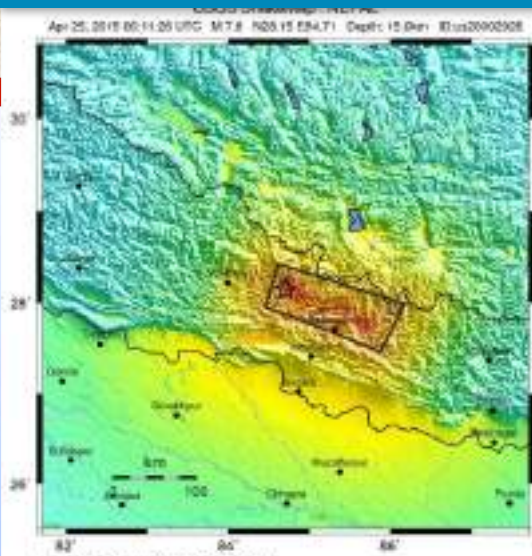
Shaking/Intensity Maps

Damage Ratio of three cities /%

	Building type	Slight	Moderate	Severe	Complete
Kathmandu	Wooden	20%	40%	25%	15%
	Masonry / Concrete	72%	20%	6%	2%
	Frame	100%	0%	0%	0%
Lalitpur	Wooden	30%	30%	28%	12%
	Masonry / Concrete	65%	20%	12%	3%
	Frame	100%	0%	0%	0%
Bhaktapur	Wooden	15%	35%	30%	20%
	Masonry / Concrete	55%	20%	15%	10%
	Frame	100%	0%	0%	0%

Residential damage in 3 cities

	Building type	Slight	Moderate	Severe	Complete
Kathmandu	Wooden	4355	8711	5444	3267
	Masonry / Concrete	235194	65332	19599	6533
	Frame	87109	0	0	0
	Sum	326658	74042	25044	9800
Lalitpur	Wooden	3285	3285	3066	1314
	Masonry / Concrete	53384	16426	9855	2464
	Frame	16426	0	0	0
	Sum	73095	19711	12922	3778
Bhaktapur	Wooden	514	1200	1028	686
	Masonry / Concrete	32050	11655	8741	5827
	Frame	6856	0	0	0
	Sum	39420	12854	9769	6513
Totals of 3 cities		439173	106608	47735	20091

Public Building Loss (field survey results)

School	Location	Students	Building type	Damage Status
Gramsewa Higher Secondary School	Dharmasthali, Kathmandu	600	Frame	Slight
Sanskrit	Kathmandu city	300	Masonry / Concrete	Severe
Unnamed	Kathmandu city	100	Manufactured; Brick & Wooden	Slight or Severe
Municipal public school	Kathmandu city	200	Teaching: Concrete & Steel (3 stories) Office : Brick & Wooden (1 story)	Teaching: Slight Office: Severe
Shree Geetamata	Kathmandu city	300	Masonry / Concrete (4 stories)	Severe

* Severe damage ratio: Schools (20%), Hospital (5%), Government Building(15%)
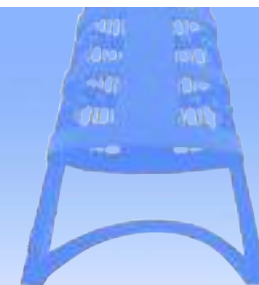
4. Infrastructures
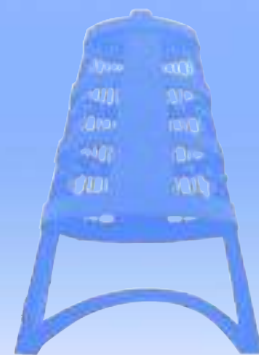
Water Tank

The water sources of residents in Kathmandu, Patan and Budgang mainly are well water, river (spring) water and tap water, which are mainly distributed water supplies. The water security rate is low.

Public water supply station

Water storage tank

Down-hole

Bottled water

Water tower

Feed mains
(Cast iron pipe)

Sparge pipe (Galvanized pipe)

Each independent water supply system is small and the water supply network coverage is low.

Except for the initial supply panic, although Kathmandu's water security is low, **the impact of the earthquake is generally small.**

Inlet branch pipe (Galvanized pipe)

Range pipe (Exposed installation，PE pipe)

**Drain cover plate
(confluence of rainwater &sewage)**

**Open drain
(confluence of rainwater & sewage)**

There are no systematic drainage facilities and municipal wastewater treatments in Kathmandu, Patan, Bhadgaon and other places.

Rainwater passes through the road runoff into the gutter or open ditch on either side of the road, and eventually pooled into the Bagati River.

During the field investigation, no drainage facilities were found to be significantly damaged after the earthquake.

Urban electricity supply & communication line（top）

Uneven settlement of junction of cross-river bridge（right）

Road system. Some cross river Bridges, in the bridge body and the land connection positions, because of uneven settlement, cracks were found along the transverse section. bridge decks and roads of other Bridges did not show abnormal changes.

Power supply and communication systems. According to the field surveys, within two months after the earthquake, the electricity supply and communication in the city were basically restored to their original level.

The fuel gas system Three cities adopt gas cylinder air supplies, During the investigation, a larger LPG transfer station was observed and its operation was normal. There should be no obvious damage.

5. Heritage

Distribution of Heritage Sites in Kathmandu

Surveyed 7 world heritage sites in 3 cities in Kathmandu Valley, including 130 individual buildings, covered area 83397m^2, total area 180ha

Surveyed and recorded seismic damage and conservation status, laws, regulations and technical standards about heritage protection

Severity Types:

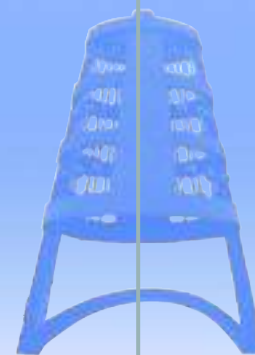Main heritage building status: collapse and conserved status

Sum-up the number and volume of each site

Building status:

A: Structural cracking, deformation, security risks

B: Structural cracking, severe deformation, severe security risks

C: Main building collapse

Heritage	Profile	Damage/Loss Status
加德满都皇宫广场	地处加德满都古城中心，皇宫广场集中了尼泊尔马拉王朝的古建筑，多建于为16世纪至19世纪，总共有43组（座）寺庙和宫殿，主要古建筑包括独木庙（Kasthamandap）、库玛莉神院（KumariBahal）、旧皇宫（Hanuman Dhoka）和塔莱珠神庙（TalejuBhawan）等。	加德满都皇宫广场文物建筑受损十分严重，共有天黑神庙、纳拉杨毗湿奴庙、玛珠庙、Kamdev神庙、独木庙、纳拉扬神庙、Panch Mukti Hanuman 神庙等七处神庙完全坍塌，皇宫城墙及塔庙遭受不同程度的局部坍塌、开裂、变形破坏。
帕坦皇宫广场	帕坦是尼泊尔最古老的城市，帕坦皇宫广场包括帕坦王宫及其附近的寺庙群，被誉为"尼泊尔建筑艺术的杰出典范"。	广场文物建筑受损严重，共有贾嘉纳拉扬神庙、哈里·尚卡尔神庙等两处神庙完全坍塌，部分塔庙遭受不同程度开裂、变形破坏。
巴德岗皇宫广场	广场修建于马拉王朝鼎盛时期，被誉为"中世纪尼泊尔艺术的精华和宝库"，特别是其中的金门和五十五窗宫，是世界罕见的艺术珍品。	广场文物建筑受损严重，共有西大门、Rameshvara神庙、国王雕像柱、瓦斯塔拉杜迦神庙和法希得噶神庙等五处主要建筑完全坍塌，部分塔庙遭受不同程度开裂、变形破坏。
斯瓦布纳特	意为"自体放光"，该寺修建于2500年前，是尼泊尔最古老的佛教寺庙，因为寺庙里猴子众多，所以得名猴庙。	佛塔震损较小，周边喇嘛庙坍塌、开裂变形十分严重。
昌古纳拉扬寺	该寺庙主供毗湿奴，受到印度教徒的尊敬，被认为是尼泊尔最古老的印度教神庙。	主体佛寺局部开裂变形，总体保存较好，但附属建筑损失严重。
帕舒帕蒂纳特	意为"一切生物的保护者和主"，帕舒帕蒂纳特庙占地面积2.6平方公里，是塔式建筑。	Bishworoop塔顶部局部坍塌，墙体开裂受损严重；部分小型佛塔坍塌，其他文物建筑受损较小，保存较好。
布达哈佛塔	又名保纳特佛塔，相传建于公元5世纪，是李察维王朝的希瓦.蒂瓦国王所建，塔中央安放释迦牟尼弟子摩柯迦叶的舍利。该塔是尼泊尔最高大的佛塔。16世纪时，该塔由西藏宁玛派喇嘛修复，19世纪中叶到20世纪中叶，该塔一直由中国西藏的喇嘛掌管。	上部塔体出现开裂变形，总体保存较好，当地正在组织抢险加固，其他文物建筑受损较小，保存较好。

Earthquake: significant magnitude and massive destruction potential

Structure:

Problematic

Weak Adhesion and joint of brick and masonry structure

Disrepair

kathmandu Durbar Square / Kasthamandap

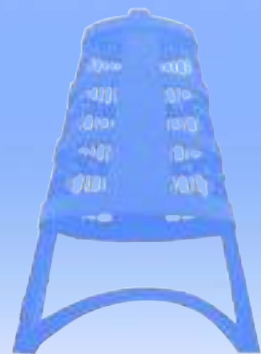Patan Durbar Square/ Jagannarayan Mandir

Bhaktapur Durbar Square / karma Cetus Temple

Changu Narayan Temple / Laxmi Narayan

6. Suggestions

Suggestions to Chinese government

1) Localization: in complied with local cultural, geophysical, and socio-economic conditions
2) Priority areas: define reconstruction priority areas: shall consider both short-term and long-term goals
3) Project types: both structure project, and technical assistance project, in order to enhance local capacity

Suggested Priority Reconstruction Projects

1) Heritage
2) Municipal infrastructure
3) Public buildings (school, hospital, government buildings)
4) Residential building

Thank you!