INDIAN INSTITUTE FOR
HUMAN SETTLEMENTS

Nepal Mission Report

Typology of Damages

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF BOXES

LIST OF FIGURES

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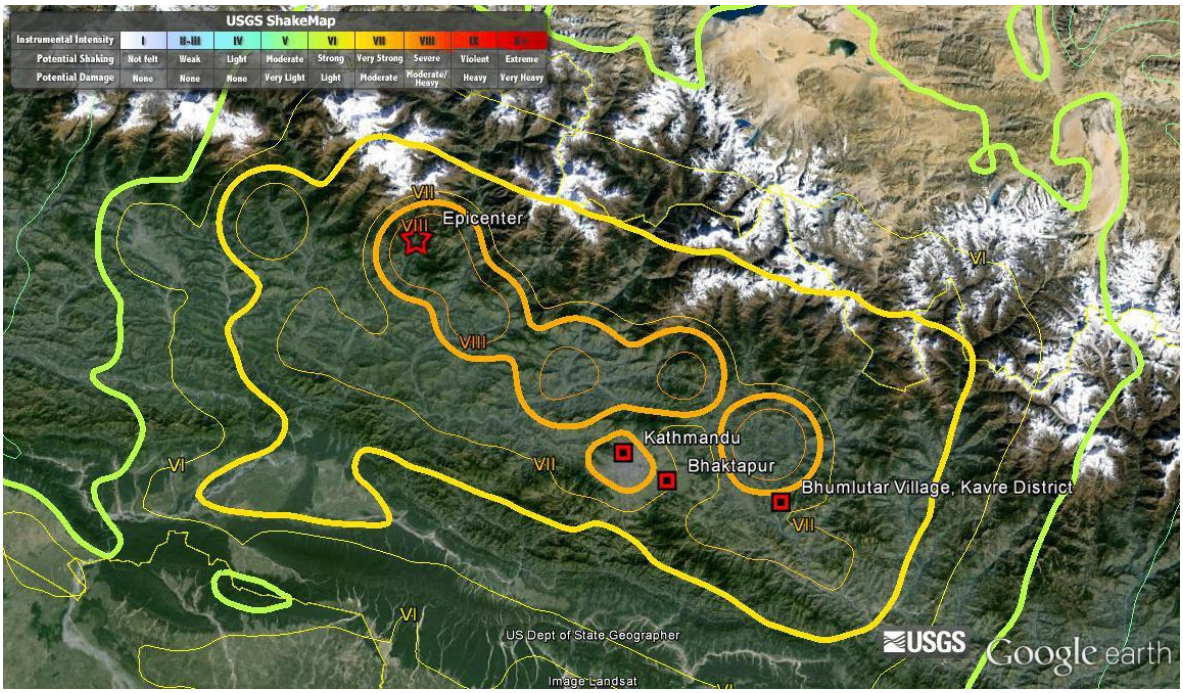
CONTEXT

Nepal was shook with a massive earthquake of magnitude 7.6 with an epicentre at Barpak in Gorkha district on the morning of 25 April, 2015[1]. It further witnessed many more aftershocks, many of which were more than magnitude 5 (see ***Appendix 1*** for more details). This was a shake that Nepal had not experienced in the last 80 years. Apart from losing around 35 per cent[2] of its GDP in a fortnight, Nepal was also left in a state of severe shock and aftermath of lives lost and physical damages that might take them a long time to recover from.

It was in this context that the team from Indian Institute for Human Settlements visited the damaged locations to document the debris and kinds of damages and assess the situation to have insights into a way for Nepal to rebuild a resilient future and other exposed areas to learn from this experience. The team visited Kathmandu, Bhaktapur and Bhumlutar in Kavre district. Due to severe accessibility challenges in those days, the team could not visit many of the other villages around Kathmandu.

Figure 1: Locations visited by the research team



Source: Locations marked on the USGS Shake Map: Nepal (USGS, 2015)

(Note: The team returned back from Nepal on 10 May, but the second strong earthquake hit Nepal on the 12 May 2015. The visual documentation may not capture some of the subsequent damages. This report was written and published on 22 May 2015. Any new information hence may not have been updated.)

[1] As recorded by Nepal's National Seismological Centre (NSC)
[2] Estimate based on secondary reports

Overview of Damages

Nepal's first post-earthquake assessment report was expected in June (please see **Appendix 2** for key findings from that). As per this Government of Nepal's Post Earthquake Assessment Report published on 21 June 2015 (National Planning Commission, June 2015): "The catastrophic earthquake on 25 April was followed by more than 300 aftershocks greater than magnitude 4.0 (as of 7 June 2015). Four aftershocks were greater than magnitude 6.0, including one measuring 6.8 which struck 17 days after the first big one with the epicentre near Mount Everest. To date, there are over 8,790 casualties and 22,300 injuries. It is estimated that the lives of eight million people, almost one-third of the population of Nepal, have been impacted by these earthquakes. 31 of the country's 75 districts have been affected, out of which 14 were declared 'crisis-hit' (see Figure 1) for the purpose of prioritizing rescue and relief operations; another 17 neighbouring districts are partially affected.

The destruction was widespread covering residential and government buildings, heritage sites, schools and health posts, rural roads, bridges, water supply systems, agricultural land, trekking routes, hydropower plants and sports facilities. The geodetic network centres including horizontal and vertical control points have been damaged in a manner that will affect reconstruction planning."[3]

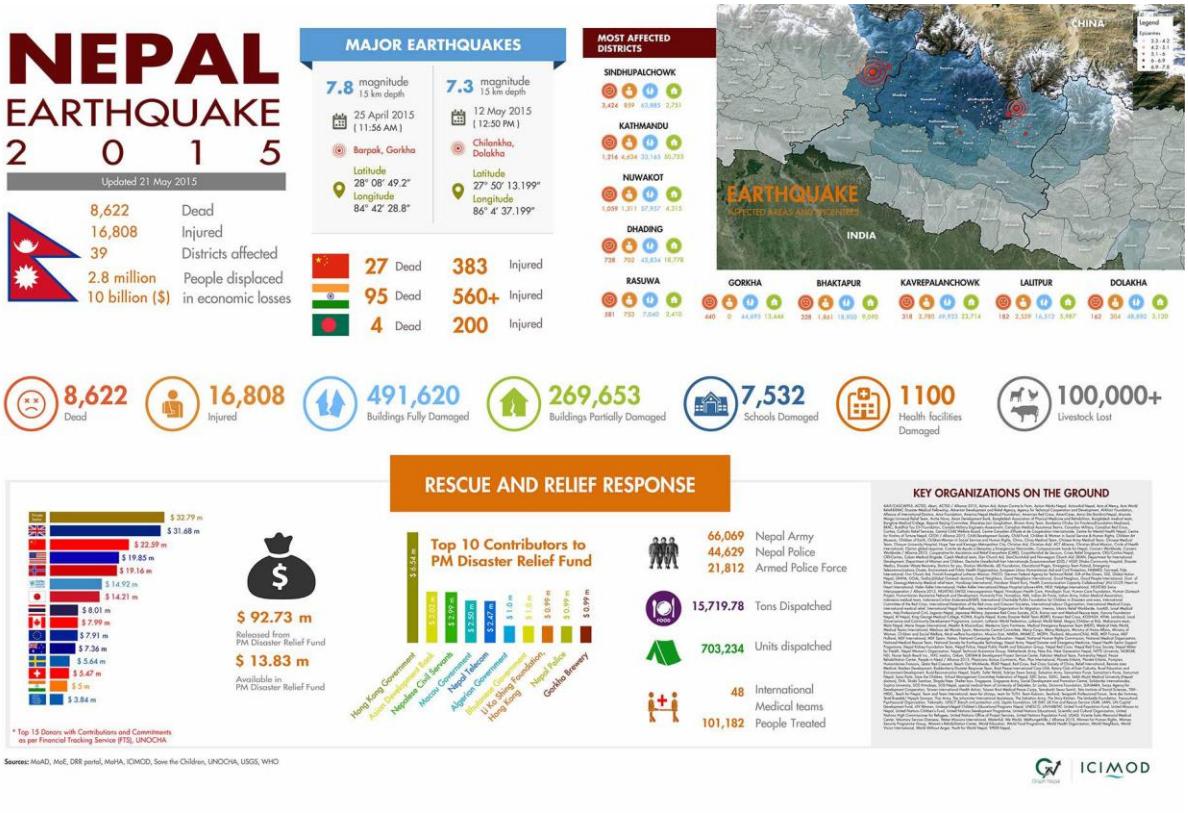
Figure 2: Summary of Disaster effects

	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	2,313	19,223	8,948	10,274	-
Productive Sectors	**58,074**	**120,046**	**178,121**	**158,079**	**20,043**	**17,124**
Agriculture	16,405	11,962	28,366	25,813	2,553	4,603
Irrigation	383	-	383	-	383	
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	5,015	26,890	31,905	20,937	10,969	-
Infrastructure Sectors	**52,460**	**14,323**	**66,783**	**17,281**	**49,502**	
Electricity	17,807	3,435	21,242	15,569	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**	**52,933**	**1,755**	**51,178**	**-**
Governance	18,757	-	18,757	-	18,757	-
Disaster Risk Reduction	155	-	155	-	155	-
Environment and Forestry	32,960	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: PDNA estimates (National Planning Commission, June 2015)

[3] Section added on 18 September 2015

Figure 3: Extent of Damages and Donations in Nepal after the earthquakes



Source: (ICIMOD, 2015)

RESEARCH QUESTIONS

The key research questions we started the mission with included:

1. What are the key causes of damages, and what can be done to abate them in the future?
2. How can we improve people's capacities and knowledge about earthquake resistant building technologies? And yet, how can we ensure proper shelter for the displaced people before the upcoming monsoon season?
3. How can we strike a balance between building new houses and toilets in the immediate future and long-term building stock resilience in Nepal?
4. What are the gaps in planning instruments and their implementation?

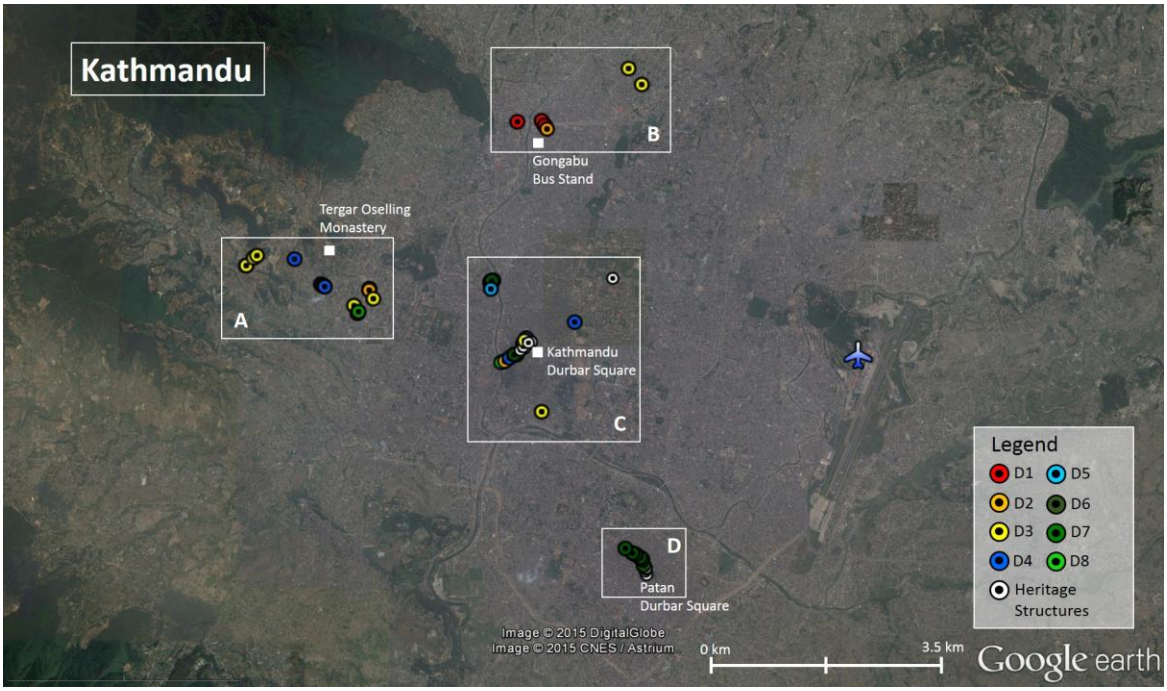
KEY FINDINGS AND REFLECTIONS

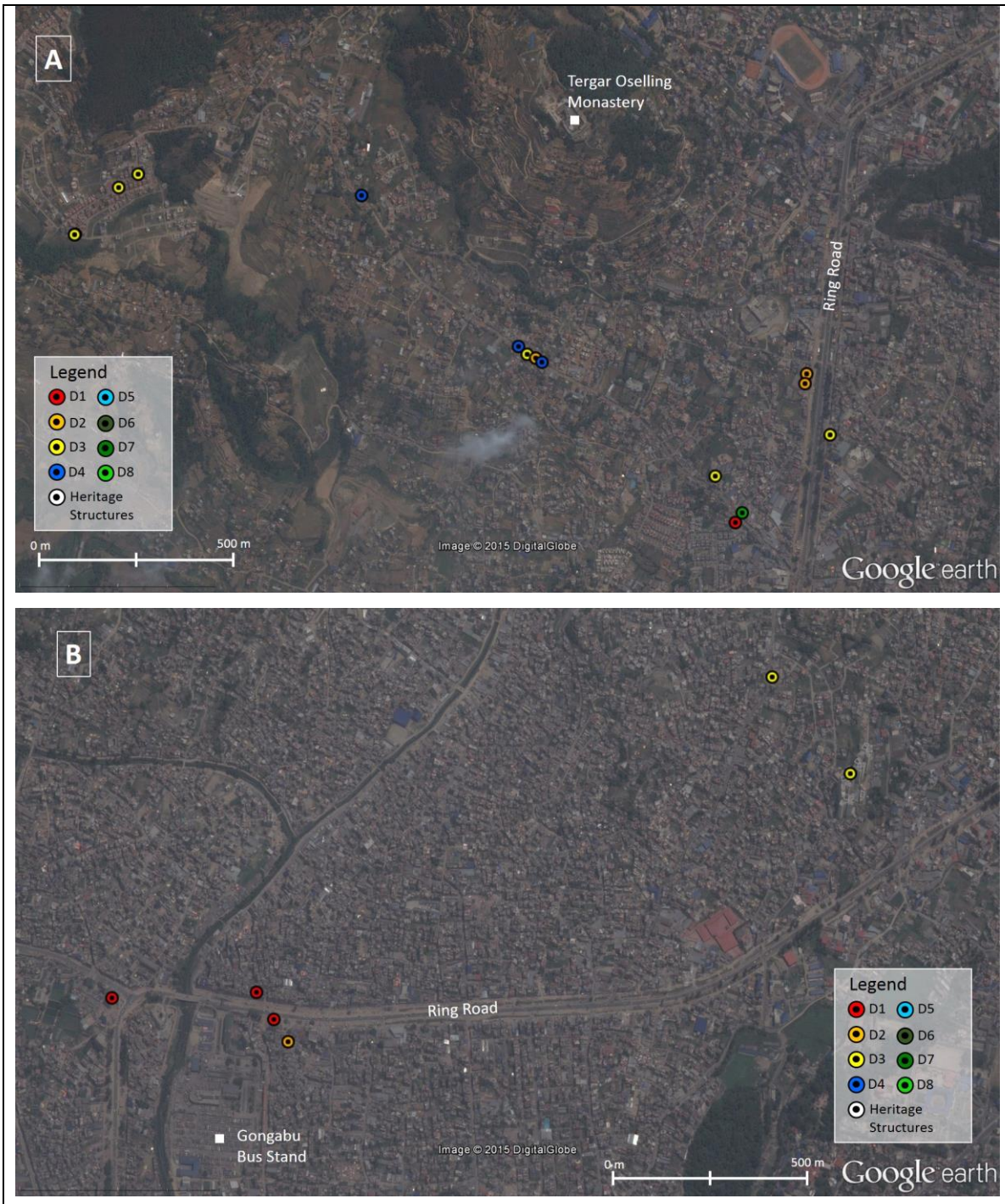
Walking around the city, we noticed that while many structures had fallen over or were severely damaged, there were many that remained intact. Connecting the dots between similar types of damaged structures to know why they failed and others didn't, this report outlines the resulting Rapid Visual Damage Assessment done leading into a needs assessment.

Types of Damages

There was a typology or pattern of damages that was observed. The following maps provide locations of the various structures documented.

Figure 4: Locations of sample structures visited by type of damages




A
Tergar Oselling
Monastery
Ring Road
Legend
D1
D2
D3
D4
D5
D6
D7
D8
Heritage
Structures
0 m
500 m
Image © 2015 DigitalGlobe
Google earth
B
Ring Road
Gongabu
Bus Stand
Legend
D1
D2
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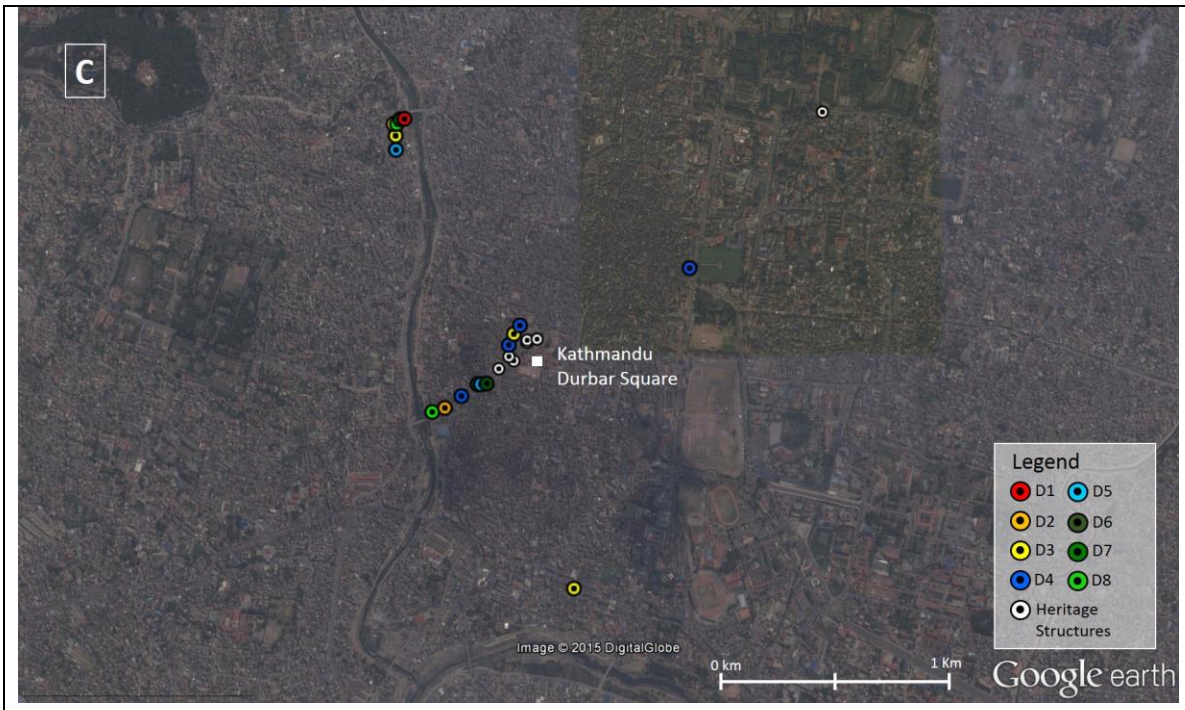
D4
D5
D6
D7
D8
Heritage
Structures
Image © 2015 DigitalGlobe
0 m
500 m
Google earth


C
Kathmandu
Durbar Square
Legend
D1
D2
D3
D4
D5
D6
D7
D8
Heritage
Structures
Image © 2015 DigitalGlobe
0 km
1 km
Google earth


D
Patan
Durbar Square
Legend
D1
D2
D3
D4
D5
D6
D7
D8
Heritage
Structures
Image © 2015 DigitalGlobe
0 m
250 m
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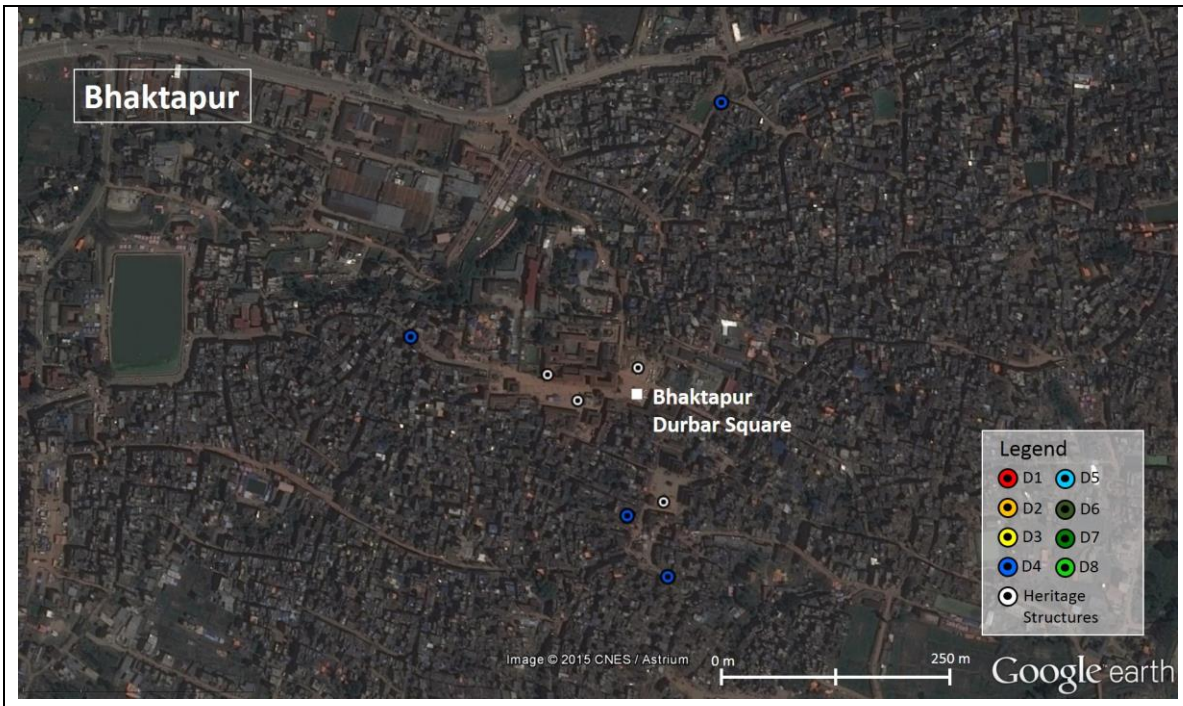


Source: Locations marked on Google Earth maps

The following sections describe the eight types of damages observed along with some illustrations, often coupled together in the same structure.

D1 – Differential sinking

Many buildings were seen to have collapsed due to partial or complete sinking of the land below. Mapping alludes that most of them were located on what used to be flood plains and wetlands with soft sub-soil conditions and technically development should not have been allowed in those areas. Currently, there is no consensus on one masterplan, and the development therefore lacks coherent vision. Detailed soil maps are not available in the public domain. In such soil conditions, additional structural measures must be taken (if at all buildings are allowed to be built, with tie beams and floor beams), but unless such areas are demarcated differently, it is difficult for people to know and adhere to any requirements. The cities need to have a detailed soil map with zones clearly demarcated (at a resolution suitable for an average building size) and building codes should be made per zone. Maps being made are mostly for damaged buildings and road blocks (http://quakemap.org/) – which are aiding in relief and response very well. But maps for soil quality also need to be made for recognising zones where strata is not suitable for building or meant to have different construction standards.

Box 1: Illustrative examples for Damage Type D1

Image 1: Type D1 – A case of partial sinking located on the wetland. Many died including those who used this as a day-time residence being night-shift workers.

Image 2: Type D1 - Building adjacent to the previous example, located next to a nallah.

Image 3: Type D1 - Another case of partial building collapse

D2 – 'Soft storey' failures

Many buildings were seen collapsed with a sole cause being 'soft storey' construction. For the uninitiated, when a building is constructed with no walls and only columns, it lends less regidity to the structure and is deemed to be inappropriate for seismic locations. Kathmandu being one of those, should not have approved such constructions. But then Kathamndu is not unique in that. Cities like Delhi, also located in seismic Zone 4, require by law (a.k.a. building bye laws) to build most new residential and commercial structures to be built on such soft storeys to provide for adequate parking. This is a regulation completely devoid of any understanding of risk, and only attempts at addressing a problem that is caused by other reasons (ease of buying and owning cars, etc.) This is a systemic problem, and can take an entire city down in case of an event, which could have been easily avoided with better integration of risk mitigation measures in the building bye laws.

Box 2: Illustrative examples for Damage Type D2

Image 4: Type D2 - Heavy buildings resting only on columns or 'soft-storey' construction. Hazard for neighbouring building. Insufficient column size giving way

Image 5: Type D2 - Complete collapse of soft storey

Image 6: Type D2 - Adjacent buildings with same problem of soft-storey

Image 7: New construction with soft-storey

D3 – Poor quality concrete framed structures

Concrete construction is only a few decades old and comparatively a recent phenomenon in Nepal. This might explain why many masons and contractors are probably unaware of the

right techniques of the use of steel and concrete. Right after the earthquake, when the debris was still present on sites, many buildings were seen with poor quality construction practices. This included large stirrup distances, insufficient overlaps in steel and insufficient torred steel sizes. Poor concrete mixes leading to honey combing effects were also seen in many instances. Poor structural designs were determined with heavy weights on cantilevers and in many cases cantilevers resting on no beams. Most of these can lead to partial or complete building collapses. Poor quality brickwork and mortar were also noticed, although these mostly only lead to cracks, but can still be fatal to people living in or around such structures. Many multi-storey structures were also seen with serious cracks and damages, although none had collapsed entirely. This is not necessarily an outcome of bad building codes, but poor implementation and monitoring. This needs to improve substantially, and rather quickly as many people have started rebuilding already, recreating the same mistakes again.

Building code violations. At present, the building code is applied only within the urban areas; however, present experience shows that such code should cover the whole country, both urban and rural. One of the top priorities of the government should be to immediately develop the land use map before it begins massive reconstruction programs.

Box 3: Illustrative examples of Damage Type D3

Image 8: Poor beam and column junctions

Image 9: Insufficient column sizes

Image 10: Large stirrup distances

Image 11:Complete collapse from multiple joint failures

Image 12: Multi-storey cantilever

Image 13: Cantilever beam resting on load bearing wall

Image 14: Poor infill walls and masonry

Image 15: Poor Multi-storey construction

Image 16: Poor multi-storey construction

Image 17: Column free corners

D4 – Poor quality mud mortar structures

All construction was using mud, timber and clay bricks for the longest, until a few decades ago when many aspired to have concrete structures. While most mud-mortar structures have collapsed anyway, the ones that have led to greater life and material loss are the ones which were a combination of mud walls and concrete slabs. Heavy concrete slabs were seen to have fallen flat, taking down anything below with them. The walls were unable to support the weight on top of them, more so as they lacked sufficient intermediate columns. While in the villages where most construction is still in mud-mortar, concrete structures are not much of an option (at least in the short term) because access to material is very difficult. Many

villagers were seen to be collecting bamboo from the neighbouring sites and rebuilding what they could. But with better knowledge and training, and use of cross beams in walls amongst other practices, bamboo and mud could be used as a much more resilient construction materials as being tested and promoted by many scientific NGOs.

Box 4: Illustrative examples of damage Type D4

Image 18: Concrete slabs supported on mud walls

Image 19: Complete collapse of mud structure

Image 20: Combination of mud and load bearing structure. Collapse of the mud structure

Image 21: Collapse of heavy concrete slab supported on mud walls

Image 22: Damage of infill walls close to the roof structure

Image 23: Insufficient columns in multiple floor mud structures

Image 24 Complete collapse of mud-construction:

Image 25:Single storey mMud and timber roof - complete collapse but no loss of life (safe failure?)

Image 26: Mud construction collapse in villages

Image 27: Mud construction collapse in villages

Image 28: Damaged roof structures

Image 29: Severe cracks around lintels

D5 – Differential bulging of soil / liquefaction

Liquefaction is a phenomenon in which the strength and stiffness of soil is reduced by earthquake shaking or other rapid movements. In many cases, the soil below the buildings looked like it experienced liquefaction, and bulges on the ground could be seen in many parts of the building. Undermining the foundations and base courses of the buildings can lead to liquefaction causing serious damage. Areas which are water-saturated, or with unconsolidated sediments can lead to such outcomes, and must be treated with additional care at the time of design and construction.

Box 5: Illustrative example of damage type D5

Image 30: Floor bulging and sinking at various locations inside buildings

D6 – Bulging of walls

In many instances, walls on the lower floors were seen to bulge with the load on top. Predominantly in mud wall structures, but was also observed in many brick and mortar structures as well. This is potentially due to insufficient column sizes and distances, and over loading of the structure. In many locations people had used props to support such bulging structures temporarily, but would have been hazardous during the second massive quake that followed in the week after.

Box 6: Illustrative examples of Damage type D6

Image 31: Concrete wall bulging under pressure from top

Image 32: Old construction bulging, but people beginning to start using them within the first week

Image 33: Buildings with bulges are propped for 'temporary?' support

Image 34: Buildings with bulges are propped. A hazard to the neighbouring buildings

Image 35: Load bearing wooden structures suffering bulges due to weight on top

Image 36: Mud mortar walls bulging in many locations, particularly in Bhaktapur

D7 – Dangerous design elements

Many buildings were also seen to have poor design features such as overhead water tanks on single columns, column-free corners (3-4 storey cantilevers), false walls as add-on false walls on facades with insufficient cross tying. Such elements should not be approved at the design level, as well as monitored closely at the time of construction completion.

Box 7: Illustrative examples of damage type D7

Image 37: Overhead water tanks with heavy dead load

Image 38: Collapse of false walls

Image 39: Column free corners and multi-storey cantilever structures

D8 – Other types of damages

Boundary collapses were common as most of them used unburnt clay bricks, insufficient spacing columns or reinforcement, and bad joinery details. These may not have led to any serious direct losses, but can cause serious disruption for access roads and emergency service delivery.

Image 40: Unburnt clay bricks with no intermediate columns

Image 41: Poor joinery details

Image 42: Unburnt clay bricks with no intermediate columns

Many instances of open wires and electric pole failures were observed across the city. This is primarily as electric poles are non-structural in nature, with an overload of wires on them.

Image 43: Collapse of electric poles on neighbouring buildings

Image 44: Fire hazard?

Image 45: Over-burdened electric poles

Image 46: Over-burdened electric poles

There were also cases where fire had broken following the quake. Usual causes were electric shortcuts, gas cylinder bursts, or combustible substances coming in contact with potential fuel (wood, fabric, etc.).

Image 47: Fire fowllowing the quake main cause for damages

Image 48: Fire following the quake

These instances can be reduced with proper public awareness and precautionary measures taken by all individuals, families and commercial enterprises.

Special Mentions

"The Curious Case of 100 houses"

There's a case of a housing development, next to a dried water channel. The development is less than 5 years old, but almost all structures have suffered severe damages. Why? What went wrong? There could be many reasons, but some that seemed to have evidence included multi-level construction with potentially insufficient ground levelling measures, uneven foundation levels leading to partial settling, questionable quality of construction and ground ramming. This is a case where almost all the above types of damages were observed, all in one location. The question arises as to why was the development located where it was, what was the process undertaken for design approvals, why was the quality of construction poor despite people having paid matching market rates, and what access did most people have to insurance as a means to recovery? This also leads to further questions with regards, what is safe failure, and how can that be incorporated in physical infrastructure?

Box 8: Illustrations for the "curious case of 100 houses"

Image 49: "The Curious Case of 100 houses" : Located next to the dried water channel

Image 50: Poor construction quality

Image 51: Poor construction quality

Image 52: Damaged interiors

Image 53: Severely damaged interiors, despite evident affluence of residents

Image 54: Structural damages

Image 55: Partial sinking in many locations

Image 56: Vertical cracks	*Image 57: Horizontal and diagonal cracks*
	

Schools and other social infrastructure

Many primary, secondary and higher secondary schools were damaged to a large extent – most of them being fully or partially constructed in mud mortar. Many vocational institutes were also damaged. Many students had lost their books and certificates. This is worse, as this was also the time for Indian graduate level competitive exams, and many potential applicants from Nepal are likely to have lost the chances to apply, while their families might be busy recollecting the missing pieces. There needs to be a special support or offering for the students hailing from Nepal such that they don't lose a precious year if their lives. This would require special attention, but is outside the purview of this study.

Box 9: Damages to Schools and other social infrastructure

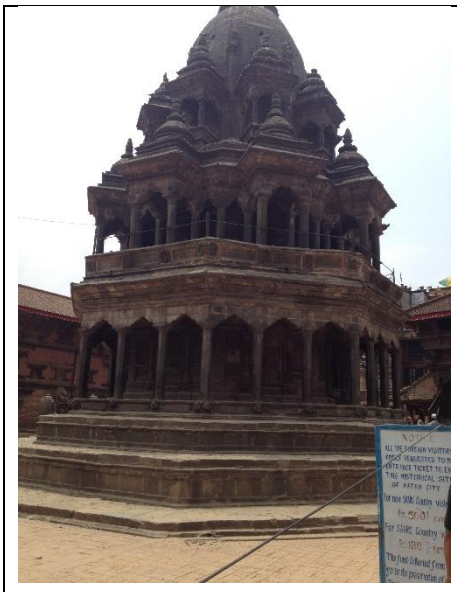
Image 58: Damaged School and vocational institute	*Image 59: Damaged School and vocational institute*	*Image 60: Damaged School and vocational institute*
		

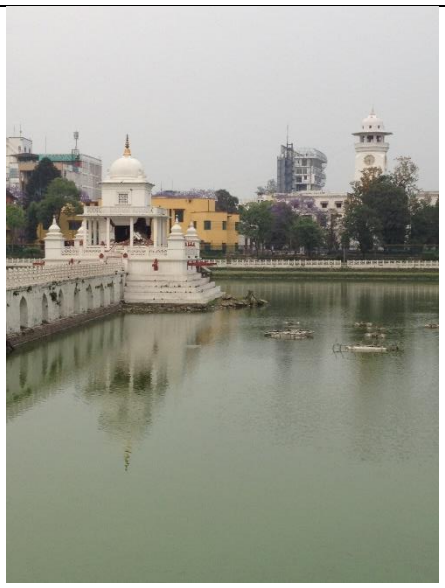
From various news reports, its gathered that more than 5,000 schools were damaged in the April 25 earthquake, and as many as 1,000 collapsed in the May 12 temblor. The government hopes to finish constructing 7,000 temporary learning centres made from tents and bamboo soon, but officials say they cannot hope to replace all of the damaged schools in time. Children's advocates fear the earthquake could reverse decades of steady progress in primary school attendance, which stood at 95 percent just before the earthquake, up from 64 percent in 1990. Schools in Nepal were woefully inadequate even before the quake, and the country's literacy rate of about 66 percent is among the lowest in Asia. Nepal's dropout rate is high. About 1.2 million children between the ages of 5 and 16 were dropping out or never attended school even before the quake, according to UNICEF. Even more than instructional materials, the children from Chautara needed ways to play so they could somehow forget the lives and property lost in repeated temblors that have shaken their confidence in the world. This would require immediate action, so there are no long term implications on children's education cycles and other psychological stresses.

Heritage Structures

Heritage sites like Bhaktapur and Patan, which formed the back bone of the cultural and social space for the locals, were severely damaged. Palace precincts had also suffered severe losses. Many other temples, shrines, old libraries, etc. have also suffered irreparable damages. There's extensive work being done by UNESCO and other agencies in recovering pieces from the rubble that need special care and protection in the time of crisis and protected from vandalism and theft. Bringing these areas back will be critical for bringing back normalcy to the people of Nepal. These damages require special focus and studies, and are outside the purview of this study.

Box 10: Damages to heritage buildings





Roads and infrastructure

While some of the major roadways have suffered severe damages due to partial sinking of the ground, many bridges across the city have remained intact.

Rebuilding in a week

People had begun rebuilding in the first week itself, using recovered material from the debris and similar construction techniques as before. Many had started filling visible cracks with plaster in an attempt to hide what could be more severe structural damages. Special attention needs to be taken immediately so the same mistakes are not repeated, and risks are not recreated. People rebuilding using old material, People reusing damaged structures

/ vulnerable locations. Hoarding relief material, as well as building material that would be required for long-term recovery. Young often work in Kathmandu, or other countries. About 6 million Nepalis, or about 22 percent of the country's 27.8 million people, live and work outside its borders, according to Krishna Prasad Dhakal, Nepal's deputy ambassador to India. Some 3 million are in India. Another 2.1 million are in the Persian Gulf area and Malaysia. Nearly 25 percent of the country's GDP comes from remittances. Lack of labour to rebuild, or restart the micro-enterprises. Political instability, with seven prime ministers in eight years and the lack of a full-fledged constitution, has only increased unemployment and will push more to leave.

Box 11: Ongoing Reconstruction work

Image 61: Woman salvaging material from the rubble

Image 62: Salvaged clay bricks being reused in building boundary wall

Image 63: Cracks being plastered to hide potential structural flaws

Although not in the ambit of this research, but here are additional mentions of socio-economic aspects for long-term recovery which we came across over various discussions and reflections from previous experiences. These need just as much attention in the short to mid-term for complete and sustainable recovery:

- As noted above, schools have fallen apart. They need to be rebuilt soon, to not just save students time but also expedite psychosocial normalcy
- Provision of clean water and toilets is absolutely necessary as the slow gains of building toilets in the last decade have now been set back. If not done in advance of the monsoons, could lead to other health hazards. Urgent task is to provide clean water and toilets before the rains make the poor sanitary environment in these devastated areas far worse by carrying contaminants into water supplies and making direct contact with faecal bacteria almost inevitable. Small outbreaks of diarrhoea have been reported across Nepal since the earthquake, and although such outbreaks are routine here, they have raised worries that the quake's aftermath is at least partly to blame. More than 80 charities and government agencies have poured into Nepal since the quake to work on its well-documented water and sanitation problems. They are coming to a country that was already among the World's most unsanitary, with a 2011 government survey finding that 45 per cent of Nepalis did not use toilets, one reason 82 percent of drinking water supplies are contaminated with faecal bacteria. A study found that about 11 percent of Nepalese children have diarrhoea at any given moment, which contributes to the stunting that affects more than a third of the nation's children, according to government figures.
- Sex-trafficking has long been a battle in many parts of Nepal and now that many more women and children are being pushed into temporary shelters with ever high vulnerabilities, it may become easier to lure them with work and other resources to across the borders. Particular attention is required to protect them from such inhuman actions. The UN estimates that 12,000 to 15,000 girls from Nepal are trafficked into the Asian sex trade every year and there are now fears that camps for those displaced by the earthquake are being targeted. According to Unicef, approximately 50,000 girls and women work in restaurants, dance bars and massage parlors in Kathmandu. Around one-third of them are sexually exploited in these jobs. Between 5,000 and 7,000 Nepali girls are trafficked every year across the border to India.
- It is learnt from other experiences such as in Haiti, that too much relief can lead to growing dependence, which in turn could be a hazard for long term recovery. There needs to be a solid exit strategy by all he donors and funding agencies currently working for aid.
- While the National Government is doing all that it could, other international agencies also need to recognise their leadership and work in coordination with them for a more holistic recovery and long-term resilient outcomes. Nepal does not have a single

responsible agency for DRR. It also lacks relevant legislation for DRR. One big problem at the organizational or administrative level for most temporary and permanent relocation implementation is that there is no statutory lead agency to coordinate things. So, what you get, is a stew of agencies working with uncoordinated, if not contradictory, agendas, with different goals and budgets, etc.

Too many actors, lack of leadership: Pushing differences aside, Nepal's political parties are keen to form a national government. Not much progress has been made on the Constitution drafting process. Political parties have been deeply divided on several key issues, including forms of governance, electoral system, federal structure and judicial system.

Immediately after the tremor, state machinery, notably the police and other security personal, had already started their engagement in rescue operations. However, coordination was the major problem. In the initial stage, the civilian part of the government was not visible. There was a gap in information-flow regarding the damage, loss, priority, processes, etc, and no one was giving any proper response.

The critical role of all security officials (army and police) played in rescue efforts. Through this response, they were able to re-establish their credibility with the people. The civil part of the government's existence has been questioned. There was a coordination gap between the civilian and security part of the government. The existing legislative and institutional environment to respond to disasters is insufficient and incomplete. The law needs to be totally reviewed to face the newer challenges. A separate entity with enough mandate, scope, resources and accountability is urgently needed to deal with the national disaster in an integrated way.

Though the level of credibility of the government is questioned, it will be encouraging to support the reconstruction and rehabilitation resources through the PM relief fund mechanisms. However, an inclusive and strong monitoring mechanism should be in place to oversee the resource mobilization.

It has also been felt that rescue, relief, and other programs would have been far better if the locally-elected bodies were in place. Government should give top priority to conducting the local level elections immediately after the rains. A strong management mechanism needs to be in place during such crisis time. A crisis communication cell could be operated within the ministry of information and communications.

SUMMARY OF INTERVENTIONS

What is safe failure, and how can that be instituted?

There is an observable pattern in the kind of damages that were noticed which can be mitigated in the future if better planning approaches are taken in time. Leading from the above analysis of the types of damages, following potential actions must be taken for reconstruction:

Planning Interventions

- Collect systematic information about soil types in the city, and identify zones for silt and black cotton soil. These zones must require special building codes.
- Zones close to river beds must be prevented from building construction, or must require special building codes and FAR regulations
- Underground aquifers must be mapped, and dried aquifers must be treated. Load bearing capacities of such areas must be tested and incorporated in soil zonation plan.

Building code and monitoring

- New building codes to be in place incorporating earthquake resistant techniques and use of local materials. Building sample structures in different zones maybe a possibility to build awareness.
- Besides building plan and structural drawing approvals, regular monitoring of construction site along with progress and completion reports
- Pre-mix concrete could be made available to standardize quality of concrete mixes
- No plan approvals till July: The Nepal government imposed a temporary ban on constructing houses taller than two storeys the earthquake and has restricted approval for house and building design until mid-July. Nepal's local development ministry issued a circular to all 75 district development committees and 191 municipalities that are authorised to approve house designs and issue house building code. What about monsoons? - However, in quake-hit areas, those who commit to building quake resistant and environment friendly prefabricated panel houses of two storeys by providing the design can be allowed to build temporary houses after approval of land space and design by local bodies. The ministry also stopped new land pooling and plotting by both government and private sectors for housing and resettlement.

Capacity building and awareness

- People using old material to rebuild, with same old technology and knowledge. Dangers of rebuilding risky structures: Training for constructing earthquake resistant housing using local materials available, especially in villages. Contractor, mason and labor training programmes for construction techniques could be very useful.

- People need to made more aware of what to do in case of such an event, and what are the fire safety measures to be taken at all times

Early action

- Act now for a building back better a more resilient and safer environment
- Labour rates and material prices are likely to increase substantially, especially as many labourers come from neighbouring villages and material from other countries like India and Bangladesh and could took advantage of the surge in demand. There's an immediate need to manage and regulate labour and material prices, along with rebuilding damaged brick kilns.

  Material and labour prices need to be regulated, and sourced in advance. Rebuild over the next three years. Many of the brick making factories have also been damaged, with kiln towers toppled and workers' housing destroyed, those who remain are labouring overtime before the anticipated rush for construction materials. Price of a brick is likely go up from 17 US cents to as much as 25 cents, or more. Almost 745,600 buildings and homes have been damaged or destroyed, including at least 87,700 in the capital, according to Nepal's emergency authority. Engineers say only 40 per cent of Kathmandu's damaged buildings as habitable.
- Rebuild villages to help the city – most people who work in the city, live in the villages, and unless their homes are brought back to safety, it would be difficult for them to get back to work – without pushing their families to help sustain themselves in the villages without their support.
- Interim shelters could become shanties in the long run. Need to replace the temporary shelters with permanent ones soon, particularly before the monsoons.

  Plan to also replace relief phase interim / temporary shelters with more earthquake resilient structures for the future, with sufficient services and access. Else can turn into shanties very quickly, that can breed disease and other burdens.

Institutional Leadership

At this juncture, though, the importance of humility must be stressed while responding to the conditions in Nepal. While it is important for institutions such as IIHS, to help build long-term partnerships to effectively contribute to long-term recovery, but this must be done in accordance with the core leadership from Nepal Government. So, one of your messages to the different agencies and departments that NDMA may think to influence is the need to establish a framework that makes clear what the organizational responsibilities are and which is the lead agency.

Appendix 1: List of magnitude 5 and above earthquakes in Nepal (25 April – 19 May 2015)

No.	Date	Latitude	Longitude	Magnitude(M)	Epicentre
1	25-04-2015	28.34	85.91	5.6	Tibet
2	25-04-2015	27.92	85.64	5.3	Sindhupalchowk
3	25-04-2015	27.73	85.9	5.0	Sindhupalchowk
4	25-04-2015	84.71	28.16	5.5	Gorkha
5	25-04-2015	28	85.6	5.5	Sindhupalchowk
6	25-04-2015	27.91	85.33	5.3	Rasuwa
7	25-04-2015	27.65	85.63	5.7	Kavrepalanchowk
8	25-04-2015	28.18	84.95	5.2	Gorkha
9	25-04-2015	27.9	84.86	5.1	Dhading
10	25-04-2015	27.78	85.84	5.2	Sindhupalchowk
11	25-04-2015	27.99	85.71	5.1	Tibet
12	25-04-2015	28.2	85.75	5.3	Rasuwa
13	25-04-2015	28.13	85.65	5.7	Rasuwa
14	25-04-2015	28.28	84.72	6.6	Gorkha
15	25-04-2015	28.41	85.8	5.5	Sindhupalchowk/Tibet
16	**25-04-2015**	**28.24**	**84.75**	**7.6**	**Gorkha**
17	26-04-2015	27.95	85.87	5.3	Sindhupalchowk
18	26-04-2015	27.89	85.6	5.0	Sindhupalchowk
19	26-04-2015	27.94	86.05	5.0	Sindhupalchowk/Tibet
20	26-04-2015	27.75	85.94	5.3	Sindhupalchowk
21	**26-04-2015**	**27.84**	**86.05**	**6.9**	**Sindhupalchowk/Dolakha**
22	26-04-2015	27.64	85.63	5.0	Kavrepalanchowk
23	26-04-2015	27.8	85.16	5.1	Nuwakot
24	26-04-2015	27.99	85.02	5.5	Nuwakot
25	02-05-2015	28.24	84.76	5.1	Gorkha
26	08-05-2015	27.69	86.04	5.0	Dolakha/Sindhupalchowk
27	12-05-2015	27.73	86.11	5.0	Dolakha
28	12-05-2015	27.76	86.31	5.3	Dolakha
29	12-05-2015	27.79	86.11	5.0	Dolakha
30	12-05-2015	27.66	86.17	5.2	Dolakha
31	12-05-2015	27.8	85.83	5.3	Sindhupalchowk
32	12-05-2015	27.8	85.94	5.1	Sindhupalchowk
33	12-05-2015	27.69	86.24	5.0	Dolakha
34	12-05-2015	27.73	86.21	6.2	Dolakha
35	12-05-2015	27.84	86.17	5.8	Dolakha
36	**12-05-2015**	**27.82**	**86.12**	**6.8**	**Dolakha/Shindhupalchowk**
37	13-05-2015	27.68	86.17	5.1	Dolakha
38	13-05-2015	27.91	84.82	5.9	Dhading

39	14-05-2015	27.67	86.08	5.0	Dolakha
40	15-05-2015	27.93	84.84	5.5	Dhading
41	16-05-2015	27.6	86.26	5.5	Dolakha

Source: (National Seismological Centre, 2015)

Note: There were many more (247) tremors other than those listed above. While being less than 5 magnitude, still may have had severe psychological and physical impacts on already shaken areas.

Appendix 2: Findings from Government of Nepal's Post Earthquake Assessment report, June 2015

	Damage and Losses	Recovery Needs	identified Recovery / Reconstruction Principles and Strategies	Implementation Arrangements
Social Sectors				
Housing and Human Settlements	• 498,852 fully damaged, 256,697 partially damaged houses • Low-strength Masonry constitutes 95% of the fully damaged houses. • Damage and losses are estimated at NPR 350,540 Million. • *'Damages are defined as the combined replacement cost of destroyed houses, the repair cost of partially damaged houses, the replacement cost of household goods destroyed, and damages to the real estate sector. Losses are the combined cost of demolition and clearing, costs of provision of transitional shelter, rental losses, and financial losses sustained by the real estate sector.'*	• 609,938 is the estimated requirement of the number of houses to be constructed. • Total recovery needs are estimated at NPR 327,762 Million spread over next 5 years – 3 years of recovery activities and 5 years of reconstruction activities • *'The needs are combined costs of demolition and clearance, construction of disaster resilient houses, repair and retrofitting, transitional shelters, training facilitation of ODR construction, settlement planning and real estate recovery. '*	• based on Owner Driven Reconstruction Approach • be equitable, inclusive and equal rights to land and property for women. • based on principles of holistic habitat development with emphasis on basic and community infrastructure • building long term community resilience • strengthen local economy and upgrade overall living and economic standards • be sustainable and environmentally conscious process addressing issues of climate change, NRM, • address specific needs of diverse communities • communication of safe construction standards, practices and reconstruction assistance from government • transit shelters should follow guidelines issued by government	• extra-ordinary mechanism to be instituted to facilitate reconstruction process for 5 years • high level body should be established to provide guidance on policy matters • damage assessment and beneficiary identification at the earliest • develop housing reconstruction policy reconstruction, repairs and retrofitting covering multiple typologies and guidelines for salvaging and re-use of building materials. • develop financing policy for to ensure fair and transparent use of funds. • increase awareness on reconstruction, repairs and retrofitting, government schemes, entitlements, • provide technical assistance for construction • hands-on skill training for 20,000 workers for reconstruction • special packages for vulnerable families, female headed households, remote areas and heritage settlements and urban areas. • communities requiring relocations should be consulted and build consensus • promote insurance of the housing stock created under recovery and reconstruction initiatives.

Health and Population	• Fully damaged - 446 public health facilities, 16 private facilities
	• Partial damage - 701 public and 64 private structures
	• estimated NPR 6.4 billion in damages and 1.1 billion in losses
	• Severely affected 14 districts account for 89 per cent of damages and losses.
	• Gorkha, Sindhupalchowk and Dolakha are hardest hit districts
		• NPR 14.7 billion is the estimated need for recovery for population and health sector of which NPR 195 million is of immediate need	• Three pillar strategy for recovery and reconstruction
			  ○ First - resume temporary health facilities and services for dealing with risks of immediate nature
			  ○ Second – replace temporary with short term arrangements for uninterrupted services. Repair and retrofit partially damaged and demolish and clearing of damaged structures. This also include strengthening of capacities for disaster preparedness
			  ○ Third – focus on long term perspective of build back better including setting up of new facilities
				• Recovery and reconstruction will be guided by Central Coordination Committee for Recovery and Reconstruction led by the MoHP and will be implemented until 2019-20
				• tasks will be accomplished by central and district administration based on the guideline developed by MoHP

Nutrition	• because of the worsened food consumption practices post earthquake • Most vulnerable group– under five years, pregnant and lactating women • 250,000 children under 5 years of age and 135,000 pregnant and lactating women in 14 worst affected districts	• NPR 5,036 Million for food supplies, nutrition supplements, surveys, training and capacity enhancement etc for 2015-16 financial year.	• supplementary food assistance to the vulnerable groups • essential nutrition programs for children, women, mothers and dalit communities. • nutrition assessment to guide interventions • working with community leaders and health officers to include most vulnerable groups in the program	•

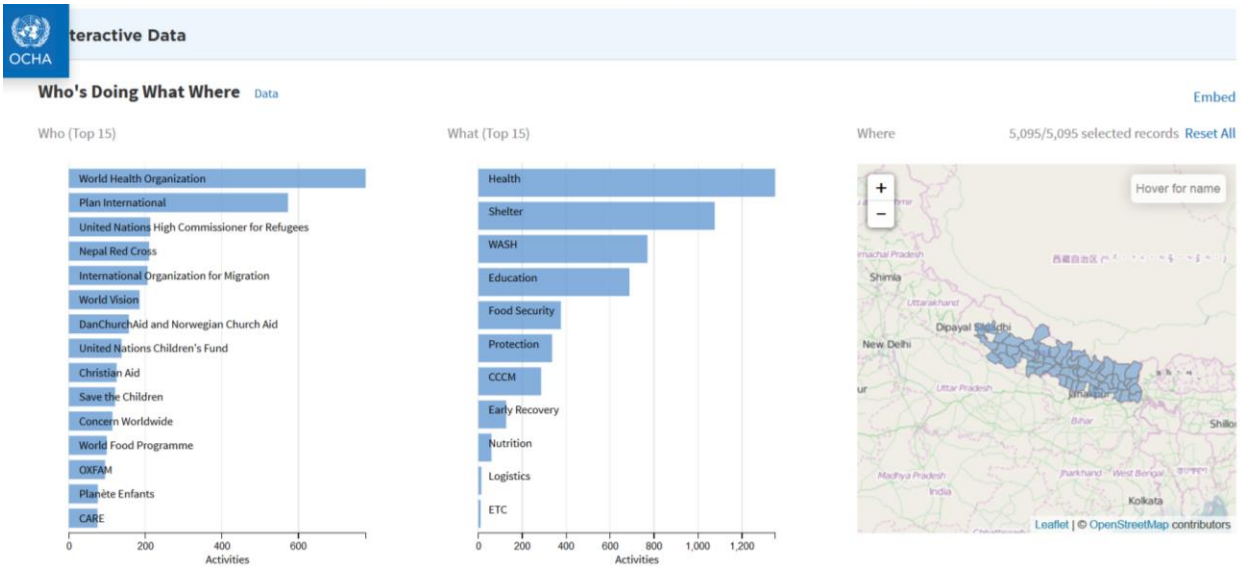
	• Situation is even worse in Dalit families because of combination of cultural norms and impact of earthquake		• will be aligned with Nepal Multi-sector Nutrition plan	
Education	• estimated damages at NPR 28 billion and NPR 3.2 billion losses. 80 percent of the damage and losses in 14 most – affected districts. *'The damages and losses reported in this assessment should be viewed as lower bound estimates owing to the underreporting of private institutions, limitations in the approach to reporting damage, and the use of conservative unit costs.'* • Short and long term impacts ○ Damage to educational impacts and increase in demand of labour at home and in the market likely to increase in number of school dropouts. ○ increase in children with disabilities because of injuries and may be unable to access schools. ○ decrease in motivation to learn over short to medium term ○ For girl child early marriage is an added reason for pulling out of the school	• estimated NPR 5.18 billion for recovery and 34.5 billion for reconstruction	• Short term ○ resumption of education services in temporary structures, ○ provision of teaching and learning material, ○ demolition of clearance of damaged structures and designs for new construction • Medium term ○ Reconstruction and retrofitting of educational structures ○ Serious consideration few large earthquake resistant schools for group of settlements instead of schools in every settlement • Long term ○ National wide policy for education safety ○ construction of adequate toilets to provide decent sanitation facilities, especially for girls ○ prioritize the needs of all affected district in phased manner ○ restructuring of the ministry for better response to disasters, recovery and reconstruction on the basis of build back better approach ○ existing policies to include special needs of girls, poor households, and children with disabilities ○ access to loans for private educational institutes for reconstruction and meeting safety standards	• instituting mechanisims in government and institutes for strictly following norms and standards in construction • Additional engineers for supervision and managing of construction and ensuring safety and quality control
Cultural Heritage	• 2900 structures of culture and heritage importance were affected. These included world heritage sites, places of worship, residential, public and private structures. • losses to tangible heritage amounts to NPR 16.9 billion • losses within Kathmandu valley from ticket sales over the next 12 months is estimated at NPR 600 million • monetary loss from offerings at temples and monasteries is estimated as 10 percent to total loss, i.e., 17 million.	• Estimated NPR 20,553 million for recovery spread over next six years • Cost of recovery is calculated as estimated loss plus 20 per cent.	• Protection of material from the damaged sites Is identified as the main priority • Master plan for restoration of heritage sites with priority and ensure local community is benefitted from the process • Restrictions on use modern materials should be reviewed with respect to DRR and building back better • Repair and retrofit of structures is priority than reconstruction of collapsed structures • Material for construction should be monitored by the government • Training programs for skill development • Preserving cultural heritage associated with these heritage sites	• Additional human resources for heritage conservation and reconstruction • Restoration activities and responsibilities distributed at local , national and international level •
Productive Sectors				
Agriculture	• Estimated damages at NPR 16,405 million and losses at NPR 11,962 million • More women associated with agriculture sector because of migration of men • Limited options of alternate livelihoods	• Recovery needs estimated at total value of NPR 15,561 million spread over three years • Immediate priority for restoration of productivity	• Implementation by multiple agencies and partners with technical expertise • Recovery and reconstruction to be implemented simultaneously	•

		• Provision of tools , livestock, machinery and infrastructure	• Will be informed by Hyogo and Sendai DRR framework • Diversification of livelihoods and good agricultural practices a medium term recovery plans • Safe livestock shelters as high priority • M&E system for efficiency and transparency of implementation • Special attention for gender difference in agriculture	
Irrigation	• 304 out of 1877 irrigation schemes affected • 79 Irrigation department offices were damaged and estimated at NPR 382.8 million • NPR 0.4 million loss from irrigation fees	• Recovery needs for reconstruction of irrigation structures and office buildings are estimated at NPR 467 million •	• Restoration of irrigation sectors at the earliest to reduce losses in agriculture. • Preparation design and retrofit guidelines for irrigation schemes • Short term o providing tools and materials to farmers for small and medium repairs o detailed inventory of damages and design for reconstruction • Medium-term – construction of irrigation schemes , • Long Term - reconstruction and retrofitting of office buildings	• Use of funds from ongoing government and partner funded schemes for reconstruction due to shortage of funds
Commerce and Industry	• Estimated NPR 16,953 million damage and loss to commercial establishments and NPR 19,271 to industries. • Damage to both large and small business, damaging raw material and finished products, related infrastructure, • losses due to lack of lack of labour, reduced demand	• estimated NPR 20, 051 million for recovery and reconstruction activities for commerce sector and NPR 7357 for industries, for the next 5 years	• rescheduling of loans • assistance for debris removal and providing capital • priority and additional support to women and youth headed enterprises	•
Tourism	• Estimated NPR 18, 863 million in damages and NPR 62,379 million in lossess	• Estimated NPR 38,710 million for recovery and reconstruction needs	•	• Promote unaffected and safe tourist spots • rebuilding and redeveloping safe tourist spots and trekking systems •
Financial Sector	• NPR 5015 million in damages to bank infrastructure and NPR 26,890 million in losses	• NPR 26,891 million of recovery and NPR 6,581 for reconstruction	• Financial stability - restructuring of loans, increase of capital, diagnosis of condition of micro finance institutions etc • better access to finance, cash transfer schemes, reconstruction of livelihoods, infrastructure, and developing insurance products • refinancing facility and capacity building to expand insurance coverage	• establishing regulatory and legal frameworks of insurance companies • develop and use insurance as disaster mitigating mechanism
Infrastructure Sectors				
Electricity	• NPR 17,807 million in damages in generation and distribution and NPR 3,435 million In loss to revenue • 603,000 households lost access to electricity	• NPR 18,586 million need for transmission generation and distribution, and reconstruction of civil structures •	• Short term – distribution of sola lamps and repair and retrofit of partially damaged structures • Medium-term – completion of new hydro projects and transmission lines to import power • long-term – reconstruction of damaged hydro power plants	• dam safety assessments for all major hydro projects • inspection of all transmission lines and infrastructure • distribution master plan in accordance international standards for recovery of electricity to houses at the earliest

Communications	• estimated NPR 3.6 billion in damages and NPR 5 billion in losses • losses due to downtime of networks and provision of free services	• cost of recovery and reconstruction is estimated at NPR 4,939 million	• Key priorities ○ providing telephone and internet to worst affected districts ○ construction of new infrastructure minimizing losses in future events ○ mobile financial service regulations, emergency information broadcasting service infrastructure, disaster recovery integrated service centers •	•
Community Infrastructure	• estimated NPR 3,349 million in damages	• NPR 4, 450 million for reconstruction activities	• high participatory approach for reconstruction • priority for high risk areas from floods and landslides • local materials and earthquake resistant technologies	• formalizing community platforms • recovery and reconstruction should be planned in consensus with local communities • technical support and supervision by local bodoes
Transport	• estimated NPR 17,188 million in damages and NPR 4,930 million in losses	• NPR 28,185 million over next 5 years for reconstruction of road network and civil aviation	• repair of minor damages and opening of blocked roads • speedy construction of damaged roads and provide access to remotely affected areas	• short-term repairs with existing government funds • medium and long term works with hiring of consultants, procurement with standard procedure
Water, Sanitation, and Hygiene	• NPR 10,506 million in damages and NPR 873 million in losses • 14 districts were classified as worst affected districts and 17 as moderately affected districts • 388,000 toilets were partially or totally destroyed in 31 affected districts • 2317 water system suffered major damages	• NPR 6,006 for recovery and NPR 12,101 for reconstruction activities	• Short-term ○ temporary repairs to water systems and rebuilding of toilets ○ campaign against open defecation ○ household water treatment ○ strengthening institutional capacity for short term needs and disaster risk management • medium term ○ construction of water systems ○ implementation of urban sludge management ○ strengthening community, governance and institutional capacities for services, monitoring and disaster risk management,	• priority to most affected districts should not affect other districts • sector development plans for effective and efficient delivery • high level technical guidance for implementation
Cross Cutting Sectors				
Governance	• 1711 structures damaged at village, district and national level • NPR 18,757 million estimated damages	• NPR 18,442 million for recovery and reconstruction activities over 3 years	• strengthening district level capacities and additional human resources for planning and reconstruction •	•
Disaster Risk Reduction	• NPR 155 million damages to DRR related infrastructure	• NPR 7700 million for recovery activities and NPR 504 million for reconstruction activity • *Short-term* ○ *reconstruction of damaged DRR assets and improvements;* ○ *measures to improve preparedness, response, relief and logistics systems;* ○ *measures to strengthen information and communication capacities for relief, response and recovery; and* ○ *measures to enhance multi-hazard risk monitoring, vulnerability assessment, risk information dissemination and awareness* • *Medium to long term priorities include:*	• focus on risk reduction even in non affected areas • *implementing building codes, enforcing appropriate techno-legal regime, motivating people to retrofit unsafe structures, and adopting risk sensitive land-use planning for future development*	• implementation by collaboration between key ministries • community participation in design implementation and monitoring

		○ *improvements in legal and institutional arrangements;* ○ *measures to mainstream DRR into the developmental sector, particularly housing, private and public infrastructure, social sectors (health and education), and livelihood; and* ○ *measures to improve integration of climate change adaptation and DRR, policy guidelines, institutional development.*		
Environment and Forestry	• NPR32,960 million in damages and NPR 1,061 million in losses	• NPR 18,424 million for recovery and NPR 6,773 million for reconstruction for next 6 years	• environmentally sustainable recovery and reconstruction activities • EIA for reconstruction activities • promote alternative and energy efficient technologies for reducing pressure on forests	• implemented jointly by lead ministries • field implementation through district offices, local forestry groups and partners
Employment and Livelihoods	• 94,814,838 total lost work days for men and women in agriculture, commerce, industry and tourism sectors • NPR 17,125 million in loss to personal income	• housing reconstruction may generate 352 million work days over next 5 years • huge demand for skilled labour • NPR 12, 547 million for recovery needs for next 6 years that cover skill training, awareness measures etc	• short-term priority to provide income opportunities for farmers and micro entrepreneurs • skill and capacity development for workers and financial support for small businesses • special programs for women and dalit communities,	• coordinated effort from all related ministries • National Employment Policy, 2015 for implementation and guidance ‘ • cash for work, skill training, labour management information system, awareness and information are some of the suggested programs
Social Protection	• estimated welfare loss of all HH at NPR101,000 million	• NPR 6,398 million for recovery activities	• adoption and expansion of social protection plans • additional cash transfers to vulnerable groups, midday school meal programme, better beneficiary identification and child friendly governance as short term intervention • strengthening administration, service delivery and integrating all social protection schemes are some of the medium and longterm interventions	•
Gender Equality and Social Inclusion	• 26 percent of total damaged houses are female headed houses • 41 percent of total damaged houses belong to dalits and indigenous communities • 23 percent of total damaged houses belong to senior citizens	• NPR 1068 million for recovery activities over next 6 years	• promoting joint and female ownership • recovery should be based on National shelter policy • reduce school dropouts, child marriages and child labor • provide health care facilities, especially to pregnant women and lactating mothers, children • speedy recovery of electricity water and transport. • support an provision of alternative livelihoods •	•

Appendix 3: Snap-shot of who all are at work in Nepal post the April-May 2015 Earthquakes



Source : UN-OCHA

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