Debris and Waste Management: Post-Earthquake Reconstruction in Rural Areas of Nepal

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Abstract

Background: Gorkha Earthquake 2015 have severely affected 33 districts causing huge loss of lives and properties. This paper is based on the assessment of debris and waste management during reconstruction activities that were carried out after the massive earthquake in Nepal. The study was executed out between April 2017 to December 2019, in Gorkha and Sindhupalchok district of Nepal that were adversely affected by an earthquake in 2015.

Research Objectives: The main objective of this study is to assess the debris and waste management at local level during housing reconstruction after Gorkha Earthquake in Earthquake affected two districts.

Methodology: The questionnaire survey was conducted in 17,814 reconstruction households (Gorkha: 4,896 and Sindhupalchok: 12,918) that were reconstructed after earthquake from 109 wards of two district. The sample household was selected randomly.

Key Results: The results show that, an average of 22.4 m^3 of debris per HH and 1.5 m^3 of construction waste per HH were generated in Gorkha (Debris: 17.3 m^3/HH, Waste 1.1 m^3/HH) district and Sindhupalchok (Debris: 23.4 m^3/HH, Waste 1.6 m^3/HH) district. Proper management of debris and waste were lacking due to unavailability of management sites. However, individuals (locals) have treated their own debris by reusing it in reconstruction process and other purposes like construction of temporary shelter, shed, fuel wood, filling potholes on the roads. Despite, lack of proper debris and waste management techniques and education, people still managed the large quantity of debris and waste aside from reuse. The study recommends for preparation of debris and wastage management plan.

Keywords: *Earthquake, debris and waste management, reconstruction, Gorkha, Sindhupalchok, Nepal.*

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INTRODUCTION

Demolish part and waste management is one of the great challenges after earthquake, in affected rural area of Nepal. Due to lack of disposal site and limitation of financial and natural resources, reusing of construction material of demolishes part (Debris) and construction waste has attracted considerable attention. It is economically feasible to recycle up to 80-90 % of the total amount of construction and demolition waste, and demolition and recycling technologies are, in general, easy to be implemented and controlled (Arslan, 2015 and Lauritzen, 1998). This paper presents the use pattern of debris during reconstruction of houses. It also compares the debris management at different local levels.

Some studies consider Nepal as a vulnerable nation to Earthquake and its damage. United Nation Development Programme (UNDP, 2009) considered Nepal as 11th most earthquake prone nation in world. These were proven right on 25 April 2015 at 11:56 AM local time when an earthquake of 7.6 magnitudes shocked Barpak VDC of Gorkha District. Similarly, on 12 May 2015, 6.8 magnitude earthquake hit Sindhupalchok District causing a mass shockwave throughout 14 mid and high hill district of Nepal (PDNA, 2015a). Combined with several aftershocks, these devastating event have claimed 8,700 lives and massively destroyed houses and infrastructures (PDNA, 2015a). The destruction was widespread dismantling residential buildings, religious and public infrastructure. Large populations were left homeless and sought shelter in makeshift tents and tarpaulin (Chapagain and Raizada, 2017). Although Nepal have faced the similar earthquakes in the past, history reveals the evidences of earthquakes in 1255, 1505, 1934, 1980 and 1988 with magnitude higher than 6.5, where thousands of Nepalese have lost their lives along with other casualties included, but could not stop the destruction (Maharjan, 2016). Thus, the scenario now is nothing different than the past, many houses were buried and local residents were made homeless with huge economic losses and long term social effects.

Earthquakes cause different levels of damages. One such example is subsequent production of significant volume of debris from the demolished building (Askarizadeh *et. al.,* 2015). Around 755,549 number of residential houses were destroyed by these earthquake (PDNA, 2015a), resulting in production of high amount of debris in earthquake effected areas. The potential to recycle or reuse the debris is sometimes overlooked in order to clear affected areas quickly (Norton, 2011). Now as the process of reconstruction is underway, the major challenge and opportunity is the management of debris at local level. Apart from varied geographical challenges in Nepal, there was lack of awareness and preparedness among the individuals, scarcity of proper technology, lack of proper disaster management plan and coordination among agencies to carry out debris management at such magnitude (Maharjan, 2016).

In developing countries, post-disaster debris cleanup and building are often undertaken manually, causing hardship to mankind who are already under stress after a disaster (Shabir, 2013). Commonly, the debris is dumped in landfills which can be costly both environmentally and economically (Esworthy et al. 2005; Muro 2014). For the people in the targeted areas, there was inadequate additional flat land to reconstruct the houses and they did not have feasibility or enough resources to move to other places. So, it poses the urgency for the removal of debris for further reconstruction process. Due to the Nepal Earthquake 2015, 498,852 houses were fully damaged and 256,697 were partially damaged (PDNA, 2015a).

Rural areas have been adversely affected than towns and cities due to their inferior quality of houses (PDNA, 2015a). The large-scale destruction of housing primarily from the seismic vulnerability of unreinforced masonry (Especially mud mortar) house that predominate thought out the country. Fifty-eight percent of all housing construction are low strength masonry stone or brick masonry with mud mortar, without seismic-resilient features. These intrinsically weak and brittle buildings suffered widespread damage and collapse thought the 14 districts that experienced intense ground shaking (PDNA, 2015b).

Debris management begins with the removal and temporary storage of debris near site. The final phase of debris management happens during reconstruction, as the debris is either disposed or recycled for use during reconstruction (Norton, 2011). Most portion of debris, from demolish house, can be reused for reconstruction or making, temporary shelter, retaining walls, boundary and land reclamation in shallow areas. Reducing and reusing earthquake related debris has financial and environmental advantage which can reduce the overall cost of debris management and reconstruction process. Moreover, rural people mostly use their bare hands while removing debris, which is risky for health. Debris removable in rural areas usually done with no or minimal safety equipment can cause minor or major injuries. Debris removal can cause injuries, which may further cause infection (Chapagain and Raizada, 2017), so, reconstruction could be hindered (Askarizadeh et al. 2015). Thus, the major objective of this study is to access the debris and waste management at local level during housing reconstruction.

METHODOLOGY

The study was conducted in two mid-hill district of Nepal (Gorkha and Sindhupalchok) between the periods of April 2017- December 2019 (Figure 1). Gorkha lies in the west to the country capital whereas Sindhupalchok to the east. The initiation of work was done through monitoring of households using predesigned questionnaire (Appendix 1).

Questionnaire Survey:

The monitoring was done by Technical Assistance Team (TA Team), which comprises a team of one Social Mobilizer (SM) and a Civil Engineer. Information were collected from the household identified as reconstruction beneficiaries by Government of Nepal on random sampling basis. The information include in the questionnaire were general information, information on debris, waste and environment.

This survey was conducted in 18 wards of 5 local levels of Gorkha and 91 wards of 12 local levels of Sindhupalchok district. 4 Gaupalikas (GPs) and 1 Nagarpalika (NP) of Gorkha and 9 GPs and 3NPs of Sindhupalchok were the study sites. The survey was done in each wards in quarter-basis with 27 HHs survey per quarter. SM of TA team were instructed to visit 27 houses randomly from each wards. At the very beginning of the survey and due to monsoon, the survey did not meet the target.

Priorities were given to the houses which were under construction during the time of visit to gather information. However, it was quite difficult to find 27 under construction houses in a ward during the time of survey. Hence, they selected the houses that have been newly constructed already were also included in survey.

Debris: In this study, debris is defined as demolished parts of damaged building or house by the earthquake. It may be in the form of stone, wood, mud, etc. Total amount of debris of an earthquake affected house is calculated from the sum of debris of stone, wood and mud. Since, the damaged house type was SMM (Stone Machinery with Mud Mortar), brick quantity from the demobilized houses were not consideration in study. Quantity of debris were obtained based on visual estimation or as per beneficiary's response (in case of debris already reused or disposed. The quantity of debris generated depends upon the size of demolished house. Debris quantity were calculated in cubic meter (m^3).

Based on use of debris, it is categorized as reusable and disposable debris. The debris used only for reconstruction of new earthquake resilient house is considered as reusable debris. The remaining debris is categorized as disposable debris. The disposable debris, may be dumped or used in construction of temporary shelter, shed, filling pits, etc.

Waste: Here, waste is defined as the remaining of construction materials during and after the reconstruction period. Waste were calculated in cubic meter (m^3).

Household heads (HHs): Household head is the person whose name is registered as the reconstruction beneficiaries by Government.

Caste and Ethnicity: In this study, caste and ethnicity is categorized in four different categories as Brahmin-Chhetri-Newar-Thakali, Dalit, Janjati and others. Others category includes Muslim, unrecognized caste during study and those who do not want to disclose their caste and ethnicity.

Reconstruction/Floor Area: Average construction or floor area per house hold will be taken. It will include entire area of house including walls and *veranda.* Value will be calculated in square meter (m^2).

Soil Cutting/Filling for reconstruction: Since the study sites are located in hilly region, it is usually difficult to find plain land for reconstruction. Average quantity of soil cutting from the hills or filling the pits were calculated in cubic meter (m^3) per HHs.

Construction Sites: Beneficiaries constructing house site will be compared with original location where house was affected by earthquake.

Housing Minimum Requirement (MR) knowledge of Beneficiaries: Beneficiary's literacy level on MR of the house type he/she is constructing will be recorded in three categories; "Good- beneficiary or any family member has appropriate knowledge on MR", "Partial- beneficiary or any family member has few knowledge on MR" and "Not at All- beneficiary or any family member has no idea about MR".

Statistical Analysis:

All the statistical analysis was performed in Microsoft Excel 2016.

Map of the study area:

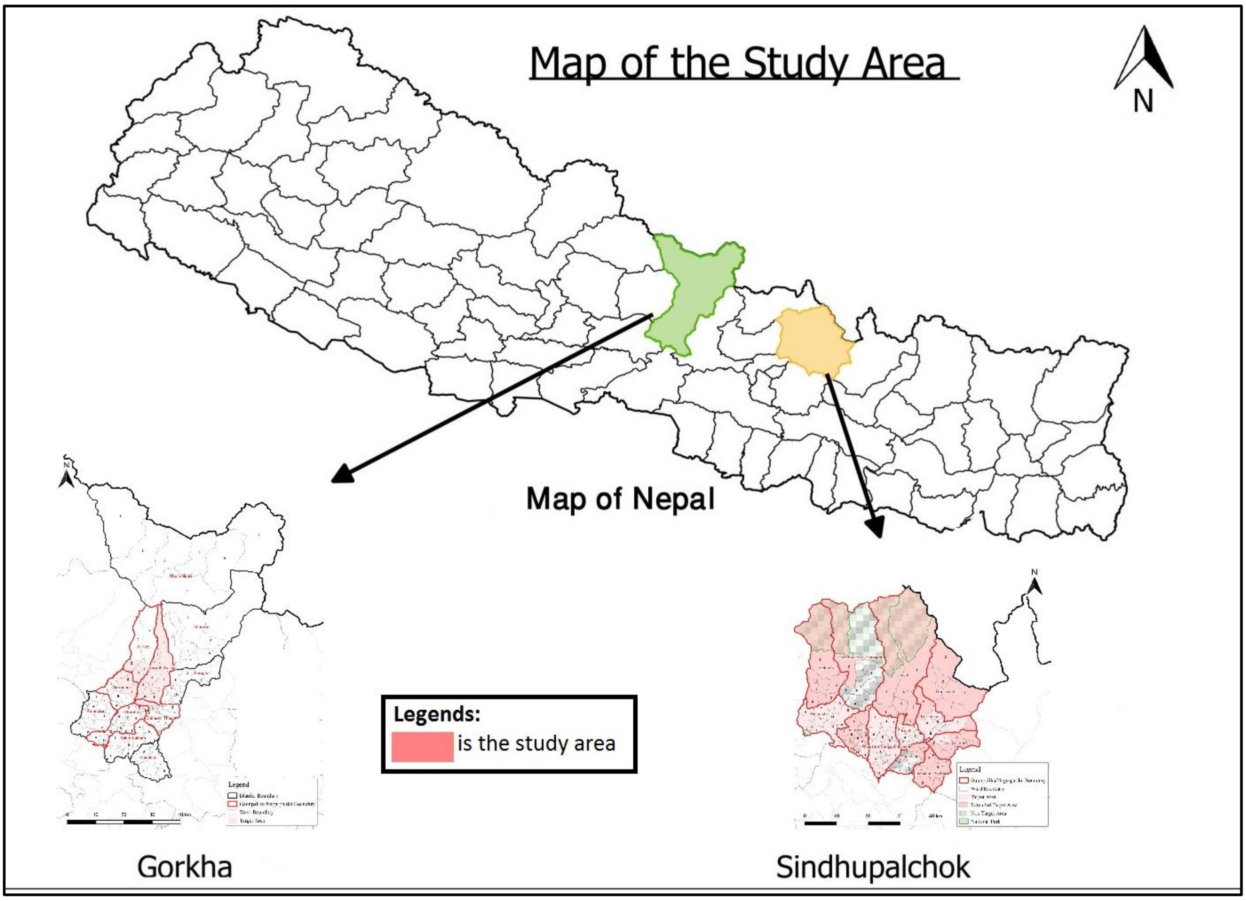


Figure 1: Map of study area

RESULTS

Gender:

Total sample size surveyed from April 2017 to December 2019 were 17,814 Households-HHs (4,896 in Gorkha and 12,918 in Sindhupalchok). Among the total, 21.8% (3,889 HHs) of identified beneficiaries were female headed, 78.2% (13,923) male headed and 0.0% (2 HHs) third gender headed. But, 24.8% house heads were female in Gorkha whereas 20.7% house heads were female in the Sindhupalchok (Table 1).

Caste and Ethnicity:

In overall survey, Janjati house heads were the dominant. 44.6% HHs were Janjati followed by Brahmin-Chhetri-Newar-Thakali (42.8), Dalit (10.1%) and others (2.5%). Nevertheless, HHs dominancy in survey based on caste and ethnicity was vice-versa in Gorkha and Sindhupalchok district (Table 1). In Gorkha, Janajit (49.3%) house heads were dominant over Beahmin-Chhetri-Newar-Thakali where as in Sindhupalchok, Brahmin-Chhetri-Newar-Thakali (46.8%) house heads were dominant over Janjati.

Table 1: Household head survey status in study area

Name of District	Gorkha	Sindhupalchok
Number of Wards	18	91
Number of Household Sampled	4,896	12,918
Household Head		
1. Gender		
Male head	75.2% (3,681 HHs)	79.3% (10,242 HHs)
Female head	24.8% (1,215 HHs)	20.7% (2,674 HHs)
Third Gender head	-	0.0% (2 HHs)
2. Caste and ethnicity:		
Brahmin-Chhetri-Newar-Thakali	32.4% (1584 HHs)	46.8% (6043 HHs)
Janjati	49.3% (2415 HHs)	42.8% (5534 HHs)
Dalit	16.4% (801 HHs)	7.7% (995 HHs)
Others	2.0% (96 HHs)	2.7% (346 HHs)

Debris and Construction Waste Management (Local level comparison):

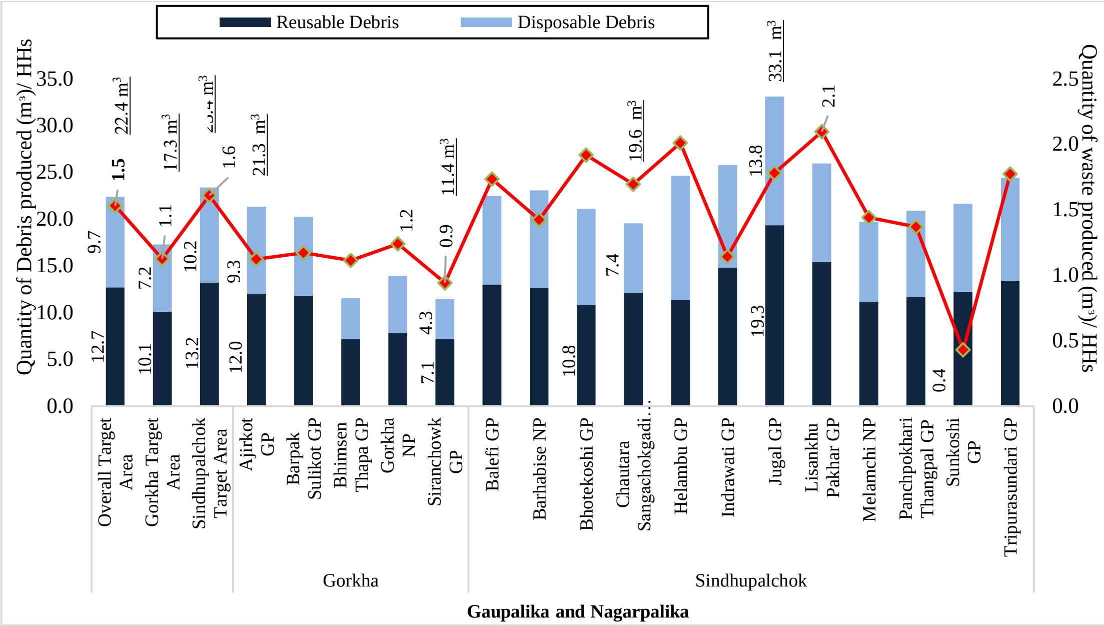
The average quantity of reusable and disposable debris produced per damaged/demolished HH in study area of Gorkha and Sindhupalchok Districts was calculated. An average of 22.4 m^3 (Gorkha: 17.3 m^3 and Sindhupalchok: 23.4 m^3) debris was generated from earthquake damaged per surveyed HH. The average quantity of reusable debris is 12.7 m^3 (Gorkha: 10.1 m^3 and Sindhupalchok: 13.2 m^3) per surveyed HH and that for disposable debris is 9.7 m^3 (Gorkha: 7.2 m^3 and Sindhupalchok: 10.2 m^3) per surveyed HH. Most of the amount of disposable debris is mud whereas major reusable debris are wood and stone.

In Gorkha, highest amount of debris was produced in Ajirkot GP (21.3 m^3) and least in Siranchok GP (11.4 m^3). Similarly, in Sindhupalchok, highest amount of debries was generated in Jugal GP (33.1 m^3) and least in Chautara Sangachokgadi NP (19.6 m^3).

The average quantity of waste generated per HH was generated from the analysis. An average of 1.5 m^3/ HH waste was produced in study area. In Gorkha, an average of 1.1 m^3/ HH waste was generated whereas the same was higher in Sindhupalchok, i.e. 1.5 m^3/HH.

In Gorkha, highest quantity of debris was produced by Gorkha NP (1.2 m^3/HH) and least by Siranchok GP (0.9 m^3/HH). Likewise, in Sindhupalchok, highest quantity of construction wastes was produced by Lisankhu Pakhar GP (2.1 m^3/HH) and least in Sunkoshi GP (0.4 m^3/HH).

The major types of construction waste were polythene, sacs, scarp metals, stones, cement and its mortar, effluents, electric wires, PVEC pipes, etc. Usually the effluents are drained to nearby area. Open defecation by HHs and construction workers was not noticed.



Note: *Underlined value represents amount of debris generated (sum of reusable and disposable debris*

Figure 2: Average quantity of debris and waste produced per HH at GPs and NPs (overall)

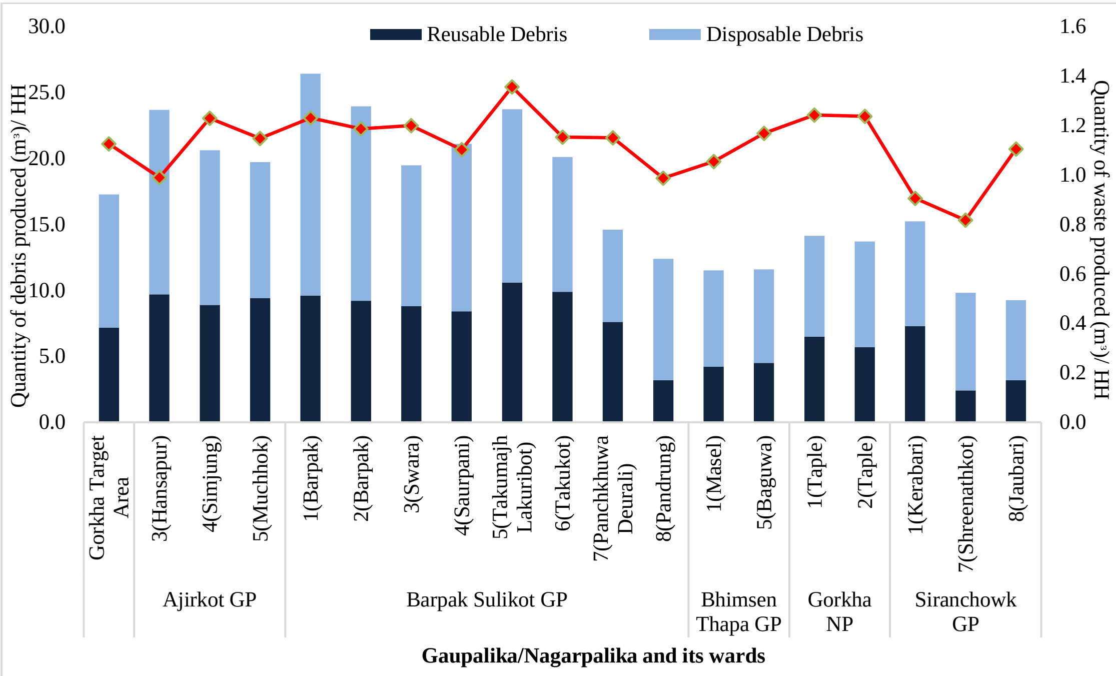


Figure 3: Average quantity of debris and waste produced per HH at GPs and NPs (Gorkha)

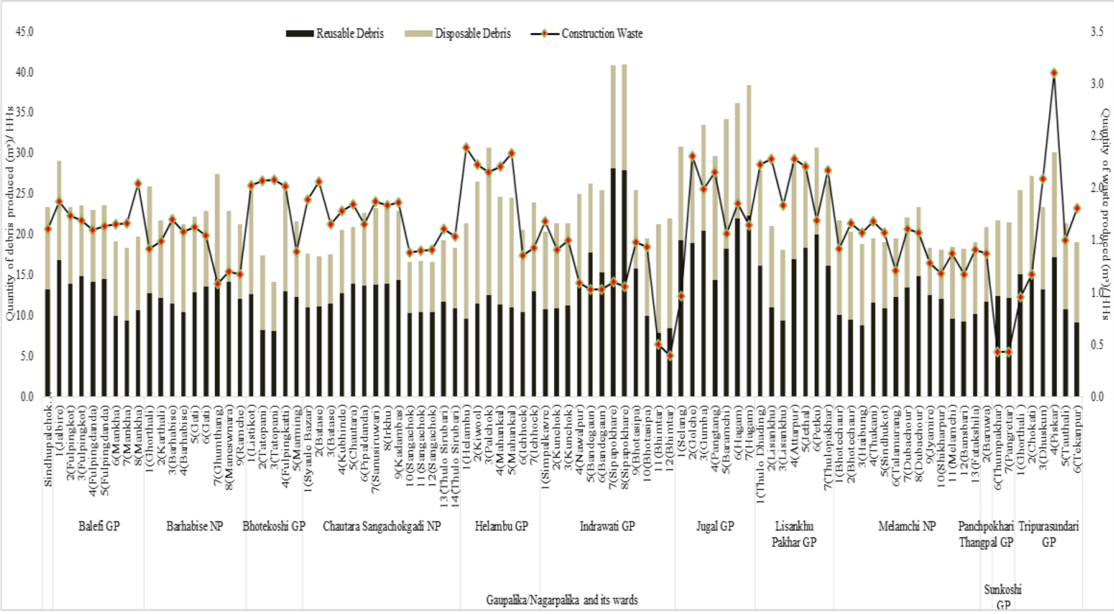


Figure 4: Average quantity of debris and waste produced per HH at GPs and NPs (Sindhupalchok)

Table 2: Reconstruction status in Gorkha and Sindhupalchok

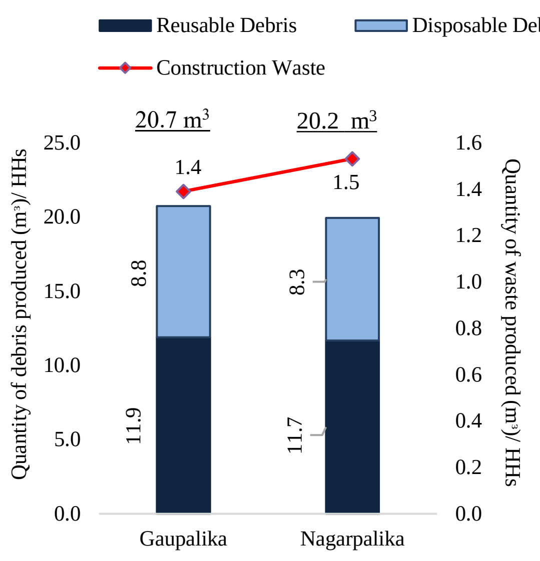
	Overall	Gorkha	Sindhupalchok
1. Debris Management:			
Debris generated	22.43 m^3/HHs	17.3 m^3/HHs	23.4 m^3/HHs
Debris reused	12.73 m^3/HHs	10.1 m^3/HHs	13.2 m^3/HHs
Debris disposed	9.73 m^3/HHs	7.2 m^3/HHs	10.2 m^3/HHs
2. Waste management:			
Construction waste generated	1.53 m^3/HHs	1.1 m^3/HHs	1.6 m^3/HHs
3. Construction/floor area	30.2 m^2/HHs	24.2 m^2/HH	31.4 m^2/HH
4. Soil cutting/filling for reconstruction	3.3 m^3/HHs	3.1 m^3/HHs	3.3 m^3/HHs

Debris and Construction Waste Management (Local level comparison):

This study also comprises the debris and waste management between Gaupalika and Nagarpalika. Major portion of debris is reused as reconstruction material for housing reconstruction in both Gaupalika and Nagarpalika.

Study reveals similar quantity of debris produced in Gaupalika (20.7 m^3/HH) and Nagarpalika (20.2 m^3/HH). Minor variation of debris reuse and dispose was observed.

Similarly, the construction waste produced in Gaupalika (1.4 m^3/HH) and Nagarpalika 1.5 m^3/HH) was also similar.



Construction particulars	Gaupalika	Nagarpalika
Reusable Debris	57.30%	58.60%
Disposable Debris	42.70%	41.40%
Construction Waste	1.4 (m^3/HH)	1.5 (m^3/HH)

Note: Underlined value represents amount of debris generated (sum of reusable and disposable debris

Figure 5: Comparison of debris and waste management at Gaupalika and Nagarpalika

Assigned debris and waste disposal site was not observed in the study targeted area, due to which beneficiaries were self-responsible for debris and waste management. Some houses were partially demolished and are used as store house or cattle shed where as small number of houses are yet to dismantle.

Optimum utilization of debris helps to reduce the adverse impact on natural environment. Wood, stone, mud, etc. from demolished houses are mostly reused. Usually, wood is reused in form of wooden band, door/window panels, furniture and form-work whereas stone is used for wall construction, foundation, soling, and gravel making. Mud is mostly utilized for land/road filling.

Floor Area:

The average floor area of house reconstructed in the study targeted area is 30.2 m^2 (Gorkha: 24.2 m^2 and Sindhupalchok: 31.4 m^2) per HH. The average family size is 4.8 person per house. Hence, the average floor area occupied is 6.3 m^2 per person in study targeted area.

Soil Cutting/Filling:

Since the study targeted wards are located in hilly region, it is usually difficult to find plain land for reconstruction. An average of 3.3 m^3 (Gorkha: 3.1 m^3 and Sindhupalchok: 3.3 m^3) volume of soil was cut or filled by each HH for housing reconstruction.

Reconstruction Sites:

92.1% beneficiaries preferred the original location for reconstruction whereas 7.9% beneficiaries preferred different sites other than the original settlement.

Knowledge on Minimum Requirements (Local level wise):

Knowledge on Minimum Requirements was assessed based on the basic knowledge on

MR of the house type beneficiaries were constructing. Study revealed that majority of the beneficiaries were aware about MR of the house type that is constructed by beneficiaries. 78.8% of beneficiaries responded as they have good knowledge on MR where as 15.5% of beneficiaries responded partial knowledge and 5.7% beneficiaries responded no knowledge on MR.

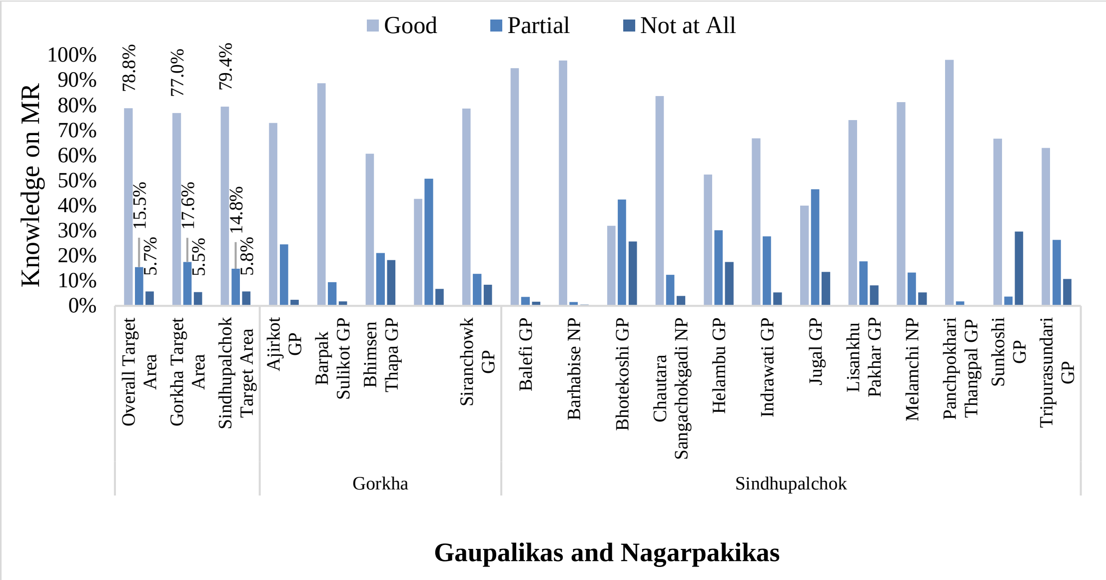


Figure 6: Knowledge level response on Minimum Requirements at local level

Knowledge on Minimum Requirements (comparison between Gaupalika and Nagarpalika):

83.9% of beneficiaries constructing house in Nagarpalika were found to have good knowledge on MR whereas same was 74.0% of the beneficiaries constructing house in Gaupalika. Likewise, the 3.9% beneficiaries residing in Nagarpalika had no knowledge on MR and 7.4% beneficiaries of Gaupalika had no knowledge on MR. Although, comparatively more percentage of beneficiaries constructing in Gaupalika had partial knowledge of MR over beneficiaries constructing in Nagarpalika. Comparison between Nagarpalika and Gaupalika resident beneficiary's knowledge on MR showed significant difference in knowledge in MR.

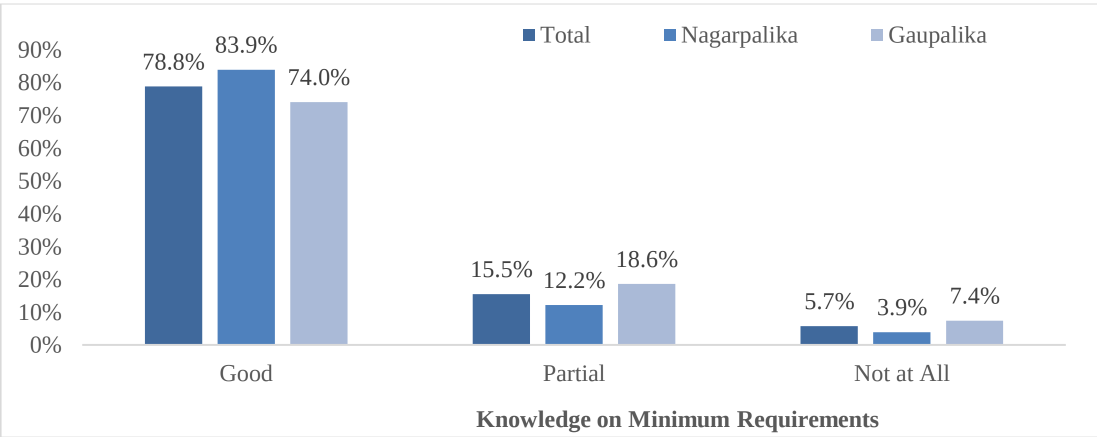


Figure 7: Comparison of literacy level of beneficiaries constructing house in Gaupalika and Nagarpalika

DISCUSSION

The house heads data analysis revealed high dominancy of male over female (24.8%). Similar results were reported by the reports of CBS 2011, CARE 2014 (26.0%) and CBS 2016 (25.9%) where those studies showed male dominancy over female.

Disaster management of the large post-earthquake waste is real challenge for developing countries with inadequate technical and financial capacities (Karunasena et al. 2012). UNDP Haiti (2010) also reported that the earthquake of 2010 in Haiti have led to the accumulation of around 20 million m^3 of debris. Similarly, our finding based on the results of Gorkha and Sindhupalchok district, showed higher quantity of debris generated from demolished houses (at an average of 22.4 m^3/households). However, the impact in the environment will be less because – (i) the result from this study shows that 56.5% of the debris were reused; (ii) the houses that were demolished were made from locally available materials (like wood, stone, mud etc). Although it is necessary to estimate total volume of debris to manage disaster waste appropriately as it provides to separate waste for necessary land fill, for relevant contract service and anticipated special handling requirements applicable to hazards debris (Karunasena et al. 2012) but such scenarios were not found in the study areas.

The commencement of reconstruction could only be feasible with the clearance of debris at the initial stage that further provides the open area and salvage materials to the beneficiaries. Pike (2007) indicates that disaster debris management commences immediately following a disaster and continues during long term reconstruction. PDNA (2015b) in its initial reports have pointed out the demolished houses that were built from low strength masonry were cleared first compared to the concrete structure. But the management or removal of debris requires both time and money, so there is a need of proper debris management plan. After demolition of the houses by an earthquake, management of the debris pose difficulties mainly due to lack of proper management sites. As individuals were responsible for the management of their own debris due to lack of management sites, thus, allocation of proper debris management sites at local levels will be commendable for the better management practice.

This study highlighted no variation in debris use practices in Gaupalikas and Nagarpalikas and this might be due to ward level mason training and awareness programs by government and support organizations.

Poorly managed post-earthquake waste can have adverse environmental impact (Brown et al. 2011) if there are deposition of toxic materials but toxic materials in the wastes were not anticipated during the study.

Similar to debris management practice, the individual households are responsible for waste management as well. The individual houses treat their own waste either by incineration, land filling or compositing (Giusti, 2009) but as the cumulative volume is less, thus the impact on environment is negligible.

Some environmental studies (Sangodoyin, 1993) suggest the use of soak-pit for the management of effluents but this practice was not seen in the study sites. In contrast, some HHs discharged cement effluents into the nearest field or tributaries will consequently decrease the fertility of the soil and also pollute the water sources (Henze et al., 2001).

Among the monitored HHs, most of the people preferred the original location for housing reconstruction which may be due to easy accessibility to livelihood and emotional attachment whereas some of the household preferred to reconstruct their house in the sites which are closer to road or easily accessible from market area.

CBS 2011 highlighted variation in literacy level in rural and urban areas which also support the findings of this paper in term of literacy of HHs in MR. Higher percentage of HHs constructing houses in Nagarpalika were aware of MR in comparison to HHs constructing house in Gaupalika.

CONCLUSION

The volume of unmanaged debris is significantly high but it is not estimated although almost debris were local materials like rubble, mud, roofing and other vegetative debris. Build Back Better policy was implemented by Government of Nepal for the overall reconstruction in earthquake affected areas. Government and other international agencies are promoting earthquake resilient society. Problems associated with debris have to be considered during the reconstruction period and recycling must be included in the community disaster management plan and also planning must ensure recycling is cost effective and approach is streamlined to avoid delaying cleanup. The effort taken by various donor organization, NGOs and INGOs are highly appreciated.

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Appendix I

Form E1: Household-level ESMS Screening Checklist

Date: ……………………………………......
Reported by: …………......…………………

A. Basic Information

1	Name of Beneficiary:		**2**	Sex: M ☐ F ☐
3	PA Number:		**4**	District:
5	VDC:		**6**	Ward:
7	Village/Tole:			
8	Reconstruction site	☐ Same as previous	☐ Different (Why)	
9	Cast and Ethnicity:		**10**	Occupation:
11	GPS: ° ' "N ; ° ' "E		**12**	Contact
13	Number of family members:	Male ………. Female …….…		

B. Debris Management

1.	Debris generated (by type)	Wood: m^3	Stone: m^3	Mud: m^3
		Bricks: m^3	CGI:	Others:
2.	Debris need to be disposed (by type)	Wood: m^3	Stone: m^3	Mud: m^3
		Bricks: m^3	CGI:	Others:
3.	Debris can be reused (by type)	Wood: m^3	Stone: m^3	Mud: m^3
		Bricks: m^3	CGI:	Others:

C. Waste Management

1.	Construction waste generated during reconstruction:				
2.	Types of construction waste generated during reconstruction:	a	Bricks	b	Plastic
		c	Wood	d	Plaster and Cement
		e	Scrap metal	f	Other (specify)

D. Housing Reconstruction

1	Entire reconstruction area: m^2	**2**	Amount of soil cutting/filling for reconstruction: m^3
2	Do you know about MR?		Good ☐ Partial ☐ Not at All ☐

Annex II

Ward	Reusable Debris (m^3/HH)	Disposable Debris (m^3/HH	Construction Waste (m^3/HH)
Overall Target Area	**12.7**	**9.7**	**1.5**
Gorkha Target Area	**10.1**	**7.2**	**1.1**
Sindhupalchok Target Area	**13.2**	**10.2**	**1.6**
Gorkha			
Ajirkot GP			
3(Hansapur)	14	9.7	1
4(Simjung)	11.7	8.9	1.2
5(Muchhok)	10.3	9.4	1.1
Barpak Sulikot GP			
1(Barpak)	16.8	9.6	1.2
2(Barpak)	14.8	9.2	1.2
3(Swara)	10.7	8.8	1.2
4(Saurpani)	12.7	8.4	1.1
5(Takumajh Lakuribot)	13.1	10.6	1.4
6(Takukot)	10.2	9.9	1.2
7(Panchkhuwa Deurali)	7	7.6	1.2
8(Pandrung)	9.2	3.2	1
Bhimsen Thapa GP			
1(Masel)	7.3	4.2	1.1
5(Baguwa)	7.1	4.5	1.2
Gorkha NP			
1(Taple)	7.6	6.5	1.2
2(Taple)	8	5.7	1.2
Siranchowk GP			
1(Kerabari)	7.9	7.3	0.9
7(Shreenathkot)	7.4	2.4	0.8
8(Jaubari)	6.1	3.2	1.1
Sindhupalchok			
Balefi GP			
1(Jalbire)	16.8	12.3	1.9
2(Fulpingkot)	13.9	9.4	1.7
3(Fulpingkot)	14.8	8.8	1.7
4(Fulpingdanda)	14.1	8.9	1.6
5(Fulpingdanda)	14.5	9	1.6
6(Mankha)	10	9.2	1.7
7(Mankha)	9.3	9	1.7
8(Mankha)	10.6	9.1	2
Barhabise NP			
1(Ghorthali)	12.7	13.2	1.4
2(Karthali)	12.1	9.6	1.5
3(Barhabise)	11.5	10.9	1.7

Ward	Reusable Debris (m^3/HH)	Disposable Debris (m^3/HH	Construction Waste (m^3/HH)
4(Barhabise)	10.4	10.8	1.6
5(Gati)	12.9	9.3	1.6
6(Gati)	13.5	9.4	1.5
7(Ghumthang)	14.5	12.9	1.1
8(Maneswnara)	14.2	8.7	1.2
9(Ramche)	12	9.2	1.2
Bhotekoshi GP			
1(Listikot)	12.6	13.5	2
2(Tatopani)	8.2	9.2	2.1
3(Tatopani)	8.1	6	2.1
4(Fulpingkatti)	12.9	13.4	2
5(Marming)	12.3	9.3	1.4
Chautara Sangachokgadi NP			
1(Syaule Bazar)	11	6.6	1.9
2(Batase)	11.1	6.2	2.1
3(Batase)	11.4	6.1	1.6
4(Kubhinde)	12.8	7.8	1.8
5(Chautara)	13.9	7	1.8
6(Pipaldanda)	13.7	8.9	1.6
7(Sanusiruwari)	13.8	9.4	1.9
8(Irkhu)	13.9	9.8	1.8
9(Kadambas)	14.4	8.5	1.9
10(Sangachok)	10.3	6.3	1.4
11(Sangachok)	10.4	6.3	1.4
12(Sangachok)	10.4	6.2	1.4
13(Thulo Sirubari)	11.6	7.6	1.6
14(Thulo Sirubari)	10.9	7.4	1.5
Helambu GP			
1(Helambu)	9.6	11.8	2.4
2(Kiwool)	11.4	15.1	2.2
3(Palchok)	12.5	18.2	2.1
4(Mahankal)	11.4	13.3	2.2
5(Mahankal)	11	13.5	2.3
6(Ichhock)	10.5	10.1	1.3
7(Ichhock)	13	11	1.4
Indrawati GP			
1(Simpalkavre)	10.7	9.6	1.7
2(Kunchok)	10.9	10.4	1.4
3(Kunchok)	11.2	10.2	1.5
4(Nawalpur)	14.1	10.8	1.1
5(Bandegaun)	17.7	8.5	1
6(Bandegaun)	15.3	10.2	1
7(Sipapokhare)	28.2	12.7	1.1

Ward	Reusable Debris (m^3/HH)	Disposable Debris (m^3/HH	Construction Waste (m^3/HH)
8(Sipapokhare)	27.8	13.1	1.1
9(Bhotasipa)	15.8	9.6	1.5
10(Bhotasipa)	9.9	9.6	1.4
11(Bhimtar)	7.9	13.4	0.5
12(Bhimtar)	8.4	13.5	0.4
Jugal GP			
1(Selang)	19.3	11.5	1
2(Golche)	18.9	10.6	2.3
3(Gumba)	20.4	13	2
4(Pangtang)	14.4	15.2	2.2
5(Baramchi)	18.2	15.9	1.6
6(Hagam)	21.9	14.2	1.9
7(Hagam)	22.3	16.1	1.6
Lisankhu Pakhar GP			
1(Thulo Dhading)	16.1	11.8	2.2
2(Lisankhu)	11	10.1	2.3
3(Lisankhu)	9.4	8.7	1.8
4(Attarpur)	16.9	11.8	2.3
5(Jethal)	18.4	10.4	2.2
6(Petku)	19.9	10.7	1.7
7(Thulopakhar)	16.1	10.5	2.2
Melamchi NP			
1(Bhotechaur)	10.1	11.6	1.4
2(Bhotechaur)	9.5	10.8	1.7
3(Haibung)	8.8	10	1.6
4(Thakani)	11.6	8	1.7
5(Sindhukot)	10.9	8.1	1.6
6(Talamarang)	12.3	7.2	1.2
7(Dubachour)	13.5	8.6	1.6
8(Dubachour)	14.9	8.5	1.6
9(Jyamire)	12.5	5.9	1.3
10(Shikharpur)	12	6.1	1.2
11(Melamchi)	9.6	8.9	1.4
12(Bansbari)	9.3	8.9	1.2
13(Fatakshila)	10.2	8.8	1.4
Panchpokhari Thangpal GP			
2(Baruwa)	11.7	9.2	1.4
Sunkoshi GP			
6(Thumpakhar)	12.4	9.4	0.4
7(Pangretar)	12.1	9.4	0.4
Tripurasundari GP			
1(Ghorthali)	15	10.4	1
2(Chokati)	15.3	11.9	1.2

Ward	Reusable Debris (m^3/HH)	Disposable Debris (m^3/HH	Construction Waste (m^3/HH)
3(Dhuskun)	13.2	10.1	2.1
4(Piskar)	17.1	12.9	3.1
5(Tauthali)	10.7	10.7	1.5
6(Tekanpur)	9.1	10	1.8