

# The Use of Lichenometry for Assessment of the Destruction and Reconstruction of Buddhist Sacred Walls in Langtang Valley, Nepal Himalaya, following the 2015 Gorkha Earthquake

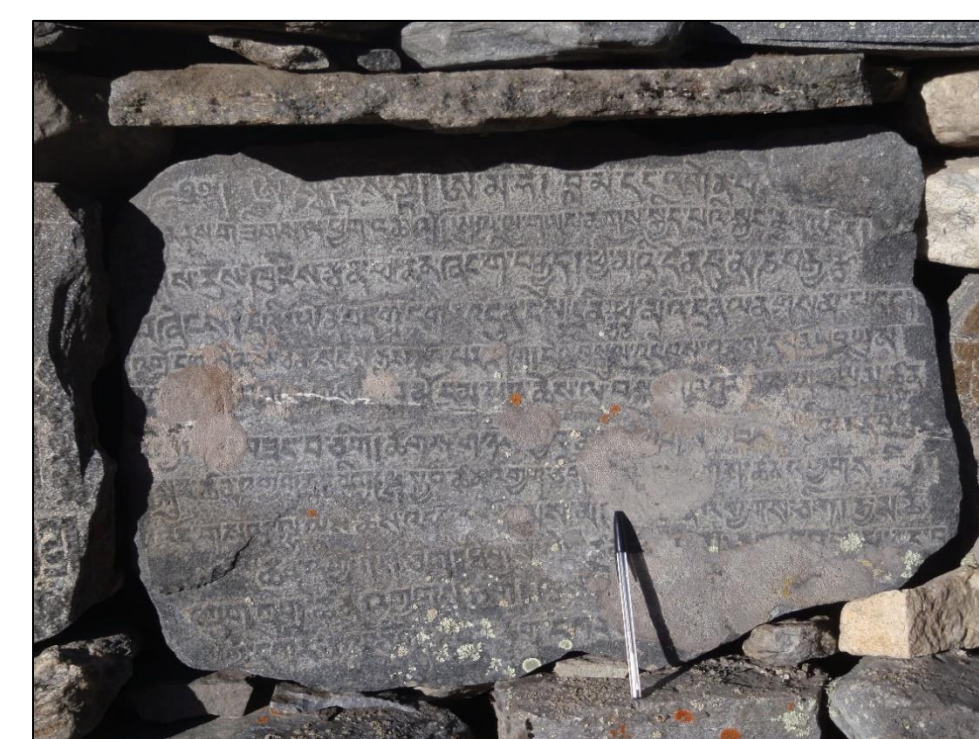
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## Lightning Summary

Six months following the 2015 Gorkha earthquake in Nepal, three fully intact mani walls hosted large crustose lichens that were not previously present. The most likely explanation was that mani walls had already been reconstructed using previously interior blocks as exterior blocks. Moreover, the original mani wall was found 170 m from its previous location. This research raises the possibility that many Himalayan religious structures are not the original structures, but are replicates that are reconstructed after natural disasters.



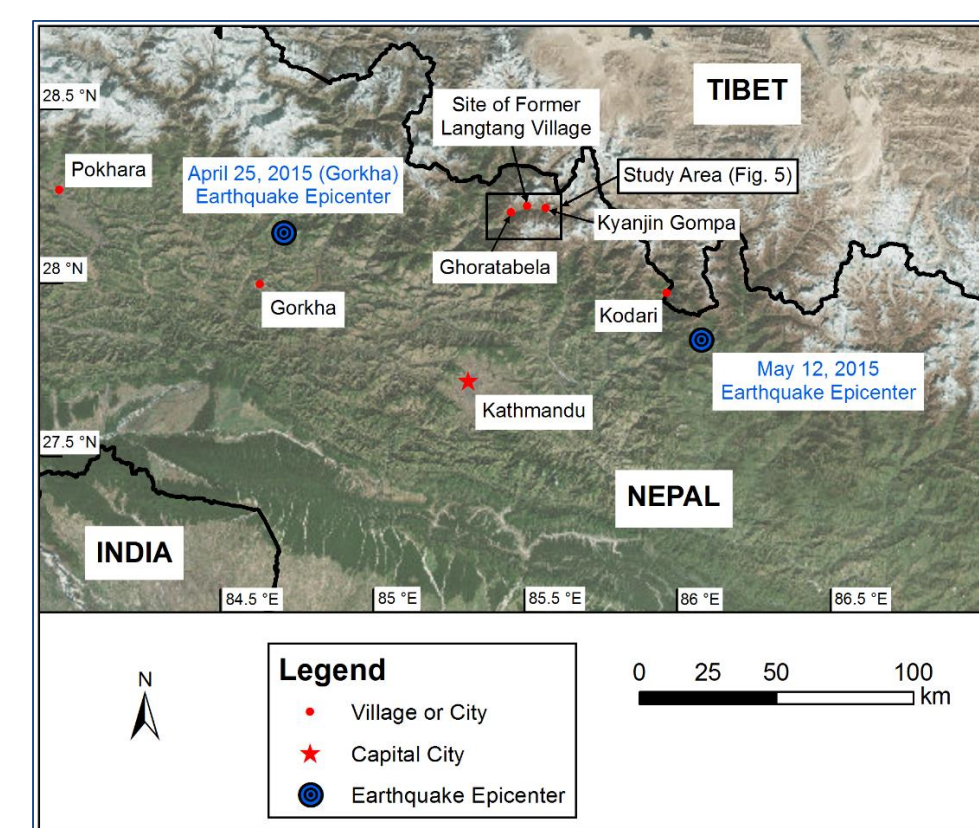
**Fig. 1** Buddhist sacred walls, called mani walls, are common in Langtang Valley (Nepal Himalaya) and especially between the site of the former Langtang Village and Kyanjin Gumpa. This mani wall is adjacent to the monastery in Kyanjin Gumpa (Mani Wall No. 80). The mani wall suffered no apparent damage from the 2015 Gorkha earthquake, although the monastery was heavily damaged.



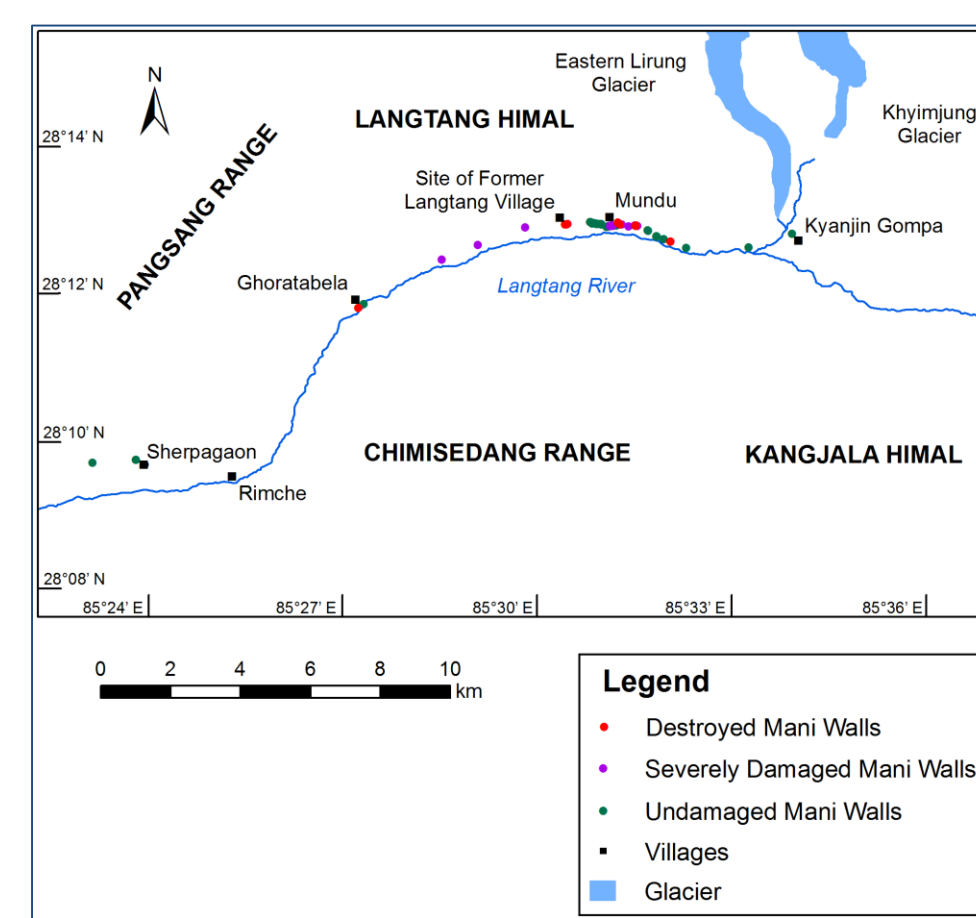
**Fig. 2** Many of the mani wall blocks include carved text in Tibetan letters (Mani Wall No. 80, Fig. 1). According to local informants, the Tibetan writing does not state the dates of construction or cleaning of the mani walls. Note that the apparent jagged edges of the block are simply shadows.



**Fig. 3** Many of the mani wall blocks include carved imagery (Mani Wall No. 80, Fig. 1). Note that the apparent jagged edges of the block are simply shadows.



**Fig. 4** The 2015 Gorkha earthquake caused massive landsliding in Langtang Valley, resulting in loss of life and the destruction of villages and cultural artifacts.



**Fig. 5** Out of 80 mapped mani walls in Langtang Valley, 12 (15%) were completely destroyed and 16 (20%) were severely damaged. The remainder suffered no apparent damage, although there was evidence that at least four had been rebuilt.



**Fig. 6** Mani Wall No. 64 was classified as "severely damaged" because it was not obvious how to reassemble the fallen blocks. The largest lichen found in 2015 (49.05 mm) was much larger than the largest lichen found in 2014 (22.82 mm) and was not the same lichen. Most likely, the earthquake damage exposed a larger lichen on an interior block.

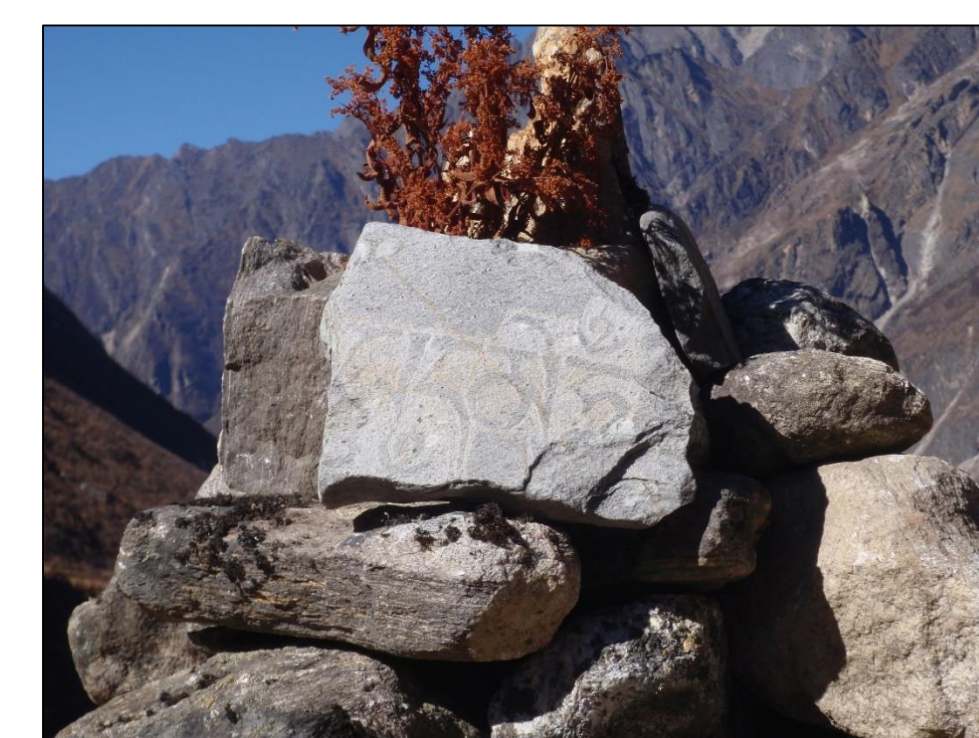
## Introduction

Mani walls, Buddhist sacred walls constructed of carved blocks with Tibetan letters and elaborate imagery, are common in Langtang Valley, Nepal Himalaya (Figs. 1-3). Fieldwork in 2009-2014 involved mapping and photographing all 80 mani walls, measuring and photographing all occurrences of the crustose lichen *Rhizocarpon geographicum*, and interviewing local informants regarding the history and traditions of the mani walls. The consensus of the informants was that the mani walls were constructed 400-600 years ago and that the original mani wall was in the village of Ghoratabela at the mouth of the glacial valley and had never been cleaned of lichen. Based on a locally-developed growth curve, the oldest lichen on a mani wall dated only to 1942. On April 25, 2015, Nepal was struck by an earthquake of moment magnitude 7.8 with epicenter 21 km NNE of the city of Gorkha (Fig. 4). The death toll of ~9,000 was accompanied by massive destruction of the temples, monuments, and other religious and cultural heritage of Kathmandu Valley. An icefall-debris avalanche triggered by the Gorkha earthquake completely buried Langtang Village, killing at least 350 people (Figs. 4-5). After learning of the tragedy in Langtang Valley, it occurred to the author that the date of the earliest mani wall was, within modeling error, concurrent with the 1934 earthquake, the last major earthquake to strike Nepal prior to the 2015 Gorkha earthquake. The concurrence of dates led to the following questions:

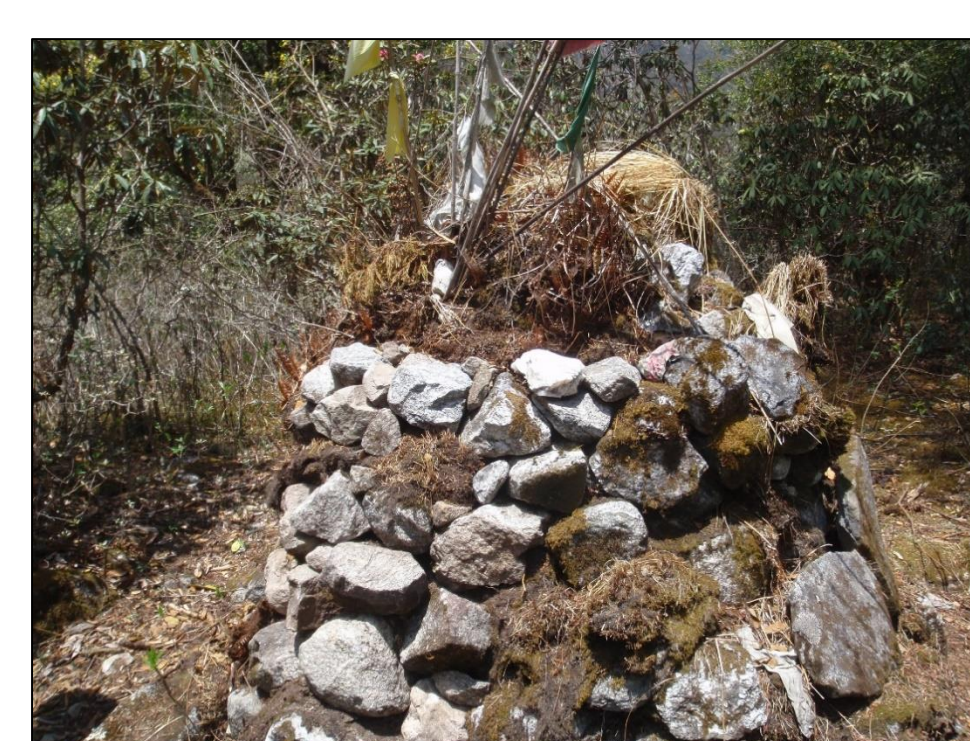
- 1) Are Himalayan religious structures actually the original structures or are they replicates that are reconstructed after natural disasters?
  - 2) Could Himalayan religious structures be used to date natural disasters?
- The objective of this study was to repeat all fieldwork in Langtang Valley, including mapping and photographing mani walls, measuring the lichens on mani walls, and interviewing the local residents, in order to assess the destruction and possible reconstruction of the mani walls following the 2015 Gorkha earthquake.



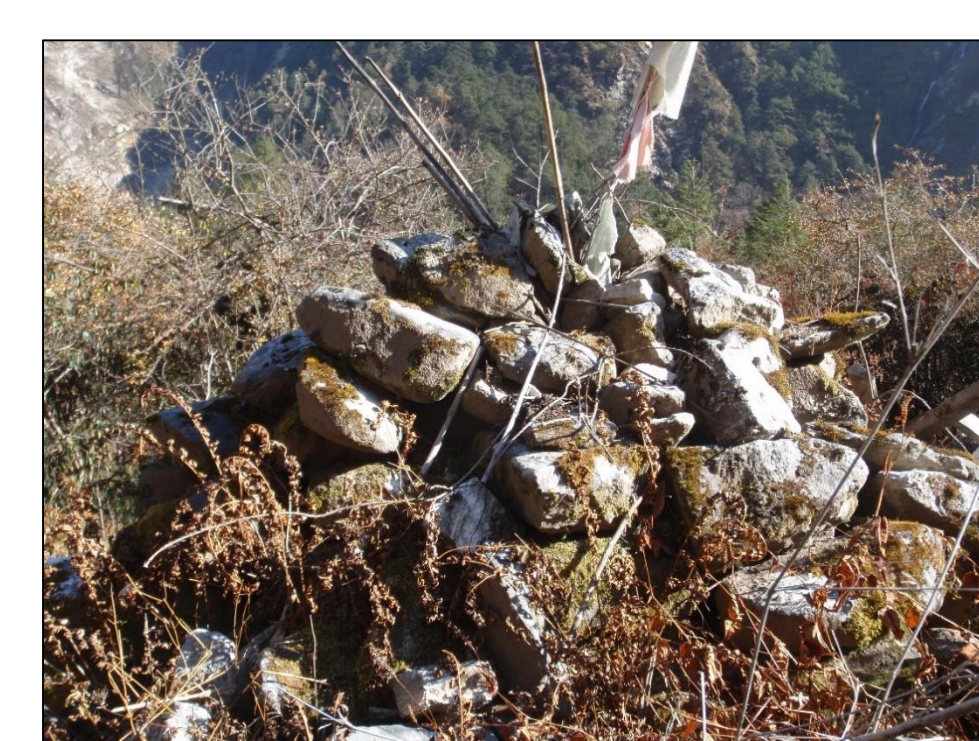
**Fig. 7a** Mani Wall No. 77 was mapped in 2009 and 2014, but could not be located in 2015. In its place stood a conical structure (called a chorten) that had been apparently constructed out of the scattered blocks.



**Fig. 7b** This is a close-up of Fig. 7a. The broken block with carved Tibetan letters on the top of the chorten was probably a remnant of Mani Wall No. 77.



**Fig. 8a** The appearance of Mani Wall No. 4 near Ghoratabela, as seen in 2014, was consistent with the oral tradition that this was the original mani wall (constructed 400-600 years ago) and had never been cleaned.



**Fig. 8b** Mani Wall No. 4 (Fig. 8a) could not be located in 2015. However, Mani Wall No. 5 with a similar appearance was found in 2015 and was also referred to as the original mani wall by local informants.



**Fig. 9** The original mani wall was apparently rebuilt 170 m to the northeast and closer to the trail that passes through Ghoratabela. The background aerial photo is a Google Earth image dated November 8, 2014 (before the 2015 Gorkha earthquake). In November 2015 all buildings in Ghoratabela were still heavily damaged and there were no residents.

## Materials and Methods

All post-earthquake fieldwork was carried out from November 18-25, 2015, almost exactly six months after the earthquake. Additional interviews with local residents did not follow a fixed set of questions, but concerned the history and traditions of the mani walls, the maintenance and cleaning of the mani walls, the damage caused by the 2015 earthquake, and any previous damage to the mani walls. Damage to mani walls was assessed in the four categories (1) none (2) slight (3) severe (4) destroyed. No damage meant that no blocks were apparently out of place. Slight damage meant that one or more blocks had slipped out of place, but it was fairly obvious how to reconstruct the mani wall. Severe damage meant that so many blocks had fallen that it was not clear to a layman how to reconstruct the mani wall (Fig. 6). A mani wall was classified as destroyed if it could not be located at all.



**Fig. 10** Although Mani Wall No. 53 had no apparent damage, the largest lichen in 2015 was 43.42 mm, although no lichens were present in 2009 or 2014. The most likely explanation is that the mani wall had already been reconstructed in such a way that a formerly interior block was placed on the exterior of the mani wall. The mani wall was in the village of Mundu (Fig. 5), which was inhabited at the time of the 2015 fieldwork (note house in background).



**Fig. 11** Although Mani Wall No. 54 had no apparent damage, the largest lichen in 2015 was 37.80 mm, although no lichens were present in 2009 or 2014. The most likely explanation is that the mani wall had already been reconstructed in such a way that a formerly interior block was placed on the exterior of the mani wall. The mani wall was in the village of Mundu (Fig. 5), which was inhabited at the time of the 2015 fieldwork. Mani Wall No. 54 is only 9 m east of Mani Wall No. 53 (Fig. 10).

## Results

Out of the 80 mani walls in Langtang Valley, it was found that 12 mani walls (15%) were completely destroyed and 16 mani walls (20%) were severely damaged (Figs. 5-6). At each of three sites of former mani walls (Mani Wall Nos. 67, 76-77), a chorten was found that was topped by what was apparently a broken, carved block of a former mani wall (Figs. 7a-b). This combination of a chorten topped by a mani wall block had never been seen by the author before anywhere in the Nepal Himalaya and could be regarded as a form of post-disaster religious art. There were no cases of slightly damaged mani walls and no transition zones between areas of undamaged and either severely damaged or destroyed mani walls (Fig. 5). It is most likely that the mani walls had already been repaired in cases where it was obvious how to put the blocks back into place. The original mani wall in Ghoratabela could not be found among the scattered boulders and fallen trees at the location where it had been previously mapped (Mani Wall No. 4, Figs. 5, 8a). However, a similar structure that had not existed prior to the 2015 Gorkha earthquake was found 170 m to the northeast of the previous original mani wall and closer to the trail that passes through Ghoratabela (Mani Wall No. 5, Figs. 8b, 9, 10). The easiest mani wall to replicate would be a mani wall that looked as if it had received no maintenance for several centuries, as opposed to replicating the intricate design of the maintained mani walls (Fig. 1).

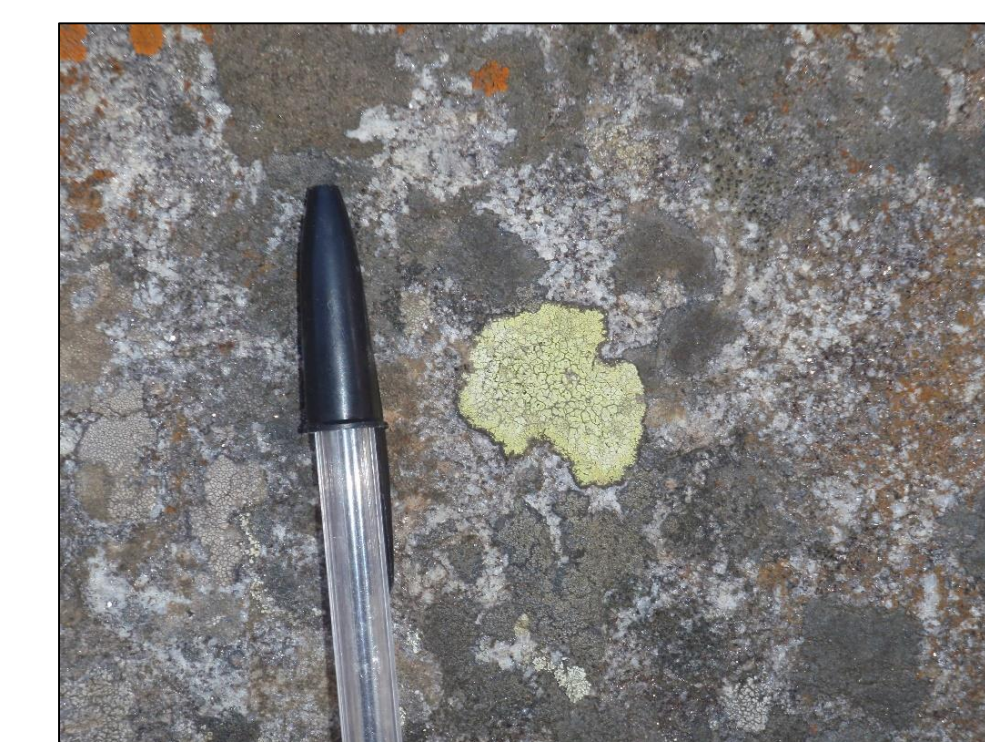


**Fig. 12** Although Mani Wall No. 44 had no apparent damage, the largest lichen in 2015 was 38.28 mm, although no lichens were present in 2009 or 2014. The most likely explanation is that the mani wall had already been reconstructed in such a way that a formerly interior block was placed on the exterior of the mani wall. The mani wall was in the village of Mundu (Fig. 5), which was inhabited at the time of the 2015 fieldwork (note house in background). The three reconstructed mani walls (Nos. 44, 53, 54) are within 195 m of one another.

The most challenging observation is the existence of five mani walls on which the largest *R. geographicum* in 2015 was not even present during any previous fieldwork. Two of the mani walls were severely damaged, but the other three appeared to have suffered no damage at all (Figs. 6, 10-12). Where did these previously unseen lichens and the mani wall blocks that hosted them come from? The only plausible explanation for the post-earthquake appearance of previously unseen lichens is that mani wall blocks that were formerly interior blocks were present on the exterior. All of the previously unseen lichens were heavily bleached with a strong color contrast from white to pale yellow (Fig. 13), as opposed to the bright yellowish-green of healthy *R. geographicum* (Fig. 14). These lichen colors were consistent with a previous history as an interior block, where only diffuse light with a strong spatial heterogeneity of light intensity would be present. The three apparently reconstructed mani walls were all within 195 m of one another in the village of Mundu (note the houses in the background of Figs. 10 and 12). At the time of the fieldwork, aside from yak-herders living in temporary dwellings above Ghoratabela, Mundu was the only inhabited village in Langtang Valley between Rimche and Kyanjin Gumpa (Fig. 5), as all other villages were heavily damaged and still abandoned. It seems reasonable that an inhabited village would be one of the first places where mani walls would be reconstructed.



**Fig. 13** The lichens found on Mani Wall No. 54 (Fig. 11) were heavily bleached with a strong color contrast from white to pale yellow, as opposed to the bright yellowish-green of healthy *Rhizocarpon geographicum* (Fig. 14). The lichen colors were consistent with a previous history as an interior block, where only diffuse light with a strong spatial heterogeneity of light intensity would be present.



**Fig. 14** Healthy *Rhizocarpon geographicum* with bright yellowish-green color were found growing on Mani Wall No. 49, indicating that the host block was an exterior block with exposure to full sunlight both before and after the 2015 earthquake.

## Discussion

There are five lines of evidence that, within six months of the 2015 Gorkha earthquake, at least four mani walls had been reconstructed in a manner similar to, but not identical to the original designs:

- 1) The structure that had been called the original mani wall by pre-earthquake informants could no longer be located. After the earthquake, a structure with a similar, but not identical, appearance was found 170 m from the previous original mani wall and was referred to as the original mani wall by post-earthquake informants.
- 2) Three apparently undamaged mani walls in a single inhabited village were hosting previously unseen *R. geographicum* individuals. The exterior blocks that hosted these lichens must have previously been interior blocks, which was consistent with the bleached appearance of the lichens.
- 3) There were no slightly damaged mani walls and no transition zones between areas of undamaged mani walls and either severely damaged or destroyed mani walls.
- 4) Two apparently undamaged mani walls had no *R. geographicum*, although lichens had been seen on these walls before the earthquake 18 months previously. This rate of cleaning contrasted with pre-earthquake fieldwork that showed that lichens were completely removed from mani walls at the rate of three mani walls every five years.
- 5) Four mani walls showed a decrease in the size of the largest lichen over the previous 18 months. This rate of cleaning contrasted with pre-earthquake fieldwork that showed that the lichens were partially cleaned from mani walls at the rate of five mani walls every five years.

The last two observations would not constitute evidence for reconstruction by themselves, but they help to support a pattern of extra attention paid to the mani walls after the earthquake.