Supplement of

Multiple remote-sensing assessment of the catastrophic collapse in Langtang Valley induced by the 2015 Gorkha earthquake

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In order to calibrate the digital surface models (DSMs) of ALOS World 3D (AW3D) and WorldView-3 (WV-3), these data were compared and validated for two of the no-damage sites (Windows A and B) in the vicinity of the collapsed sediment surface (Fig. S1). For sites with no horizontal shift, the differences in values obtained from AW3D and WV-3 DSMs were extracted every 5 m (the pixel spacing for AW3D) in the rectangles of Windows A and B. The average difference between the values of altitude derived from WV-3 DSM and AW3D DSM was 27.4 m (standard deviation of 1.7 m) and 26.2 m (standard deviation of 1.438 m) at Windows A and B, respectively, where WV-3 yields the higher values.

Secondly, the AW3D DSM for Window A was horizontally shifted within Site A at 5 m steps to increase its consistency with the WV-3 DSM, and the standard deviation of the altitude difference from the WV-3 DSM in the original location was calculated for all such location shifts. The minimum standard deviation was calculated to be 1.5 m, when the AW3D DSM is longitudinally shifted to −5 m (i.e., 5 m to the west) (Fig. S2a). In case of Site B, the minimum standard deviation was calculated to be 1.427 m, when the AW3D DSM is longitudinally shifted to −5 m (Fig. S2b). These results suggest that the AW3D DSM should be shifted 5 m to the west (or that the WV-3 DSM should be shifted 5 m to the east) in order to obtain the most consistent outputs using both the DSMs.

In Window A, the values of altitude derived from WV-3 were, on an average, 28.2 m higher than those derived from AW3D (with a standard deviation of 1.5 m). In Window B, the values of altitude derived from WV-3 were, on an average, 25.9 m higher than those derived from AW3D (with a standard deviation of 1.427 m). To check any deviation of orientation, the horizontal profiles of the AW3D and WV-3 DSMs along the longitudinal and latitudinal ranges were plotted as shown in Fig. S3. Along the four example lines denoted in Fig. S1 (ax–ax’, ay–ay’, bx–bx’, and by–by’), the values obtained from WV-3 are consistently higher than those obtained from AW3D by about 26 to 28 m. No anomaly trend was found along any direction.

Considering these results, we considered 27.0 m to be the altitude difference between the shifted AW3D DSM and AW3D DSM in this study site. From the derived standard deviations of 1.427 m and 1.5 m, taking the greater one, we defined 1.5 m as the possible error in altitude estimation to calculate the sediment volume (Chapters 3.4. and 4.2.).
**Fig. S1** Location of the two calibration sites (Site A and Site B) near the collapsed sediment surface. Locations of the related lines and rectangles used in Figs. S2 and S3 are also shown. The background is a WorldView-3 image acquired after the collapse (May 8, 2015).
Fig. S2 Standard deviation of the elevation difference between AW3D and WV-3 DSMs. (a) AW3D DSM in Window A is shifted within Site A at 5 m steps, then the standard deviation is calculated with the WV-3 DSM at the original location in Site A. X-axis and Y-axis correspond to the distance from AW3D to the east and to the north, respectively. (b) Same calculation is done for the combination of the Window B in Site B.
Fig. S3 Longitudinal and latitudinal profiles generated from the AW3D and WV-3 DSMs in Site A and Site B.