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*Supplement of*

## **A new remote hazard and risk assessment framework for glacial lakes in the Nepal Himalaya**

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1 **Supplementary Materials**

2 Table S.1. Results of O'Connor et al. (2001) hazard assessment.

| Lake                | Freeboard | Steep glacier calving | Total |
|---------------------|-----------|-----------------------|-------|
| Chamlang North Tsho | None      | Yes                   | 2/2   |
| Chamlang South Tsho | None      | Yes                   | 2/2   |
| Dig Tsho            | None      | Yes                   | 2/2   |
| Imja Tsho           | None      | No                    | 1/2   |
| Lower Barun Tsho    | None      | Yes                   | 2/2   |
| Lumding Tsho        | None      | Yes                   | 2/2   |
| Thulagi Tsho        | None      | No                    | 1/2   |
| Tsho Rolpa          | None      | Yes                   | 2/2   |

5 Table S.2. Results of Costa and Schuster (1988) hazard assessment.

| Lake                | Ice-cored moraine | Unstable young moraine, no vegetation | Steep slope moraine (> 40°) | Rock/ice avalanche into lake | Total |
|---------------------|-------------------|---------------------------------------|-----------------------------|------------------------------|-------|
| Chamlang North Tsho | No                | Yes                                   | Yes                         | Yes                          | 3/4   |
| Chamlang South Tsho | Yes               | Yes                                   | No                          | Yes                          | 3/4   |
| Dig Tsho            | No                | Yes                                   | No                          | Yes                          | 2/4   |
| Imja Tsho           | Yes               | Yes                                   | No                          | No                           | 2/4   |
| Lower Barun Tsho    | Yes               | Yes                                   | No                          | Yes                          | 3/4   |
| Lumding Tsho        | No                | Yes                                   | No                          | Yes                          | 2/4   |
| Thulagi Tsho        | Yes               | No                                    | No                          | Yes                          | 2/4   |
| Tsho Rolpa          | Yes               | Yes                                   | No                          | Yes                          | 3/4   |

8 Table S.3. Results from Wang et al. (2008) hazard assessment.

| Lake                | Top width of dam (< 600 m) | Distal flank steepness* (> 20°) | Ice-cored moraine | Dam width : height (< 2) | Slope of glacier snout (> 8°) | Temp & precip (hot & wet) | Freeboard : dam height (0) | Lake-glacier proximity (< 500 m) | Total |
|---------------------|----------------------------|---------------------------------|-------------------|--------------------------|-------------------------------|---------------------------|----------------------------|----------------------------------|-------|
| Chamlang North Tsho | 530                        | 41.5°                           | No                | 5.4                      | 27.4°                         | Yes                       | 0                          | 0                                | 6/8   |
| Chamlang South Tsho | 1050                       | 39.7°                           | Yes               | 6.2                      | 26.6°                         | Yes                       | 0                          | 270                              | 6/8   |
| Dig Tsho            | 460                        | 30.1°                           | No                | 7                        | 37.6°                         | Yes                       | 0                          | 960                              | 5/8   |
| Imja Tsho           | 650                        | 31.7°                           | Yes               | 11.1                     | 1.7°                          | Yes                       | 0                          | 0                                | 5/8   |
| Lower Barun Tsho    | 1000                       | 26.7°                           | Yes               | 15                       | 7.0°                          | Yes                       | 0                          | 0                                | 5/8   |
| Lumding Tsho        | 530                        | 31.3°                           | No                | 13.7                     | 12.4°                         | Yes                       | 0                          | 0                                | 6/8   |
| Thulagi Tsho        | 1000                       | 28.1°                           | Yes               | 22.7                     | 5.7°                          | Yes                       | 0                          | 0                                | 5/8   |
| Tsho Rolpa          | 530                        | 39.2°                           | Yes               | 3.4                      | 3.0°                          | Yes                       | 0                          | 0                                | 6/8   |

9 \*maximum slope on terminal moraine was used

1 Table S.4. Results of Bolch et al. (2011) hazard assessment

| <b>Lake</b>         | Lake area change | Risk of ice avalanche | Rick of rockfall | Ice core | Debris flow | Flash flood | Contact with glacier | Lake area (km <sup>2</sup> ) | Glacier shrinkage | Glacier slope | Stagnant glacier | <b>Hazard</b> | <b>Score</b> |
|---------------------|------------------|-----------------------|------------------|----------|-------------|-------------|----------------------|------------------------------|-------------------|---------------|------------------|---------------|--------------|
| Chamlang North Tsho | No               | Yes                   | Yes              | No       | Yes         | -           | No                   | 0.90                         | No                | 27.4°         | No               | Medium        | 0.45         |
| Chamlang South Tsho | No               | Yes                   | Yes              | Yes      | Yes         | -           | No                   | 0.82                         | No                | 26.6°         | Yes              | Medium        | 0.57         |
| Dig Tsho            | No               | Yes                   | Yes              | No       | No          | Yes         | No                   | 0.40                         | No                | 37.6°         | No               | Medium        | 0.41         |
| Imja Tsho           | Yes              | No                    | No               | Yes      | No          | Yes         | Yes                  | 1.22                         | Yes               | 1.7°          | Yes              | High          | 0.63         |
| Lower Barun Tsho    | Yes              | Yes                   | Yes              | Yes      | No          | Yes         | Yes                  | 1.61                         | Yes               | 7.0°          | Yes              | High          | 0.89         |
| Lumding Tsho        | Yes              | Yes                   | Yes              | No       | No          | Yes         | Yes                  | 1.09                         | Yes               | 12.4°         | Yes              | High          | 0.79         |
| Thulagi Tsho        | Yes              | No                    | Yes              | Yes      | No          | Yes         | Yes                  | 0.95                         | Yes               | 5.7°          | Yes              | High          | 0.71         |
| Tsho Rolpa          | Yes              | Yes                   | Yes              | Yes      | Yes         | -           | Yes                  | 1.59                         | No                | 3.0°          | Yes              | High          | 0.89         |

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4 Table S.5. Results from Wang et al. (2011) hazard assessment

| <b>Lake</b>         | Area of mother glacier (km <sup>2</sup> ) | Distance between lake and glacier (m) | Slope between lake and glacier (°) | Slope of downstream face of dam (°) | Mother glacier snout steepness (°) | <b>Hazard</b> | <b>Score</b> |
|---------------------|---|---------------------------------------|------------------------------------|-------------------------------------|------------------------------------|---------------|--------------|
| Chamlang South Tsho | 7.5                                       | 270                                   | 45                                 | 10.4                                | 26.6                               | Very High     | 0.84         |
| Chamlang North Tsho | 0.01                                      | 0                                     | 27.5                               | 12.2                                | 27.5                               | Very High     | 0.85         |
| Dig Tsho            | 23.9                                      | 600                                   | 31.3                               | 8.9                                 | 37.6                               | High          | 0.72         |
| Imja Tsho           | 2.12                                      | 0                                     | 1.7                                | 6.8                                 | 1.7                                | Low           | 0.49         |
| Lower Barun Lake    | 55  | 0                                     | 7                                  | 4.9                                 | 7                                  | Medium        | 0.51         |
| Lumding Lake        | 29.1                                      | 0                                     | 12.4                               | 10.5                                | 12.4                               | Medium        | 0.61         |
| Thulagi Tsho        | 56.8                                      | 0                                     | 5.7                                | 7.1                                 | 5.7                                | Medium        | 0.51         |
| Tsho Rolpa          | 61.5                                      | 0                                     | 3                                  | 16.4                                | 3                                  | Medium        | 0.6          |

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1 Table S.6. Results from Emmer and Vilimek (2014) hazard assessment

|  | Chamlang      |               | Lower       |              |               |                 | Lumding         |              |                 | Tsho           |                         |
|--|---------------|---------------|-------------|--------------|---------------|-----------------|-----------------|--------------|-----------------|----------------|-------------------------|
|  | North<br>Tsho | South<br>Tsho | Dig<br>Tsho | Imja<br>Tsho | Barun<br>Tsho | Seto<br>Pohkari | Lumding<br>Tsho | Teng<br>Tsho | Thulagi<br>Tsho | Tsho<br>Rolpa* | Tsho<br>Rolpa<br>Upper1 |
| <u>Terminal Moraine</u>                          |               |               |             |              |               |                 |                 |              |                 |                |                         |
| Dam Type   | moraine       | moraine       | moraine     | moraine      | moraine       | moraine         | moraine         | moraine      | moraine         | moraine        | moraine                 |
| Dam Freeboard (m)                                | 0             | 0             | 0           | 0            | 0             | 0               | 0               | 0            | 0               | 0              | 0                       |
| Dam Width (m)                                    | 1770          | 1050          | 460         | 750          | 1000          | 900             | 490             | 475          | 1000            | 530            | 500                     |
| Dam Height (m)                                   | 330           | 169.8         | 66          | 69           | 66.6          | 50              | 32.3            | 200          | 44              | 165            | 50                      |
| Maximum slope of distal face of dam (°)          | 40            | 27.4          | 34.6        | 15           | 23.2          | 31.3            | 31.3            | 46.6         | 21.5            | 30             | 39                      |
| Remedial work                                    | no            | no            | no          | no           | no            | no              | no              | no           | no              | yes            | no                      |
| <u>Lake Characteristics</u>                      |               |               |             |              |               |                 |                 |              |                 |                |                         |
| Lake Area (m <sup>2</sup> )                      | 9.1E+05       | 8.2E+05       | 4.0E+05     | 1.2E+06      | 1.6E+06       | 3.6E+05         | 1.1E+06         | 3.3E+05      | 8.8E+05         | 1.6E+06        | 1.2E+05                 |
| Lake Perimeter (m)                               | 6990          | 4920          | 3480        | 6540         | 8310          | 2850            | 7530            | 3260         | 7230            | 10140          | 2040                    |
| Maximum lake width (m)                           | 650           | 550           | 450         | 690          | 800           | 430             | 510             | 475          | 830             | 600            | 240                     |
| Lake Volume (m <sup>3</sup> )                    | 3.7E+07       | 3.2E+07       | 1.2E+07     | 7.5E+07      | 8.1E+07       | 9.9E+06         | 4.7E+07         | 9.1E+06      | 3.5E+07         | 8.6E+07        | 2.1E+06                 |
| <u>Lake Surrounding Characteristics</u>          |               |               |             |              |               |                 |                 |              |                 |                |                         |
| Distance b/w lake and glacier (m)                | 0             | 200           | 600         | 0            | 0             | 500             | 0               | 500          | 0               | 0              | 240                     |
| Width of calving front (m)                       | 175           | 0             | 0           |              | 700           | 0               | 510             | 0            | 575             | 240            | 0                       |
| Mean slope b/w lake and glacier (°)              | 27.5          | 30.6          | 31.3        | 1.0          | 7.0           | 46.1            | 12.4            | 30.0         | 5.7             | 3.0            | 45.2                    |
| Mean slope of last 500m of glacier tongue (°)    | 27.5          | 26.6          | 31.3        | 1.0          | 7.0           | 18.8            | 12.4            | 20.0         | 5.7             | 3.0            | 29.1                    |
| Max slope of moraine surrounding lake (°)        | 74.5          | 73.2          | 67.8        | 54.5         | 70.1          | 57.8            | 66.0            | 56.3         | 68.8            | 57.0           | 67.0                    |
| Mean slope of lake surroundings (°)              | 34.0          | 45.0          | 45.0        | 37.5         | 45.0          | 35.0            | 35.0            | 30.0         | 45.0            | 45.0           | 35.0                    |
| <u>Results</u>                                   |               |               |             |              |               |                 |                 |              |                 |                |                         |
| Dam overtopping from mass movement into lake     | 1.00          | 0.96          | 0.93        | 1.00         | 1.00          | 0.85            | 1.00            | 0.83         | 1.00            | 1.00           | 1.00                    |
| Dam overtopping from upstream GLOF               | 0.00          | 0.00          | 0.00        | 0.00         | 0.85          | 0.00            | 0.83            | 0.00         | 0.00            | 1.00           | 0.00                    |
| Dam failure from mass movement into lake         | 0.64          | 0.46          | 0.57        | 0.21         | 0.39          | 0.52            | 0.52            | 0.73         | 0.37            | 0.50           | 0.63                    |
| Dam failure from upstream GLOF                   | 0.00          | 0.00          | 0.00        | 0.00         | 1.00          | 0.00            | 0.83            | 0.00         | 0.00            | 1.00           | 0.00                    |
| Dam failure from strong earthquake               | 0.03          | 0.03          | 0.02        | 0.01         | 0.00          | 0.00            | 0.00            | 0.18         | 0.00            | 0.10           | 0.10                    |
| <b>Number of failures lake is susceptible to</b> | <b>2/5</b>    | <b>1/5</b>    | <b>2/5</b>  | <b>1/5</b>   | <b>3/5</b>    | <b>2/5</b>      | <b>4/5</b>      | <b>2/5</b>   | <b>1/5</b>      | <b>4/5</b>     | <b>2/5</b>              |

\*Tsho Rolpa has three sizeable glacial lakes upstream, but only one was used for this analysis as it gave the highest results for the upstream GLOF scenarios

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1 Table S.7. Details concerning the satellite imagery, dates, bands, thresholds, and area (km<sup>2</sup>) for  
 2 each glacial lake in this study.

| Year | Date  | Imagery<br>(Bands) | Area (km <sup>2</sup> ) [Threshold] |                     |              |              |               |                 |               |                 |
|------|-------|--------------------|-------------------------------------|---------------------|--------------|--------------|---------------|-----------------|---------------|-----------------|
|      |       |                    | Chamlang<br>N. Tsho*                | Chamlang<br>S. Tsho | Dig<br>Tsho  | Imja<br>Tsho | Barun<br>Tsho | Lumding<br>Tsho | Tsho<br>Rolpa | Thulagi<br>Tsho |
| 2000 | 09/12 | L7(1,4)            | -                                   | 0.815 [0.68]        | 0.400 [0.55] | -            | -             | 0.773 [0.64]    | -             | -               |
|      | 09/26 | L7(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.860 [0.56]    |
|      | 09/28 | L7(2,4)            | -                                   | -                   | -            | -            | 0.949 [0.43]  | -               | -             | -               |
|      | 10/14 | L7(2,4)            | -                                   | -                   | -            | 0.835 [0.50] | -             | -               | -             | -               |
|      | 10/14 | L7(1,4)            | -                                   | -                   | -            | -            | -             | -               | 1.520 [0.43]  | -               |
|      | 10/30 | L7(2,4)            | -                                   | -                   | -            | -            | Supp [0.25]   | -               | -             | -               |
| 2001 | 09/15 | L7(2,4)            | -                                   | -                   | -            | 0.853 [0.55] | 0.932 [0.45]  | -               | -             | -               |
|      | 09/29 | L7(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.864 [0.56]    |
|      | 10/07 | L7(1,4)            | -                                   | -                   | -            | -            | -             | 0.797 [0.61]    | 1.541 [0.43]  | -               |
|      | 12/20 | L7(2,4)            | -                                   | -                   | -            | -            | Supp [0.05]   | -               | -             | -               |
| 2002 | 10/04 | L7(2,4)            | -                                   | -                   | -            | 0.863 [0.35] | 0.974 [0.23]  | -               | -             | -               |
|      | 10/04 | L7(1,4)            | -                                   | -                   | -            | -            | -             | 0.821 [0.41]    | 1.553 [0.27]  | -               |
|      | 10/20 | L7(2,4)            | -                                   | -                   | -            | -            | Supp [0.43]   | -               | -             | -               |
|      | 12/05 | L7(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.887 [0.35]    |
| 2003 | 10/23 | A(1,3)             | -                                   | -                   | -            | -            | 1.022 [0.00]  | -               | -             | -               |
|      | 11/08 | L7(2,4)            | -                                   | -                   | -            | 0.871 [0.50] | -             | -               | -             | -               |
|      | 11/08 | L7(1,4)            | -                                   | -                   | -            | -            | -             | 0.818 [0.64]    | -             | -               |
|      | 11/14 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.885 [0.54]    |
|      | 11/16 | L7(1,4)            | -                                   | -                   | -            | -            | -             | Supp [0.60]     | -             | -               |
| 2004 | 10/09 | A(1,3)             | -                                   | -                   | -            | -            | 1.035 [0.00]  | -               | -             | -               |
|      | 10/17 | L5(1,4)            | -                                   | -                   | -            | -            | -             | 0.851 [0.62]    | 1.536 [0.44]  | -               |
|      | 11/10 | L7(2,4)            | -                                   | -                   | -            | 0.893 [0.35] | -             | -               | -             | -               |
|      | 11/16 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.912 [0.51]    |
| 2005 | 10/10 | L7(2,4)            | -                                   | -                   | 0.406 [0.12] | -            | 1.082 [0.45]  | -               | -             | -               |
|      | 10/28 | L7(2,4)            | -                                   | -                   | -            | 0.898 [0.10] | Supp [0.15]   | 0.887 [0.20]    | -             | -               |
|      | 11/03 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.923 [0.48]    |
|      | 11/05 | L5(1,4)            | -                                   | 0.822 [0.63]        | -            | -            | -             | Supp [0.34]     | 1.535 [0.41]  | -               |
| 2006 | 09/05 | L5(1,4)            | -                                   | -                   | -            | -            | -             | 0.888 [0.57]    | 1.517 [0.44]  | -               |
|      | 10/15 | A(1,3)             | -                                   | -                   | -            | -            | 1.165 [0.45]  | -               | -             | -               |
|      | 11/16 | L7(4,5)            | -                                   | -                   | -            | 0.943 [0.35] | -             | -               | -             | -               |
|      | 11/22 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.925 [0.50]    |
| 2007 | 09/22 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.940 [0.48]    |
|      | 10/02 | L7(2,4)            | -                                   | -                   | -            | 0.947 [0.30] | -             | -               | -             | -               |
|      | 10/02 | L7(1,4)            | -                                   | -                   | -            | -            | -             | Supp [0.41]     | Supp [0.25]   | -               |
|      | 10/18 | L7(2,4)            | -                                   | -                   | -            | -            | 1.213 [0.45]  | -               | -             | -               |
|      | 11/03 | L7(2,4)            | -                                   | -                   | -            | -            | Supp [0.30]   | -               | -             | -               |
|      | 11/19 | L7(1,4)            | -                                   | -                   | -            | -            | -             | 0.900 [0.48]    | 1.534 [0.25]  | -               |
| 2008 | 10/12 | L5(1,4)            | -                                   | -                   | -            | -            | -             | 0.965 [0.65]    | 1.532 [0.41]  | -               |
|      | 10/20 | L7(2,4)            | -                                   | -                   | -            | 0.992 [0.30] | -             | -               | -             | -               |
|      | 10/26 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.932 [0.47]    |
|      | 11/05 | L7(2,4)            | -                                   | -                   | -            | -            | 1.261 [0.45]  | -               | -             | -               |
| 2009 | 04/30 | L7(2,4)            | -                                   | -                   | -            | -            | Supp [0.45]   | -               | -             | -               |
|      | 09/27 | L5(1,4)            | -                                   | -                   | -            | -            | -             | -               | -             | 0.941 [0.45]    |
|      | 10/15 | L5(2,4)            | -                                   | -                   | -            | -            | 1.370 [0.15]  | -               | -             | -               |
|      | 10/15 | L5(1,4)            | -                                   | -                   | -            | -            | -             | 0.977 [0.64]    | 1.541 [0.41]  | -               |
|      | 10/23 | L7(2,4)            | -                                   | -                   | -            | 1.041 [0.30] | -             | -               | -             | -               |

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1 Table S.7 (Continued)

|      |       |         |              |              |              |              |              |              |              |              |
|------|-------|---------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| 2010 | 10/10 | L7(1,4) | -            | -            | 0.390 [0.54] | -            | -            | Supp [0.65]  | Supp [0.36]  |              |
|      | 10/26 | L7(2,4) | -            | -            | -            | 1.101 [0.30] | 1.389 [0.30] | -            | -            |              |
|      | 10/26 | L7(1,4) | -            | 0.817 [0.48] | -            | -            | -            | 0.989 [0.54] | 1.545 [0.29] |              |
|      | 12/03 | L5(1,4) | -            | -            | -            | -            | -            | -            | -            | 0.952 [0.43] |
| 2011 | 01/14 | L7(2,4) | -            | -            | -            | -            | Supp [0.05]  | -            | -            |              |
|      | 09/03 | L5(1,4) | -            | -            | -            | -            | -            | -            | 1.542 [0.43] |              |
|      | 10/13 | L7(2,4) | -            | -            | -            | -            | 1.432 [0.35] | -            | -            |              |
|      | 10/13 | L7(1,4) | -            | -            | -            | -            | -            | Supp [0.44]  | -            |              |
|      | 10/19 | L5(1,4) | -            | -            | -            | -            | -            | -            | -            | 0.950 [0.43] |
|      | 10/29 | L7(2,4) | -            | -            | -            | 1.139 [0.30] | Supp [0.35]  | -            | -            |              |
|      | 10/29 | L7(1,4) | -            | -            | -            | -            | -            | 1.001 [0.45] | -            |              |
| 2012 | 09/27 | L7(1,4) | -            | -            | -            | -            | -            | -            | -            | Supp [0.28]  |
|      | 09/29 | L7(4,5) | -            | -            | -            | 1.187 [0.10] | -            | -            | -            |              |
|      | 09/29 | L7(2,4) | -            | -            | -            | -            | 1.525 [0.40] | -            | Supp [0.18]  |              |
|      | 10/13 | L7(1,4) | -            | -            | -            | -            | -            | -            | -            | 0.936 [0.28] |
|      | 10/31 | L7(2,4) | -            | -            | -            | -            | Supp [0.40]  | -            | -            |              |
|      | 10/31 | L7(1,4) | -            | -            | -            | -            | -            | 1.064 [0.44] | -            |              |
|      | 11/16 | L7(1,4) | -            | -            | -            | -            | -            | Supp [0.21]  | 1.538 [0.05] |              |
| 2013 | 10/08 | L8(2,5) | -            | -            | -            | -            | -            | -            | -            | 0.950 [0.05] |
|      | 10/10 | L8(3,5) | -            | -            | -            | 1.206 [0.10] | 1.595 [0.10] | -            | -            |              |
|      | 10/10 | L8(2,5) | -            | -            | -            | -            | -            | 1.071 [0.22] | 1.571 [0.08] |              |
| 2014 | 09/27 | L8(3,5) | -            | -            | -            | 1.220 [0.15] | 1.635 [0.08] | -            | -            |              |
|      | 09/27 | L8(2,5) | -            | -            | -            | -            | -            | Supp [0.22]  | -            |              |
|      | 10/11 | L8(2,5) | -            | -            | -            | -            | -            | -            | -            | 0.947 [0.04] |
|      | 11/14 | L8(2,5) | -            | -            | -            | -            | -            | 1.094 [0.18] | 1.589 [0.05] |              |
| 2015 | 05/25 | L8(2,5) | 0.910 [0.05] | -            | -            | -            | -            | -            | -            |              |
|      | 09/30 | L8(2,5) | -            | 0.818 [0.21] | 0.396 [0.14] | 1.265 [0.15] | 1.670 [0.08] | 1.115 [0.20] | 1.588 [0.06] |              |
|      | 11/15 | L8(2,5) | -            | -            | -            | -            | -            | -            | -            | 0.948 [0.04] |

\*Required heavy manual editing to account for shadows

Note: Error in lake area as a percentage of lake area ranged from 4 to 14% with an average of 10%.

"Supp" stands for supplementary image used to fill in for clouds or stripping

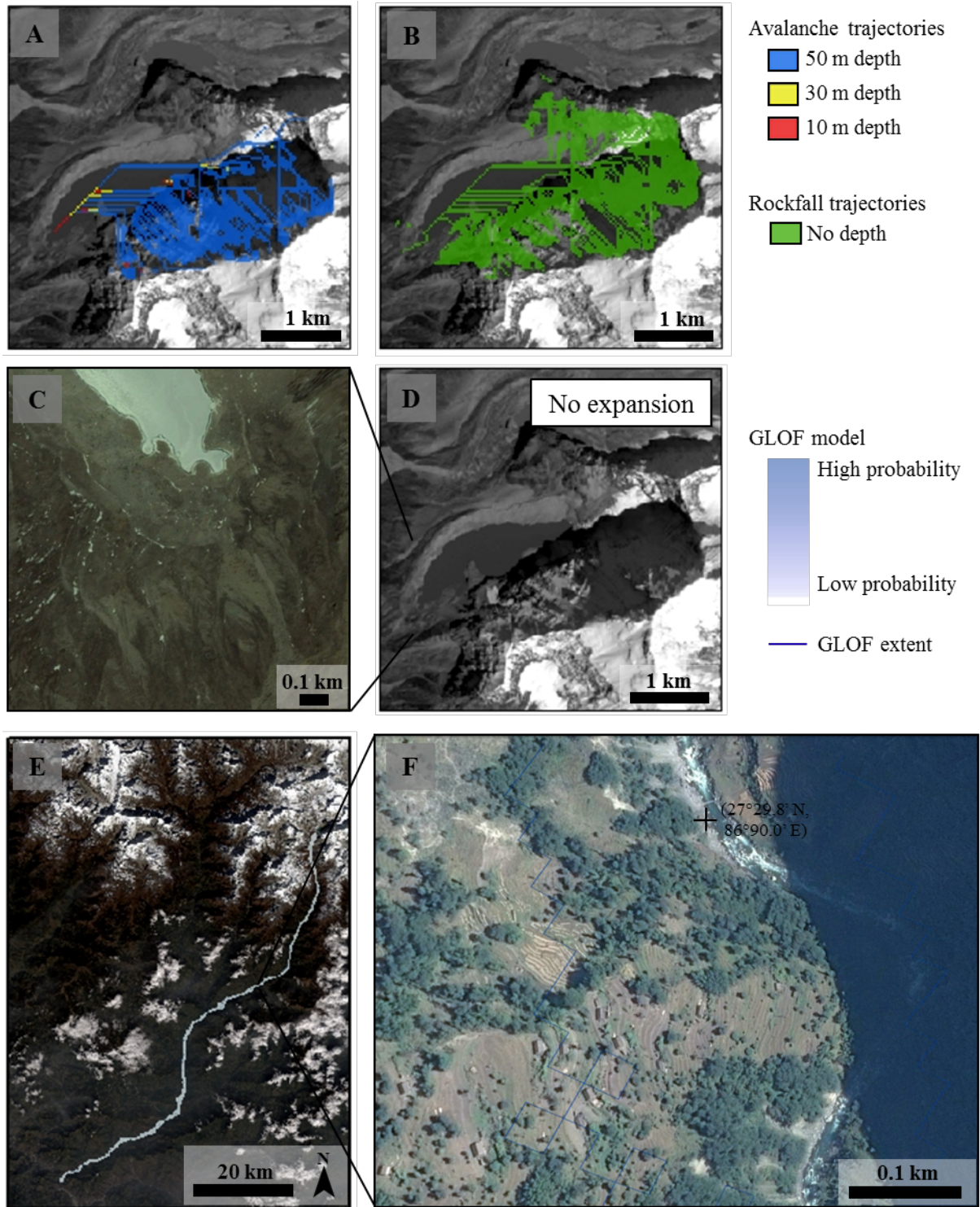
"L5" stands for Landsat 5

"L7" stands for Landsat 7

"L8" stands for Landsat 8

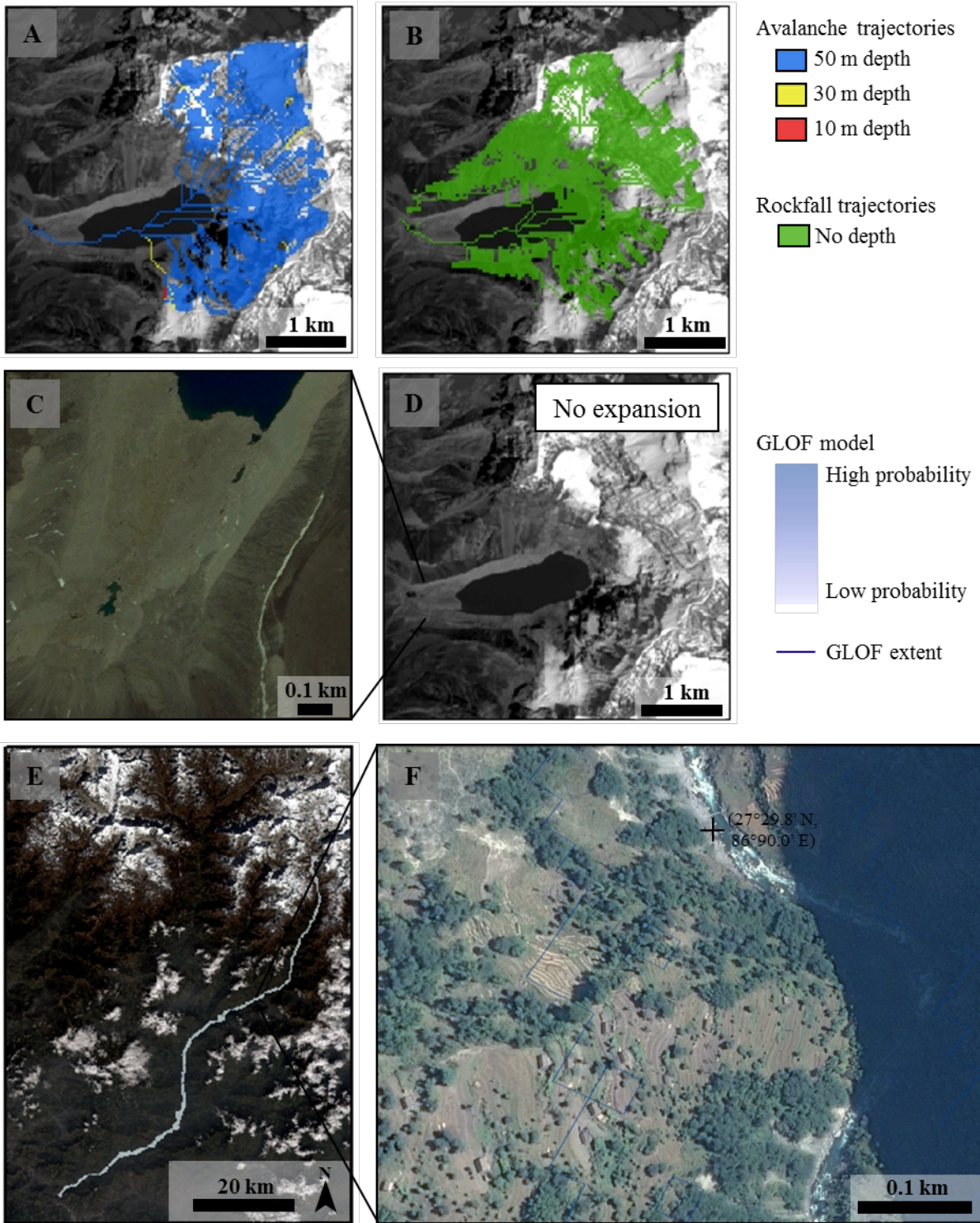
2 "A" stands for ASTER

3



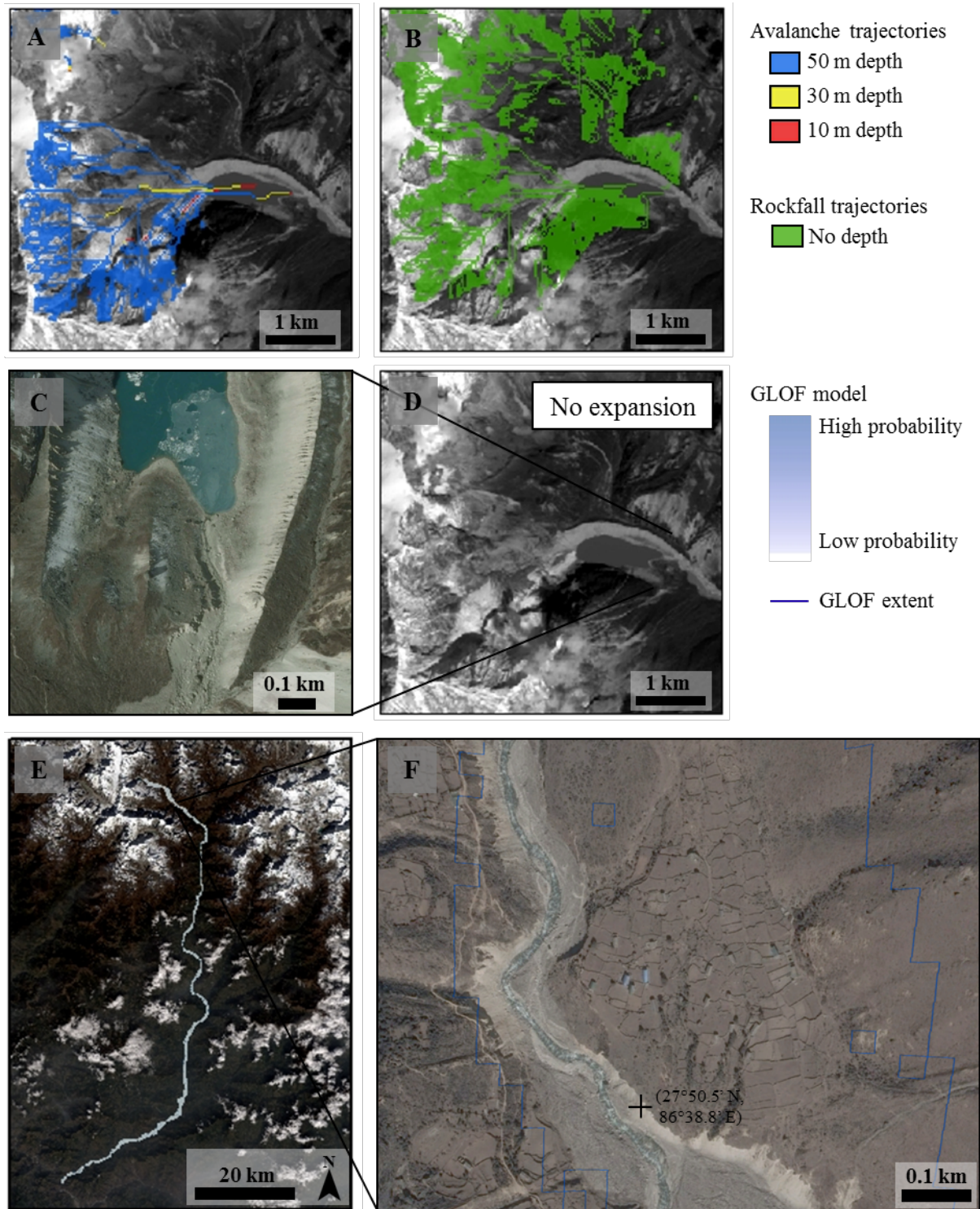
1  
 2 Figure S1. Hazards and downstream impact for Chamlang North Tsho: (A) avalanche trajectories,  
 3 (B) rockfall trajectories (C) lack of ponds on the moraine, (D) future lake expansion, and (E) the  
 4 extent of MC-LCP GLOF model (F) highlighting the impacts downstream. Background image  
 5 (A-E) is Landsat 8 from 30 September 2015 and (F) Google Earth.





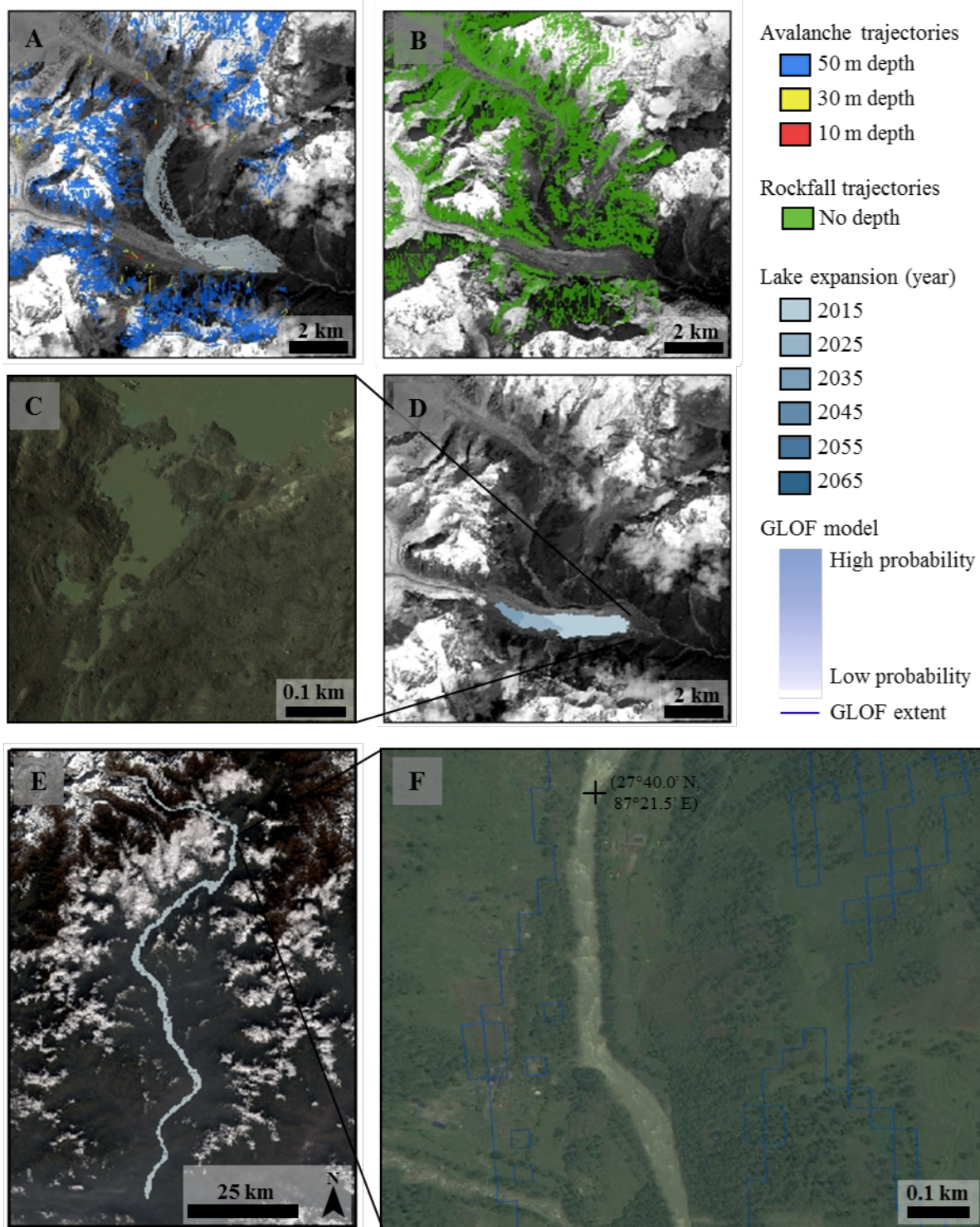
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 2 Figure S2. Hazards and downstream impact for Chamlang South Tsho: (A) avalanche trajectories,  
 3 (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent  
 4 of MC-LCP GLOF model (F) highlighting the impacts downstream. Background image (A-E) is  
 5 Landsat 8 from 30 September 2015 and (F) Google Earth.





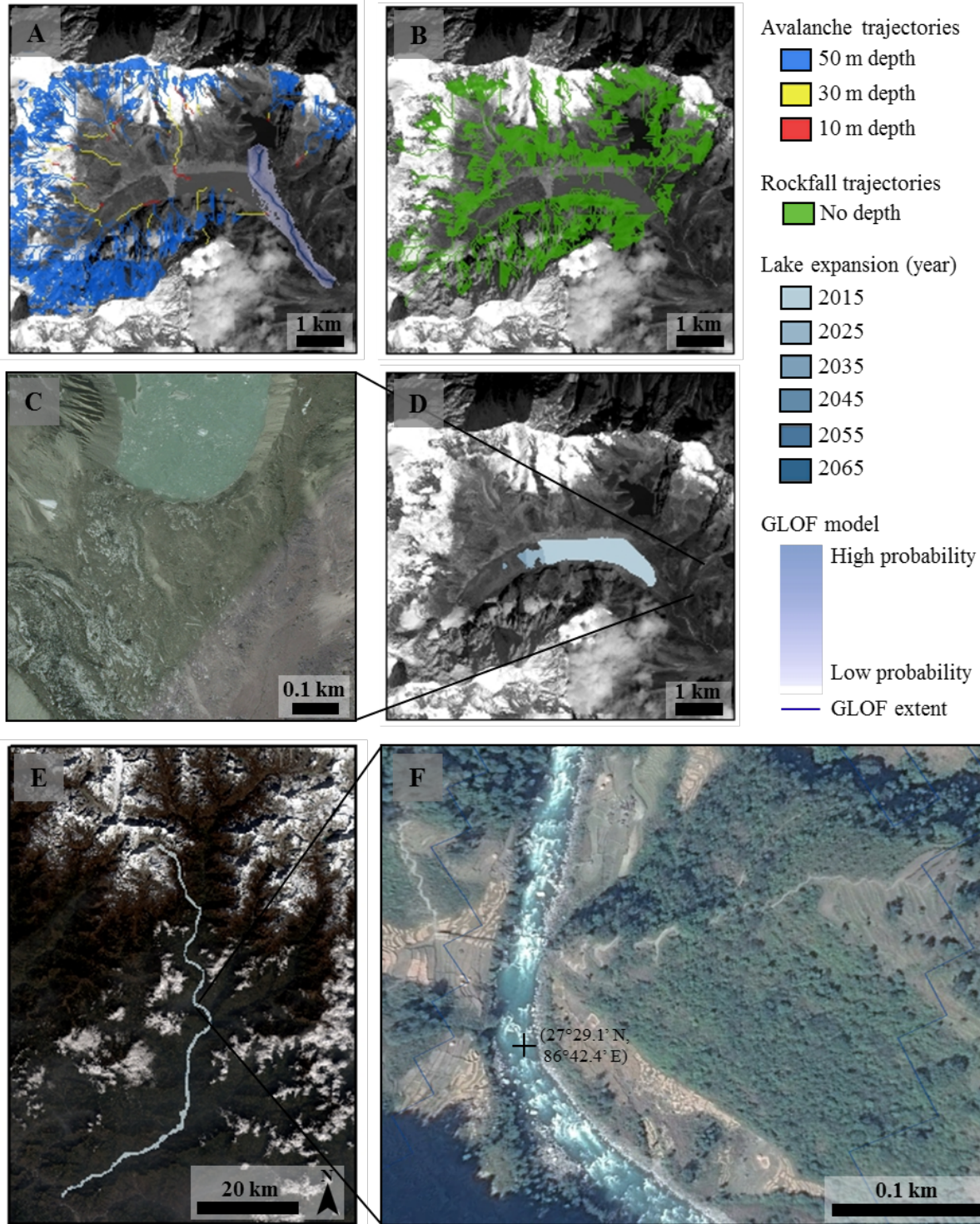
1  
 2 Figure S3. Hazards and downstream impact for Dig Tsho: (A) avalanche trajectories, (B) rockfall  
 3 trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP  
 4 GLOF model (F) highlighting the impacts downstream. Background image (A-E) is Landsat 8  
 5 from 30 September 2015 and (F) Google Earth.





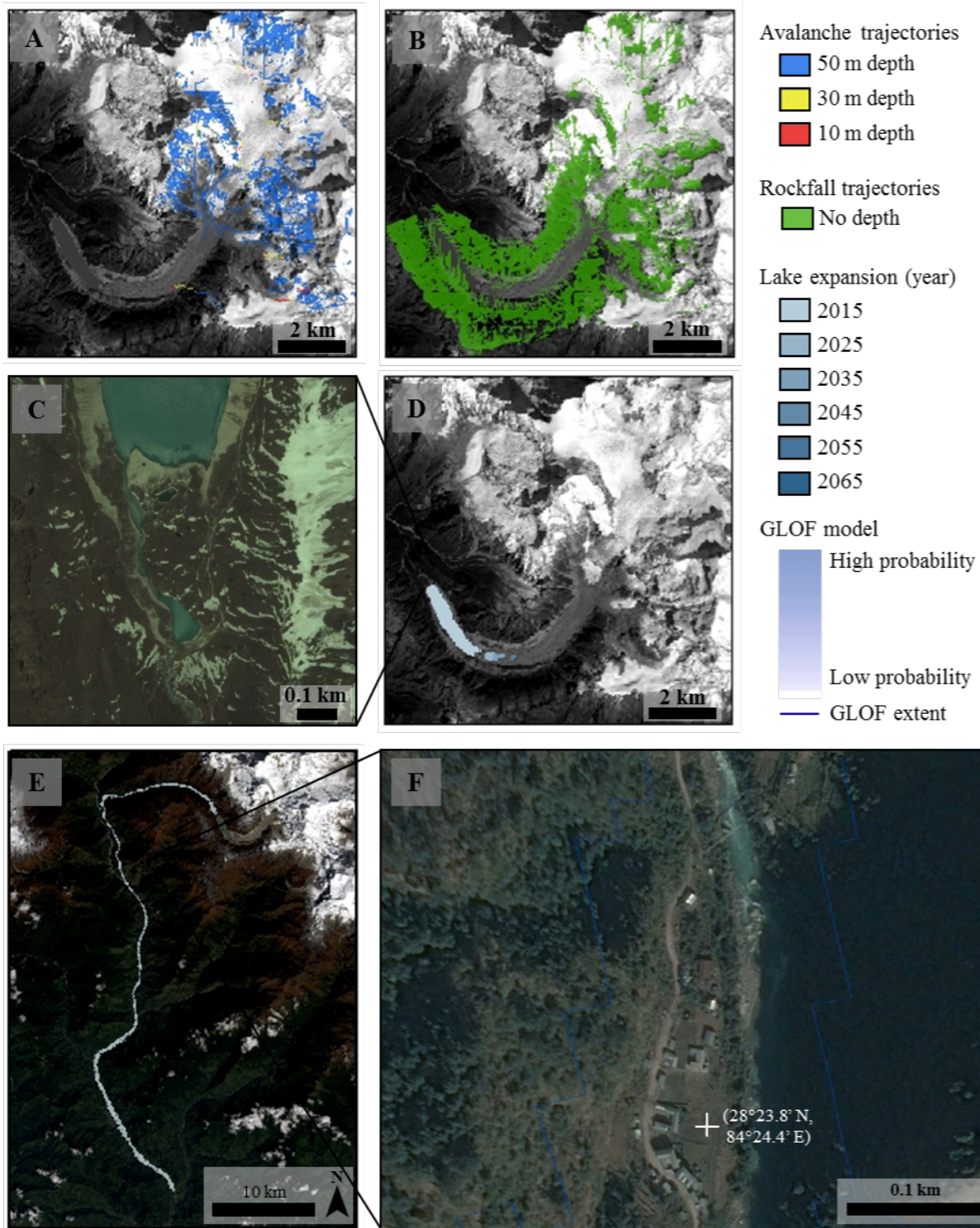
1  
 2 Figure S4. Hazards and downstream impact for Lower Barun Tsho: (A) avalanche trajectories  
 3 and upstream GLOF, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake  
 4 expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.  
 5 Background image (A-E) is Landsat 8 from 30 September 2015 and (F) Google Earth.





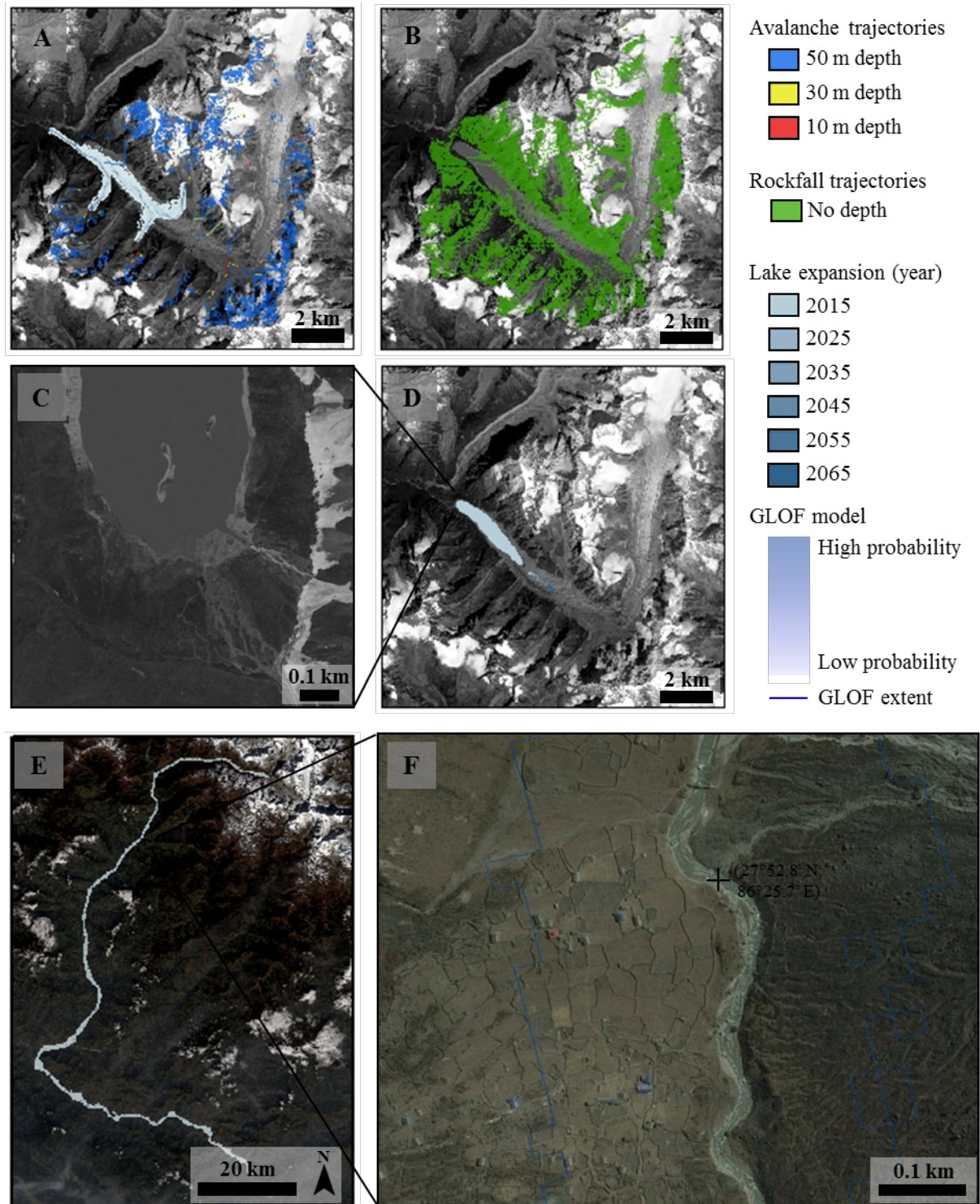
1  
 2 Figure S5. Hazards and downstream impact for Lumding Tsho: (A) avalanche trajectories and  
 3 upstream GLOF, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion,  
 4 and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.  
 5 Background image (A-E) is Landsat 8 from 30 September 2015 and (F) Google Earth.





1  
 2 Figure S6. Hazards and downstream impact for Thulagi Tsho: (A) avalanche trajectories, (B)  
 3 rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of  
 4 MC-LCP GLOF model (F) highlighting the impacts downstream. Background image (A-E) is  
 5 Landsat 8 from 15 November 2015 and (F) Google Earth.





1  
 2 Figure S7. Hazards and downstream impact for Tsho Rolpa: (A) avalanche trajectories, (B)  
 3 rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of  
 4 MC-LCP GLOF model (F) highlighting the impacts downstream. Background image (A-E) is  
 5 Landsat 8 from 30 September 2015 and (F) Google Earth.