Supplementary Materials

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

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

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

*maximum slope on terminal moraine was used

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

Lake	Lake area change	Risk of ice avalanche	Rick of rockfall	Ice core	Debris flow	Flash flood	Contact with glacier	Lake area (km^2)	Glacier shrinkage	Glacier slope	Stagnant glacier	**Hazard**	**Score**
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

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

Lake	Area of mother glacier (km^2)	Distance between lake and glacier (m)	Slope between lake and glacier (°)	Slope of downstream face of dam (°)	Mother glacier snout steepness (°)	**Hazard**	**Score**
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

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

	Chamlang North Tsho	Chamlang South Tsho	Dig Tsho	Imja Tsho	Lower Barun Tsho	Seto Pohkari	Lumding Tsho	Lumding Teng Tsho	Thulagi Tsho	Tsho Rolpa*	Tsho Rolpa Upper1
Terminal Moraine											
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
Lake Characteristics											
Lake Area (m^2)	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^3)	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
Lake Surrounding Characteristics											
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
Results											
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
Number of failures lake is susceptible to	2/5	1/5	2/5	1/5	3/5	2/5	4/5	2/5	1/5	4/5	2/5

*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

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

			Area (km^2) [Threshold]							
Year	**Date**	**Imagery (Bands)**	Chamlang N. Tsho*	Chamlang S. Tsho	Dig Tsho	Imja Tsho	Barun Tsho	Lumding Tsho	Tsho Rolpa	Thulagi 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]	-	-	-	

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

"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

"A" stands for ASTER

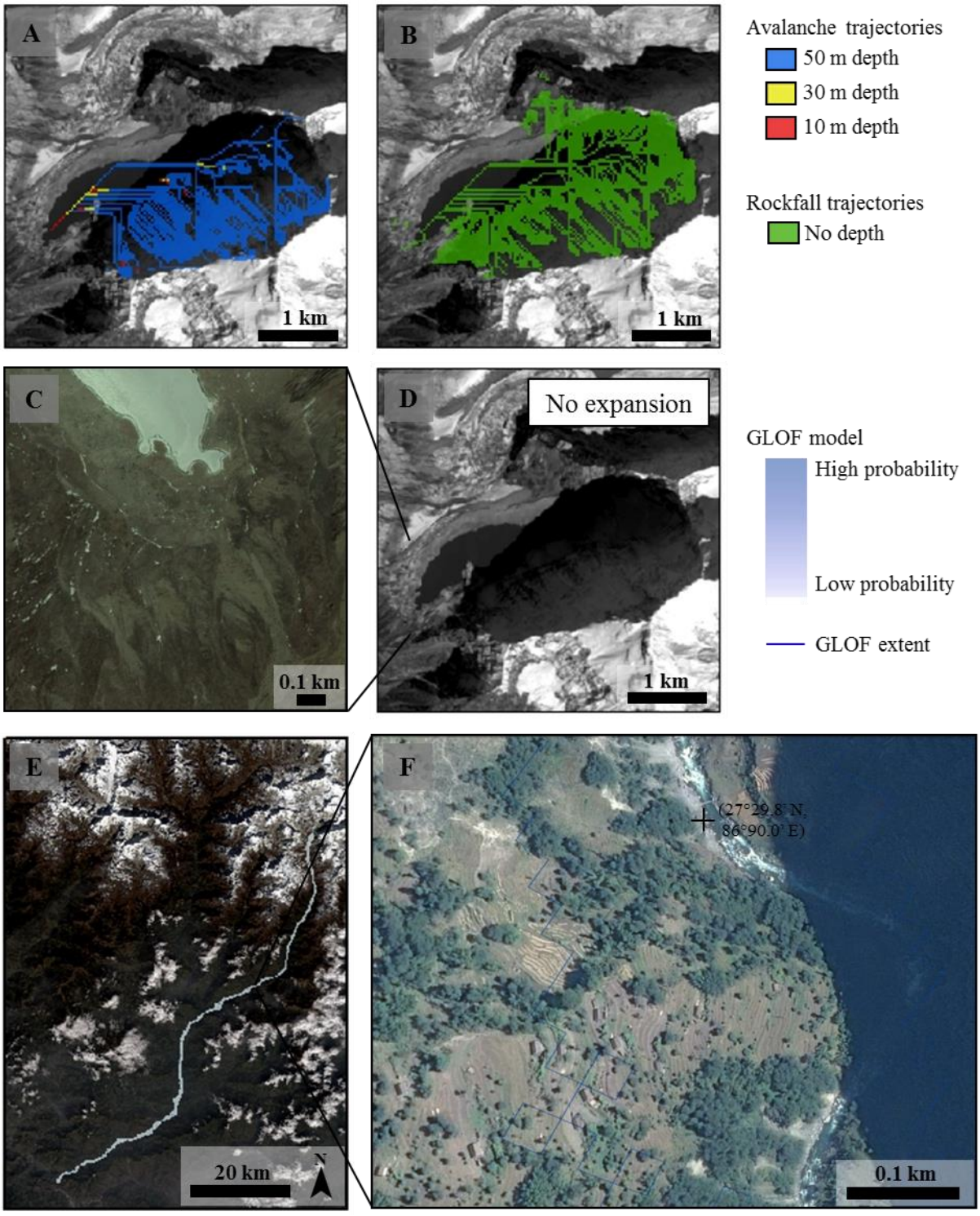

Figure S1. Hazards and downstream impact for Chamlang North Tsho: (A) avalanche trajectories, (B) rockfall trajectories (C) lack of ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.

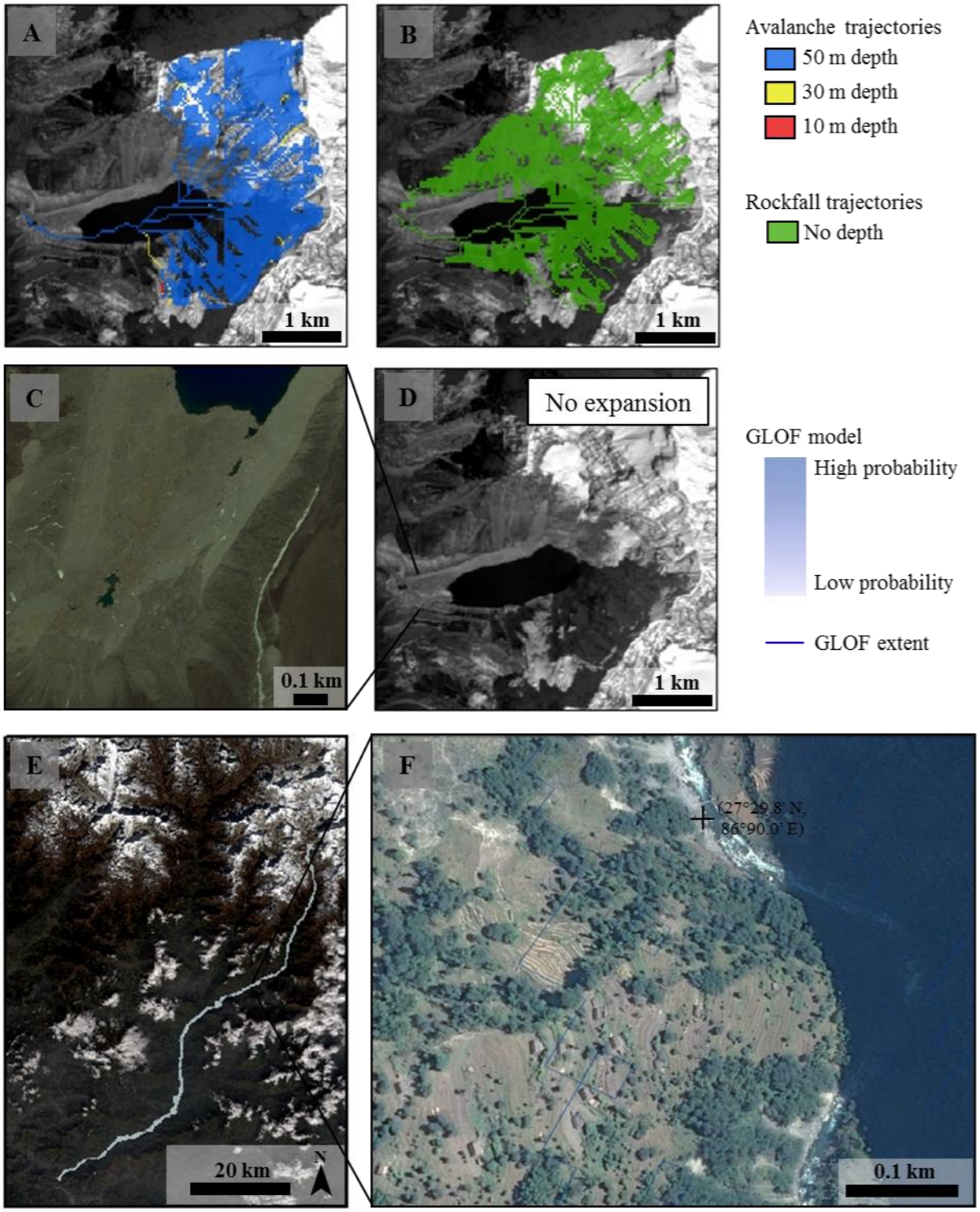

Figure S2. Hazards and downstream impact for Chamlang South Tsho: (A) avalanche trajectories, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.

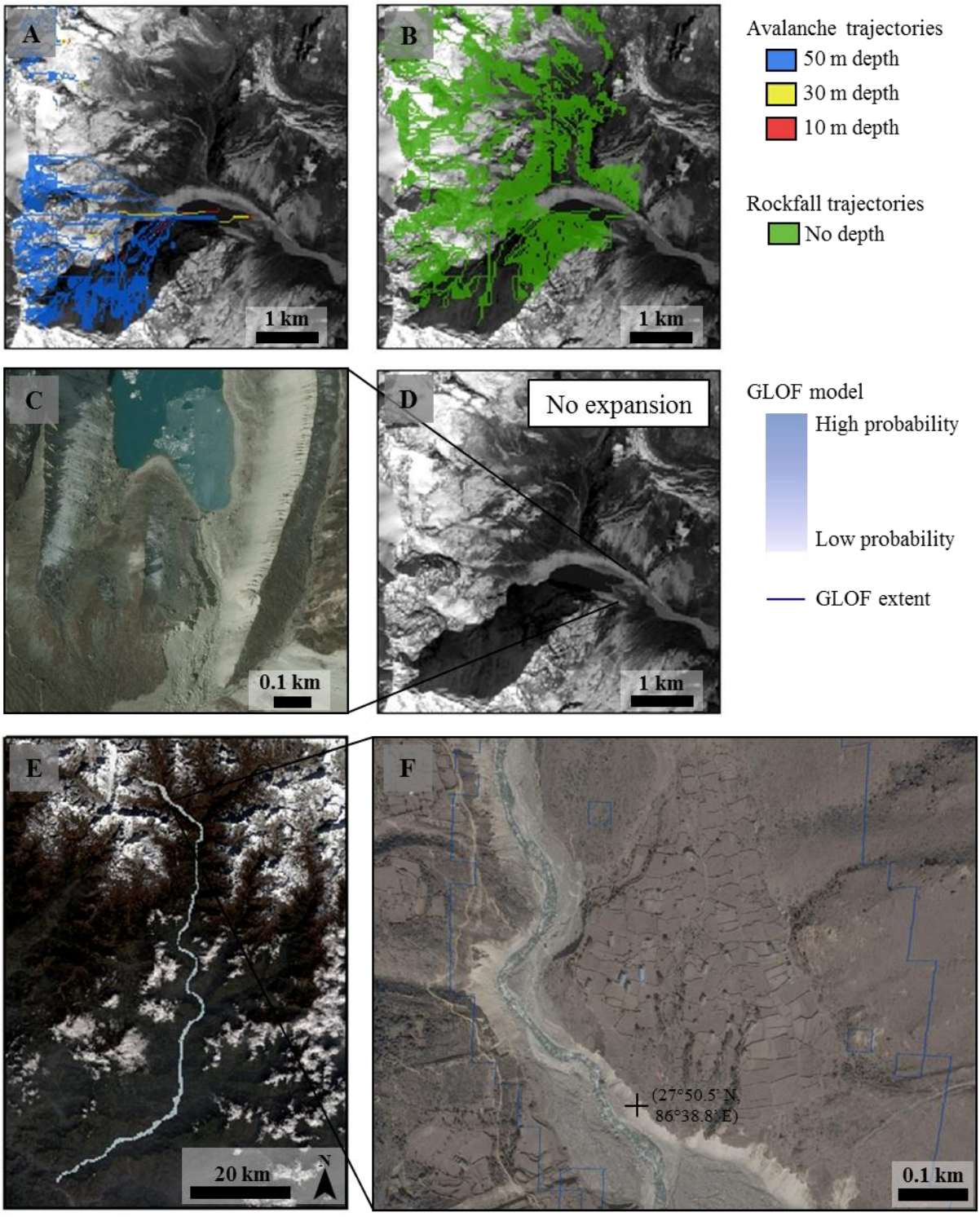

Figure S3. Hazards and downstream impact for Dig Tsho: (A) avalanche trajectories, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.

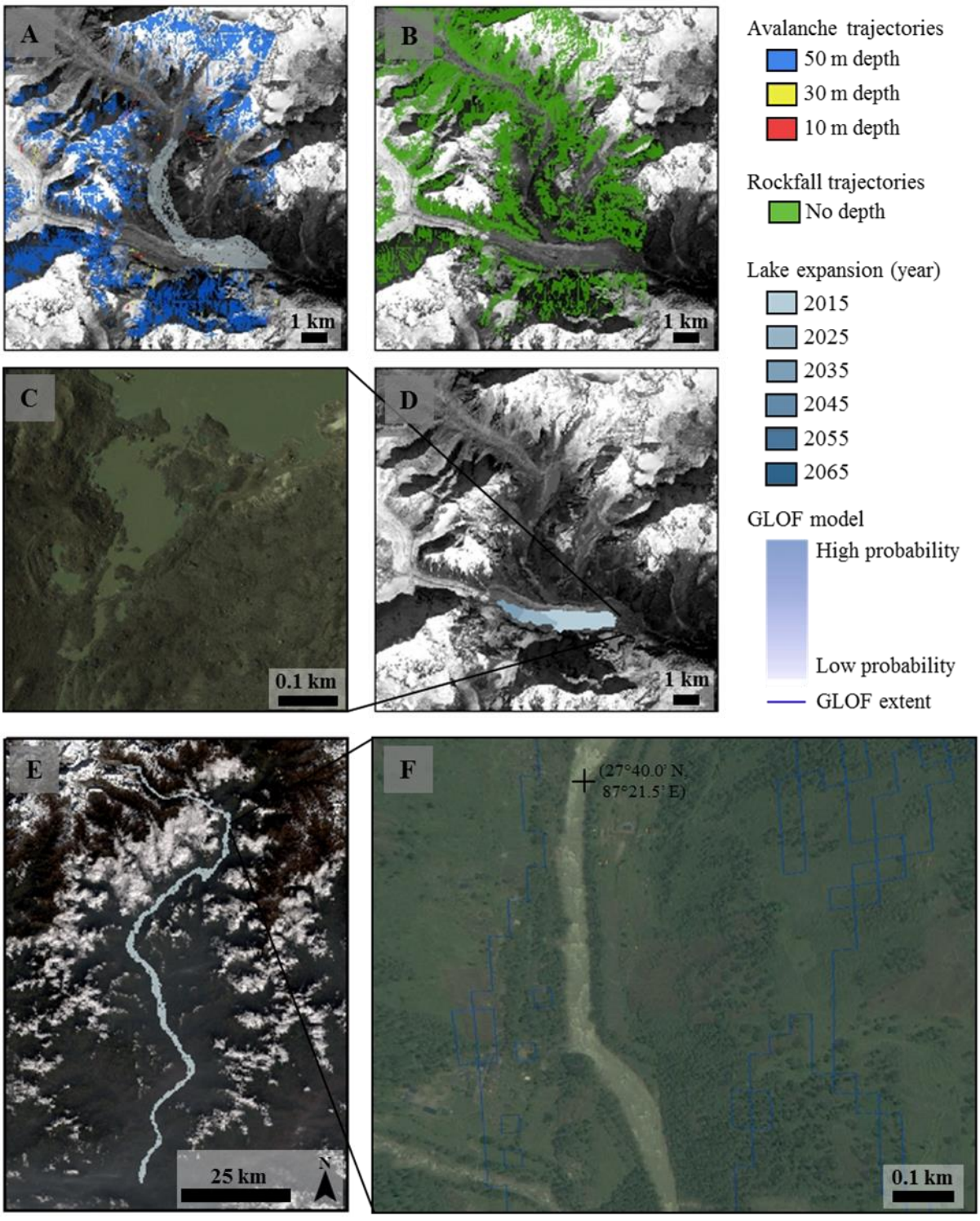

Figure S4. Hazards and downstream impact for Lower Barun Tsho: (A) avalanche trajectories and upstream GLOF, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake

expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.

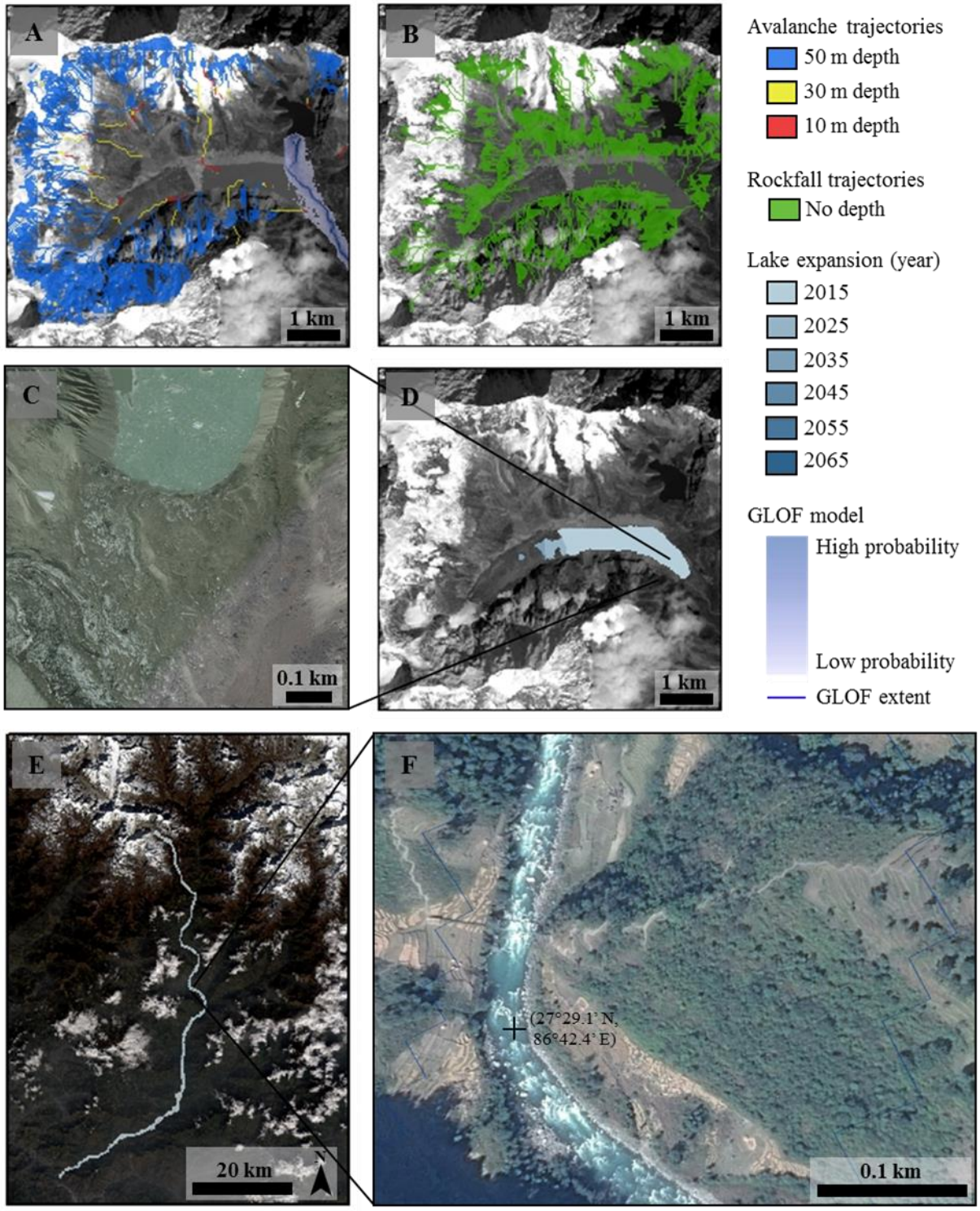

Figure S5. Hazards and downstream impact for Lumding Tsho: (A) avalanche trajectories and upstream GLOF, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.

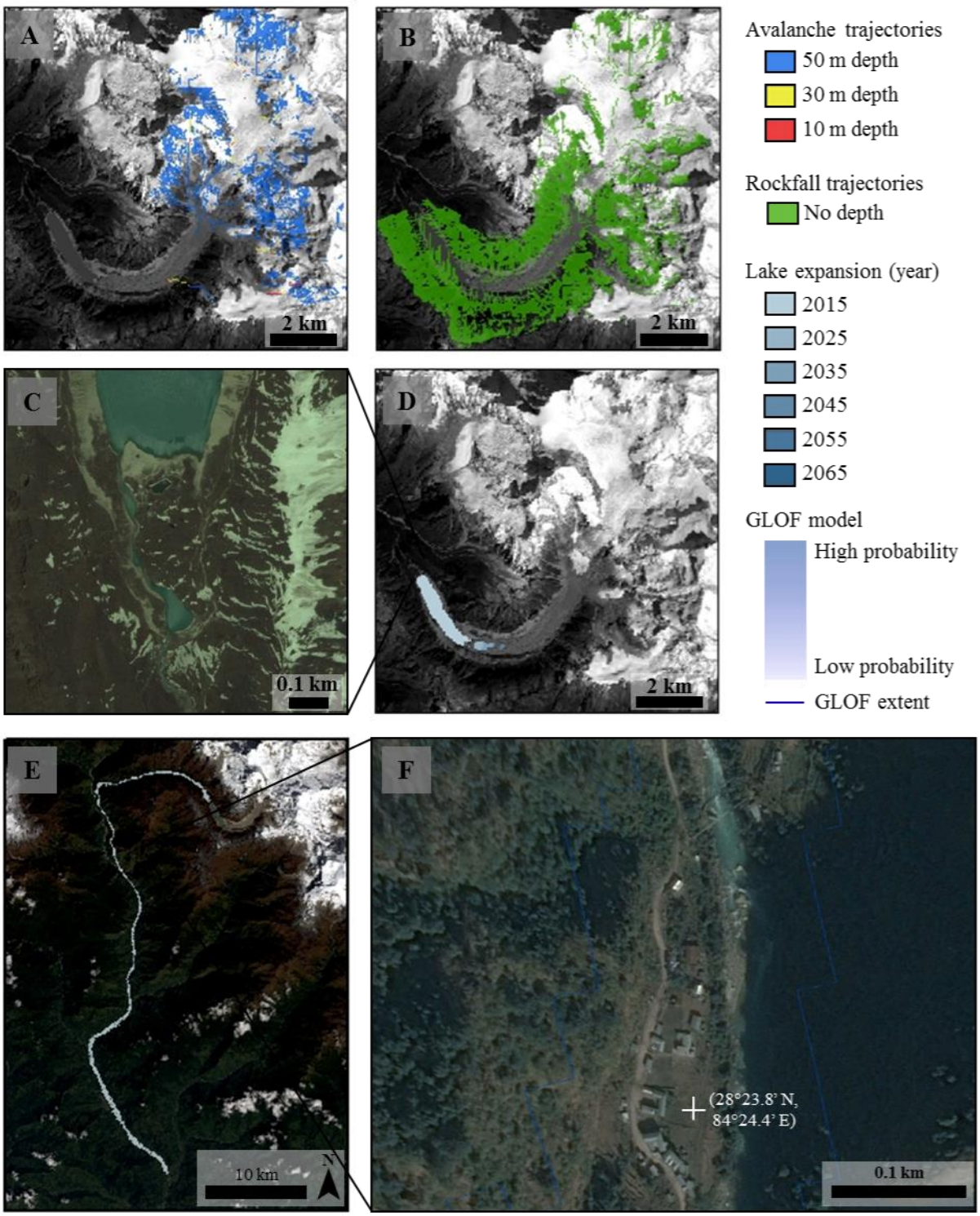

Figure S6. Hazards and downstream impact for Thulagi Tsho: (A) avalanche trajectories, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.

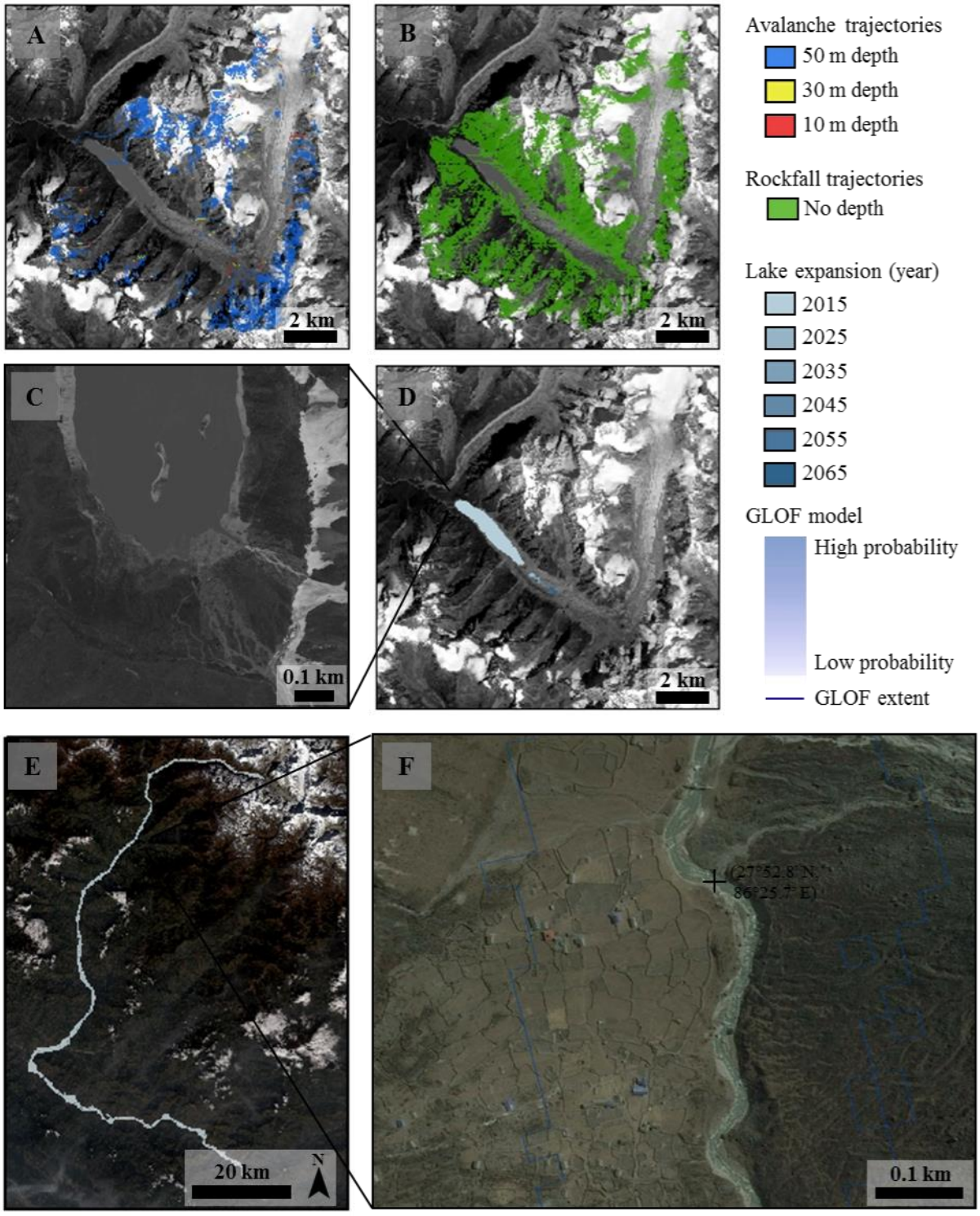

Figure S7. Hazards and downstream impact for Tsho Rolpa: (A) avalanche trajectories, (B) rockfall trajectories (C) ponds on the moraine, (D) future lake expansion, and (E) the extent of MC-LCP GLOF model (F) highlighting the impacts downstream.