Chapter 11
The Potentially Dangerous Glacial Lakes

On the basis of actively retreating glaciers and other criteria, the potentially dangerous glacial lakes were identified using the spatial and attribute database complemented by multi-temporal remote-sensing data sets. Medium- to large-scale aerial photographs were used for detailed geomorphic studies and evaluation of the active glaciers and potentially dangerous lakes.

In general, based on geomorphological characteristics, glacial lakes can be grouped into three types: glacial erosion lakes, glacial cirque lakes, and moraine-dammed lakes. The former two types of glacial lakes occupy the lowlands or emptying cirques eroded by ancient glaciers. These glacial lakes are more or less located away from present-day glaciers and the downstream banks are usually made of bedrock or covered with a thinner layer of loose sediment. Both of these glacial lakes do not generally pose an outburst danger. On the other hand, the moraine-dammed glacial lakes have the potential for bursting. A standard index to define a lake that is a source of potential danger because of possible bursting does not exist.

Moraine-dammed glacial lakes, which are still in contact or very near to the glaciers, are usually dangerous. In most of the literature/reports, the term 'glacier lake' is used for such lakes, and the term 'glacial lakes' used for glacier erosion lakes and glacier cirque lakes. The present study defines all the lakes formed by the activity of glaciers as 'glacial lakes'. Moraine-dammed glacial lakes are usually dangerous. These glacial lakes were partly formed between present-day glaciers and Little Ice Age moraine. The depositions of Little Ice Age moraines are usually about 300 years old, form high and narrow arch-shaped ridges usually with a height of 20–150m, and often contain dead glacier ice layers beneath them. These end moraines are loose and unstable in nature. The advance and retreat of the glacier affect the hydrology between the present-day glacier and the lake dammed by the moraines. Sudden natural phenomena with a direct effect on a lake, like ice avalanches or rock and lateral moraine material collapsing on a lake, cause moraine breaches with subsequent lake outburst events. Such phenomena have been well known in the past in several cases of moraine-dammed lakes, although the mechanisms at play are not fully understood.

11.1 Criteria for Identification

The criteria for identifying the potentially dangerous glacial lakes are based on field observations, processes and records of past events, geomorphological and geo-technical characteristics of the lake and surroundings, and other physical conditions. The potentially dangerous lakes were identified based on the condition of lakes, dams, associated mother glaciers, and topographic features around the lakes and glaciers.

Rise in lake water level

In general the lakes which have a volume of more than 0.01 km^3 are found to have past events. A lake which has a larger volume than this, is deeper, with a deeper part near the dam (lower part of lake) rather than near the glacier tongue, and has rapid increase in lake water volume is an indication that a lake is potentially dangerous.

Activity of supraglacial lakes

Groups of closely spaced supraglacial lakes of smaller size at glacier tongues merge as time passes and form bigger lakes such as Tsho Rolpa Glacial Lake which is associated with many supraglacial lakes in the topographic map of 1974 (Figure 10.25). The merging of supraglacial lakes in the Tsho Rolpa Glacial Lake has formed a bigger lake in the topographic map of 1981, aerial photograph of 1992, and topographic map of 1996 (Figures 10.26 and 10.29).

Some new lakes of considerable size are also formed at glacier tongues such as the lake at Lower Barun Glacier. The lake is not visible in the topographic map published by the Survey of India in 1967 (Figure 10.1) nor is it visible in the topographic map published by Nepal-Kartenwerk der Arbeitsgenmeinschaft für vergleichende Hochgebirgsforschung Nr. 2 (Figure 10.2). The lake is more distinct and sufficiently large enough in the topographic map of 1996 published by the Department of Survey, Nepal (Figure 10.10). These activities of supraglacial lakes are an indication that the lakes are becoming potentially dangerous.

Position of lakes

The potentially dangerous lakes are generally at the lower part of the ablation area of the glacier near to the end moraine, and the mother glacier should be sufficiently large to create a potentially dangerous lake environment. Regular monitoring needs to be carried out for such lakes with the help of multi-temporal satellite images, aerial photographs, and field observations.

In general, the potentially dangerous status of moraine-dammed lakes can be defined by the conditions of the damming material and the nature of the mother glacier. The valley lakes with an area bigger than 0.1 sq.km and a distance less than 0.5 km from the mother glacier of considerable size are considered to be potentially dangerous. Cirque lakes even smaller than 0.1 sq.km associated (in contact or distance less than 0.5 km) with steep hanging glaciers are considered to be potentially dangerous. Even the smaller size steep hanging glacier may pose a danger to the lake.

Dam conditions

The natural conditions of the moraine damming the lake determine the lake stability. Lake stability will be less if the moraine dam has a combination of the following characteristics:

- narrower in the crest area
- no drainage outflow or outlet not well defined
- steeper slope of the moraine walls
- ice cored
- very tall (from toe to crest)
- mass movement or potential mass movement in the inner slope and/or outer slope
- breached and closed in the past and refilled again with water
- seepage flow at moraine walls

A moraine-dammed lake, which has breached and closed subsequently in the past and has refilled again with water, can breach again. Nagma Pokhari Lake in the Tamor Basin burst out in 1980. The study of recent aerial photographs and satellite images shows a very quick regaining of lake water volume. Zhangzangbo Lake in the Sun Koshi Basin (the Poiqu Basin in Tibet (China)) burst out in 1964 and again in 1981. Recent satellite images show that the lake has refilled with water and, therefore, could pose danger. Ayaco Lake in the Pumqu Basin in Tibet (China) burst out in 1968, 1969, and 1970 and at

present it is refilled again with water and poses danger. Regular monitoring of such lakes is necessary using multi-temporal satellite images.

Condition of associated mother glacier

Generally, the bigger valley glaciers with tongues reaching an elevation below 5,000 masl have well-developed glacial lakes. Even the actively retreating and steep hanging glaciers on the banks of lakes may be a potential cause of danger. The following general characteristics of associated mother glaciers can create danger to moraine-dammed lakes:

- hanging glacier in contact with the lake,
- bigger glacier area,
- fast retreating,
- debris cover at glacier tongue area,
- steep gradient at glacier tongue area,
- presence of crevasses and ponds at glacier tongue area,
- toppling/collapses of glacier masses at the glacier tongue, and
- ice blocks draining to lake.
- hanging glacier in contact with the lake

Physical conditions of surroundings

Besides moraines, mother glaciers, and lake conditions, other physical conditions of the surrounding area as given below may also cause the lake to be potentially dangerous:

- potential rockfall/slide (mass movements) site around the lake which can fall into the lake suddenly
- snow avalanches of large size around the lake which can fall into the lake suddenly
- neo-tectonic and earthquake activities around or near the lake area
- climatic conditions of successive years being a relatively wet and cold year followed by a hot and wet or hot and arid year
- very recent moraines damming the lake at the tributary glaciers that used to be just a part of a former complex of valley glacier middle moraines as a result of the fast retreat of a complex mother valley glacier (e.g. Lunana area in Pho Chu Basin in Bhutan)
- sudden advance of a glacier towards the lower tributary or mother glacier having a well-developed lake at its tongue

11.2 Major Glacial Lakes Associated with the Glaciers

For identification of potentially dangerous glacial lakes, the glacial lakes associated with glaciers like supraglacial lakes and/or dammed by lateral moraine or end moraine with an area larger than 0.02 sq.km have been considered and they have been defined as major glacial lakes. The area of the inventoried glacial lakes is larger than 0.003 sq.km. There are 2,323 such glacial lakes in Nepal. Among these lakes, glacial lakes having an area larger than 0.02 sq.km number 347. Most of the major glacial lakes are in contact with or at a distance of less than 500m away from the glaciers and some of them are 1,500m away from the glaciers.

The Tamor Sub-basin of the Koshi Basin comprises 33 major glacial lakes associated with glaciers. The glaciers are at a contact distance of less than 1 km (Table 11.1). Seven major glacial lakes are found in contact with the mother glacier. The areas of the major glacial lakes range from 0.020 sq.km to 0.184 sq.km and the location of these lakes are between the elevations of 4,602 masl and 5,601 masl. Considering the different criteria as mentioned above in Section 11.1 only two glacial lakes are identified as potentially dangerous in the Tamor River Valley. The potentially dangerous glacial lakes are Ktr_gl 146 and Ktr_gl 192 (Nagma Pokhari). Nagma Pokhari Lake had an outburst event in 1980 and its size is growing to the potentially dangerous stage again.

Altogether 14 major glacial lakes are associated with the glaciers within the range of 1 km in the Arun Sub-basin of the Koshi Basin (Table 11.2). Not a single lake is in contact with the mother glacier. The areas of the major glacial lakes range from 0.020 sq.km to 0.119 sq.km and their altitudinal locations lie

Table 11.1: Major glacial lakes associated with the glaciers in the Tamor Sub-basin						
Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to Glacier (m)
Ktr_gl 146		4877	Moraine- dammed	181 147	Ktr_gr 30	0
Ktr_gl 148		4938	LM dammed	21 660	Ktr_gr 35	215
Ktr_gl 152		4785	Valley	25 373	Ktr_gr 39	355
Ktr_gl 162		4688	Valley	184 728	Ktr_gr 42	450
Ktr_gl 174		5273	Valley	58 413	Ktr_gr 67	475
Ktr_gl 179		5121	Valley	63 048	Ktr_gr 79	537
Ktr_gl 180		5151	Valley	41 585	Ktr_gr 80	160
Ktr_gl 181		5334	Block	20 738	Ktr_gr 81	45
Ktr_gl 189		5174	Valley	20 979	Ktr_gr 85	475
Ktr_gl 192	Nagama*	4884	Moraine-dammed	149 689	Ktr_gr 87	980
Ktr_gl 200		5121	Supraglacial	37 477	Ktr_gr 98	40
Ktr_gl 214		5090	Cirque	36 642	Ktr_gr 102	290
Ktr_gl 237		4602	Valley	36 972	Ktr_gr 126	560
Ktr_gl 249		4938	Valley	20 386	Ktr_gr 132	980
Ktr_gl 250		5060	Moraine- dammed	22 275	Ktr_gr 135	0
Ktr_gl 251		5151	Erosion	26 361	Ktr_gr 137	430
Ktr_gl 254	Nupchu	4877	Cirque	140 287	Ktr_gr 146	225
Ktr_gl 255		4846	Erosion	44 002	Ktr_gr 148	425
Ktr_gl 256		5121	Erosion	30 469	Ktr_gr 151	280
Ktr_gl 260		5395	Valley	22 473	Ktr_gr 175	850
Ktr_gl 262		5502	Block	58 676	Ktr_gr 177	275
Ktr_gl 263		5014	Moraine- dammed	30 425	Ktr_gr 171	0
Ktr_gl 265		5601	Erosion	26 647	Ktr_gr 182	100
Ktr_gl 266		5593	Moraine- dammed	153 094	Ktr_gr 183	20
Ktr_gl 270		4671	Supraglacial	21 880	Ktr_gr 193	0
Ktr_gl 291		4816	Supraglacial	57 731	Ktr_gr 193	0
Ktr_gl 297	Dudh Pokhari	4607	Valley	24 296	Ktr_gr 227	760
Ktr_gl 314		4999	Valley	24 604	Ktr_gr 237	425
Ktr_gl 316		5019	Cirque	24 560	Ktr_gr 238	405
Ktr_gl 320		4447	Supraglacial	28 295	Ktr_gr 248	0
Ktr_gl 328		4874	Supraglacial	45 671	Ktr_gr 248	455
Ktr_gl 332		5075	Supraglacial	33 633	Ktr_gr 255	0
Ktr_gl 336		5029	Valley	26 142	Ktr_gr 258	135
* In Nagma Ktr_gl 191 has been merged.						

Table 11.2: Major glacial lakes associated with the glaciers in the Arun Sub-basin						
Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kar_gl 27		4862	Erosion	20 205	Kar_gr 25	410
Kar_gl 28		4862	Erosion	23 669	Kar_gr 25	630
Kar_gl 29		4862	Valley	119 114	Kar_gr 31	610
Kar_gl 30		5273	Moraine dammed	117 190	Kar_gr 40	100
Kar_gl 32		4968	Erosion	48 685	Kar_gr 46	295
Kar_gl 57	Chhawa	4940	Erosion	84 477	Kar_gr 63	1000
Kar_gl 67		5040	Cirque	41 757	Kar_gr 72	115
Kar_gl 68		5040	Erosion	33 290	Kar_gr 74	110
Kar_gl 71		5100	Erosion	26 555	Kar_gr 80	250
Kar_gl 77		4910	Erosion	33 098	Kar_gr 83	15
Kar_gl 79		4935	Valley	25 401	Kar_gr 84	705
Kar_gl 81		4785	Erosion	35 599	Kar_gr 87	660
Kar_gl 82		4764	Erosion	20 782	Kar_gr 89	455
	Lower Barun	4570	Valley	666 000	Kar_gr 20	0

between the elevations of 4,764 masl and 5,273 masl. There is only one major glacial lake which is dammed by an end moraine and no supraglacial lakes are observed in the Arun River Sub-basin. Two major glacial lakes (Kar_gl 29 and Kar_gl 30) in the topographic map published by the Survey of India and one (Lower Barun) from the satellite images are identified as potentially dangerous lakes in the Arun Sub-basin. The first two lakes have been found with outburst events in the aerial photographs and satellite images of later dates. The Lower Barun Glacial Lake was not formed in the 1960s. The rapid growth of the lake at the tongue of the Lower Barun Glacier is the reason it is considered a potentially dangerous lake.

The Dudh Koshi Sub-basin is the one that contains the highest number of glacial lakes as well as lakes associated with glaciers. Altogether 98 major glacial lakes are associated with the glaciers. This includes also the blocked lakes within the range of 1.65 km (Table 11.3). The areas of the major glacial lakes range from 0.021 sq.km to 0.529 sq.km and their elevations are between 4,349 masl and 5,636 masl. There are 267 supraglacial lakes, out of which only 31 lakes are larger than 0.02 sq.km in area. The sub-basin consists of 10 blocked lakes and 33 moraine-dammed lakes which are susceptible to lake outburst. Thirteen lakes are identified as potentially dangerous in the Dudh Koshi Sub-basin. The potentially dangerous lakes of the Dudh Koshi Sub-basin are Kdu_gl 28 (Lumding Tsho), Kdu_gl 55 (Dig Tsho), Kdu_gl 349 (Chokarma Cho), Kdu_gl 350 (Imja Tsho), Kdu_gl 399 (Tam Pokhari), Kdu_gl 449 (Hungu Lake), Kdu_gl 459 (East Hungu 1), Kdu_gl 462 (East Hungu 2), Kdu_gl 464 and Kdu_gl 466 (West Chamjang). Among these, Dig Tsho and Tam Pokhari already had outburst events in 1985 and

Table 11.3: Major glacial lakes associated with glaciers in the Dudh Koshi Sub-basin

Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kdu_gl 18		4,901	Cirque	25,467	Kdu_gr 1	220
Kdu_gl 19		4,816	Block	78,177	Kdu_gr 5	1,305
Kdu_gl 20		4,822	Block	103,007	Kdu_gr 5	870

Table 11.3: Cont….

Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kdu_gl 159	Dudh Pokhari	4,734	Valley	426,38	Kdu_gr 86	1410
Kdu_gl 164		5,246	Erosion	21,541	Kdu_gr 90	125
Kdu_gl 165		5,267	Erosion	21,620	Kdu_gr 91	270
Kdu_gl 169		4,956	LM dammed	32,178	Kdu_gr 94	1565
Kdu_gl 170		5,145	Erosion	20,586	Kdu_gr 95	1105
Kdu_gl 173		5,148	Erosion	55,363	Kdu_gr 95	545
Kdu_gl 174		5,209	Cirque	35,123	Kdu_gr 95	85
Kdu_gl 175		5,410	Erosion	20,586	Kdu_gr 96	270
Kdu_gl 184		4,798	Supraglacial	24,750	Kdu_gr 100	0
Kdu_gl 206	Kyajumba Cho	5,364	Moraine-dammed	160,785	Kdu_gr 106	0
Kdu_gl 216	Diwanare Cho	5,066	Block	197,340	Kdu_gr 106	645
Kdu_gl 227		4,715	Block	36,608	Kdu_gr 100	250
Kdu_gl 228		4,892	Valley	25,042	Kdu_gr 100	0
Kdu_gl 232		5,343	Erosion	33,160	Kdu_gr 112	180
Kdu_gl 233	Naktok Cho	4,947	Moraine-dammed	84,783	Kdu_gr 113	85
Kdu_gl 234		4,874	Erosion	28,279	Kdu_gr 114	250
Kdu_gl 240		5,450	Erosion	30,931	Kdu_gr 118	780
Kdu_gl 243	Chola Cho	4,499	Block	529,069	Kdu_gr 120	75
Kdu_gl 249	Nire Cho	5,102	Erosion	35,361	Kdu_gr 128	140
Kdu_gl 252		4,980	Erosion	37,298	Kdu_gr 129	810
Kdu_gl 253		4,993	Cirque	45,734	Kdu_gr 129	335
Kdu_gl 269		5,322	Erosion	27,881	Kdu_gr 133	0
Kdu_gl 271		5,215	Supraglacial	45,071	Kdu_gr 133	0
Kdu_gl 272		5,223	Supraglacial	25,414	Kdu_gr 133	0
Kdu_gl 280		5,273	Erosion	25,812	Kdu_gr 134	520
Kdu_gl 283	Gorakashep Cho	5,145	LM dammed	81,626	Kdu_gr 133	0
Kdu_gl 287		5,304	Supraglacial	48,811	Kdu_gr 133	0
Kdu_gl 298		5,328	Erosion	38,731	Kdu_gr 137	70
Kdu_gl 304		4,907	LM dammed	33,611	Kdu_gr 133	235
Kdu_gl 308		5,441	LM dammed	31,966	Kdu_gr 148	0
Kdu_gl 310		5,456	Erosion	25,997	Kdu_gr 149	450
Kdu_gl 311		5,191	Erosion	28,040	Kdu_gr 150	850
Kdu_gl 320		5,636	Supraglacial	21,514	Kdu_gr 152	0
Kdu_gl 339		5,032	Supraglacial	20,426	Kdu_gr 156	0
Kdu_gl 341		5,051	Supraglacial	22, 681	Kdu_gr 156	0
Kdu_gl 349	Chokarma Cho	4,987	LM dammed	52,790	Kdu_gr 160	0
Kdu_gl 350	Imja Cho	5,023	Supraglacial	48,811	Kdu_gr 160	0
Kdu_gl 351		5,032	Supraglacial	21,992	Kdu_gr 160	0
Kdu_gl 364		5,236	Supraglacial	34,168	Kdu_gr 160	0
Kdu_gl 388		5,264	Supraglacial	31,860	Kdu_gr 174	0
Kdu_gl 399	Tam Pokhari	4,432	Moraine-dammed	138,846	Kdu_gr 202	45
Kdu_gl 400		4,481	Valley	83,828	Kdu_gr 205	0
Kdu_gl 401		4,871	Supraglacial	84,305	Kdu_gr 205	0
Kdu_gl 403		4,932	Supraglacial	70,352	Kdu_gr 205	0
Kdu_gl 406		5,127	LM dammed	56,265	Kdu_gr 203	35
Kdu_gl 419		5,145	Moraine-dammed	108,233	Kdu_gr 216	0
Kdu_gl 422	Dudh Pokhari	4,761	LM dammed	274,297	Kdu_gr 229	655
Kdu_gl 423		4,685	Erosion	155,161	Kdu_gr 231	705
Kdu_gl 428		4,349	LM dammed	105,368	Kdu_gr 233	335
Kdu_gl 435		4,883	Cirque	120,569	Kdu_gr 240	330
Kdu_gl 442		5,267	Supraglacial	133,753	Kdu_gr 247	0
Kdu_gl 443		5,023	Valley	75,392	Kdu_gr 249	0
Kdu_gl 444		5,057	Moraine-dammed	112,398	Kdu_gr 249	0
Kdu_gl 445		5,230	Supraglacial	79,955	Kdu_gr 249	0
Kdu_gl 446		5,352	Supraglacial	207,314	Kdu_gr 249	0
Kdu_gl 447		5,389	Supraglacial	67,407	Kdu_gr 249	0
Kdu_gl 448		5,456	Moraine-dammed	22,61	Kdu_gr 250	0
Kdu_gl 449		5,182	Supraglacial	198,905	Kdu_gr 249	0
Kdu_gl 451		5,425	Moraine-dammed	107,782	Kdu_gr 252	25

Table 11.3: Cont….

Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kdu_gl 452		5,441	Moraine-dammed	37,935	Kdu_gr 254	125
Kdu_gl 454		5,480	Moraine-dammed	209,834	Kdu_gr 255	115
Kdu_gl 455		5,441	Moraine-dammed	88,788	Kdu_gr 249	0
Kdu_gl 456		5,410	Erosion	84,146	Kdu_gr 258	70
Kdu_gl 457		5,419	Moraine-dammed	27,403	Kdu_gr 258	0
Kdu_gl 459		5,380	Supraglacial	78,761	Kdu_gr 260	0
Kdu_gl 460		5,389	Supraglacial	58,043	Kdu_gr 260	0
Kdu_gl 462		5,483	Block	211,877	Kdu_gr 260	0
Kdu_gl 464		5,206	Erosion	349,397	Kdu_gr 263	325

1998 respectively. The glacial lake Kdu_gl 349 (Chokarma Cho) has also drained out in the past but this is not recorded.

Seven major glacial lakes in the Tama Koshi Sub-basin of the Koshi Basin are associated with glaciers within the range of 1 km (Table 11.4). Out of them, 2 lakes are supraglacial in contact with the mother glacier. The areas of the major glacial lakes range from 0.020 sq.km to 0.231 sq.km and their elevations are between 4,423 and 5,496 masl. The Tama Koshi Sub-basin comprises Tsho Rolpa Glacial Lake in the Rolwaling Valley. Tsho Rolpa Glacial Lake is identified as being a supraglacial lake in the 1960s. The area of the lake has increased from 0.23 to 1.39 sq.km and has developed into a moraine-dammed lake. Tsho Rolpa Glacial Lake is identified as one of the most potentially dangerous glacial lakes in Nepal. The most recent area of the lake is detected from the Indian remote sensing (IRS) linear imaging and self scanning sensor (LISS) 3D satellite image of 1999. Tsho Rolpa Glacial Lake has received wide media coverage and is known even to laymen. Mitigation measures have been applied recently to prevent possible glacial lake outburst flood (GLOF) hazards along the downstream valley. The Rolwaling Valley of the Tama Koshi Sub-basin already had a GLOF event from the Chhubung Glacial Lake, which was not mapped in the 1960s topographic map published by the Survey of India and the Survey Department of Nepal in 1995. This lake might have formed around the 1970s and the outburst event occurred in 1991.

Table 11.4: Major glacial lakes associated with glaciers in the Tama Koshi Sub-basin

Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kta_gl 8		4,423	Erosion	22,893	Kta_gr 18	940
Kta_gl 9		4,862	Block	48,201	Kta_gr 20	45
Kta_gl 15	Omai Tsho	4,801	Block	91,653	Kta_gr 38	340
Kta_gl 26	Tsho Rolpa	4,557	Supraglacial	231,693	Kta_gr 46	0
Kta_gl 35		5,496	Supraglacial	20,639	Kta_gr 46	0
Kta_gl 42		4,563	Cirque	113,618	Kta_gr 67	805
Kta_gl 43		4,901	Erosion	27,615	Kta_gr 73	745

The Sun Koshi, Likhu, and Indrawati Sub-basins consist of 35, 14, and 18 glacial lakes respectively (Table 11.5). All these three sub-basins consist of only one major glacial lake each. From the parameters considered for the identification of the potentially dangerous lakes, none of the major lakes are potentially dangerous in these sub-basins.

Table 11.5: Major glacial lakes associated with the glaciers in the Sun Koshi, Likhu, and Indrawati sub-basins

Lake number	Sub-basin	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Ksun_gl 3	Sun Koshi	4,718	Supraglacial	21,381	Ksun_gr 2	0
Klik_gl 4	Likhu	4,951	Erosion	26,316	KlikGr_8	250
Kin_gl 9	Indrawati	4,572	Supraglacial	12,337	Kin_gr 8	0

The Trishuli and Seti Sub-basins of the Gandaki Basin consist of 117 and 10 glacial lakes respectively (Table 11.6). Only six glacial lakes are major glacial lakes in the Trishuli Sub-basin, whereas only one glacial lake is a major glacial lake in the Seti River Sub-basin. The major glacial lakes are of the erosion, blocked, supraglacial, and valley type. None of these lakes are potentially dangerous lakes.

Table 11.6: Major glacial lakes associated with glaciers in the Trisuli and Seti Sub-basins

Lake number	Sub-basin	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Gtri_gl 5	Trishuli	4705	Erosion	214 714	Gtri_gr 7	215
Gtri_gl 6		4731	Block	52 452	Gtri_gr 9	415
Gtri_gl 8		4596	Supraglacial	19 430	Gtri_gr 19	0
Gtri_gl 9		4603	Valley	29 969	Gtri_gr 33	515
Gtri_gl 12		3655	Erosion	20 024	Gtri_gr 37	1065
Gtri_gl 27		4749	Supraglacial	16 045	Gtri_gr 44	0
Gset_gl 7	Seti	2377	Valley	28 165	Gset_gr 52	0

Three major glacial lakes are in contact with the glaciers in the Budhi Gandaki Sub-basin (Table 11.7). The glacial lakes extend down to 3,472 masl. There are 27 supraglacial lakes of which only two lakes have areas greater than 0.02 sq.km. The supraglacial lakes in the Budhi Gandaki Sub-basin do not fall in the potentially dangerous category, but the moraine-dammed glacial lake Gbu_gl 9 is identified as a potentially dangerous lake in this sub-basin.

Table 11.7: Major glacial lakes associated with glaciers in the Budi Gandaki Sub-basin

Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Gbu_gl 3		3472	Supraglacial	22 018	Gbu_gr 22	0
Gbu_gl 6		3536	Supraglacial	54 415	Gbu_gr 22	0
Gbu_gl 9		3591	Moraine-dammed	81 545	Gbu_gr 32	0

There are 76 glacial lakes in the Marsyangdi Sub-basin, out of which 25 lakes have areas greater than 0.02 sq.km (Table 11.8). The areas of the major glacial lakes range from 0.020 sq.km to 3.945 sq.km and their elevations are between 3,825 masl and 5,669 masl.

There are a number of supraglacial lakes in the Marsyangdi Sub-basin but none of them is potentially dangerous. The glacial lake Gmar_gl 70 (Thulagi) is the only one identified as a potentially dangerous lake in the Marsyangdi Sub-basin.

There are 96 glacial lakes in the Kali Gandaki Sub-basin, out of which 27 are major glacial lakes with areas greater than 0.02 sq.km. The major glacial lakes are formed above 5,400 masl (Table 11.9). There are two supraglacial lakes and 11 moraine-dammed lakes, but only four lakes are identified as potentially dangerous glacial lakes in the Kali Gandaki Sub-basin. All the identified potentially dangerous lakes are moraine-dammed. The potentially dangerous lakes are Gka_gl 38, Gka_gl 41, Gka_gl 42, and Gka_gl 67. Among them Gka_gl 41 and Gka_gl 42 are found to have outburst events in the aerial photographs and satellite images of 1996. The glacial lake Gka_gl 67 is found to be growing in size.

The Bheri Sub-basin is one of the bigger sub-basins in the Karnali Basin. It consists of 152 glacial lakes, out of which 25 are major glacial lakes (Table 11.10). The major glacial lakes are located at elevations ranging from 4,237 to 5,593 masl. The glacial lakes are smaller in size and the largest glacial lake is 0.396 sq.km. Among the major glacial lakes, two are moraine-dammed lakes and one is a supraglacial lake. The sub-basin does not have any potentially dangerous glacial lakes.

Out of 280 glacial lakes in the Mugu Sub-basin of the Karnali Basin, 31 glacial lakes are major glacial lakes with an area greater than 0.02 sq.km. There are three moraine-dammed and two supraglacial lakes (Table 11.11). The areas of the glacial lakes range from 0.020 sq.km to 0.681 sq.km and their locations are at elevations between 4,404 and 5,560 masl. The glacial lake Kmu_gl 129, having the largest area in the Mugu Sub-basin, has been identified as a potentially dangerous lake. It also had an outburst event in the past, but this is not recorded.

Table 11.8: Major glacial lakes associated with glaciers in the Marsyangdi Sub-basin						
Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Gmar_gl 1		5023	Erosion	59 861	Gmar_gr 35	375
Gmar_gl 2		4920	Erosion	3 945 017	Gmar_gr 37	900
Gmar_gl 3		5121	Cirque	66 752	Gmar_gr 40	455
Gmar_gl 4		5090	Valley	94 564	Gmar_gr 42	790
Gmar_gl 5		4990	Valley	175 546	Gmar_gr 44	1435
Gmar_gl 19		5517	Valley	34 213	Gmar_gr 122	150
Gmar_gl 20		5669	Supraglacial	54 129	Gmar_gr 127	345
Gmar_gl 21		5639	Supraglacial	20 363	Gmar_gr 127	0
Gmar_gl 22		5669	Supraglacial	31 692	Gmar_gr 129	0
		5636	Erosion	30 689	Gmar_gr 153	0

Table 11.9: Major glacial lakes associated with glaciers in the Kali Gandaki Sub-basin						
Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Gka_gl 17		5654	Valley	49 743	Gka_gr 82	485
Gka_gl 19		5480	Cirque	80 975	Gka_gr 103	120
Gka_gl 20		5538	Valley	24 817	Gka_gr 112	45
Gka_gl 21		5636	Erosion	21 610	Gka_gr 122	470
Gka_gl 25		5669	Supraglacial	20 821	Gka_gr 131	0
Gka_gl 28		5459	Valley	30 090	Gka_gr 142	195
Gka_gl 32			Valley	52 271	Gka_gr 174	275
Gka_gl 33		5465	Moraine-dammed	40 528	Gka_gr 176	0
Gka_gl 38		5419	Moraine-dammed	149 202	Gka_gr 184	0
Gka_gl 41		5444	Moraine-dammed	21 583	Gka_gr 183	90
Gka_gl 42		5450	Moraine-dammed	26 829	Gka_gr 183	60
Gka_gl 43		5569	Moraine-dammed	21 447	Gka_gr 190	365
Gka_gl 47		5630	Moraine-dammed	34 412	Gka_gr 195	65
Gka_gl 55			Moraine-dammed	46 291	Gka_gr 211	0
Gka_gl 56			Valley	83 612	Gka_gr 211	550
Gka_gl 57			Moraine-dammed	40 936	Gka_gr 217	45
Gka_gl 58			Moraine-dammed	54 690	Gka_gr 224	60
Gka_gl 64		5593	Valley	128 054	Gka_gr 233	785
Gka_gl 67		5453	Moraine-dammed	1 013 344	Gka_gr 247	0
Gka_gl 68		5633	Erosion	62 111	Gka_gr 248	232
Gka_gl 69		5654	Erosion	48 003	Gka_gr 248	310
Gka_gl 70			Valley	28 650	Gka_gr 259	130
Gka_gl 71		5365	Moraine-dammed	36 505	Gka_gr 276	0
Gka_gl 72		6017	Supraglacial	36 016	Gka_gr 279	0
Gka_gl 73		5313	Valley	32 401	Gka_gr 282	65
Gka_gl 83		5474	Erosion	25 959	Gka_gr 339	740
Gka_gl 84		5785	Valley	29 601	Gka_gr 338	0

Table 11.10: Major glacial lakes associated with glaciers in Bheri sub-basin						
Lake Number	Lake Name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kbh_gl 1	Dudh Kundli	4,633	Valley	327,131	Kbh_gr 10	1,310
Kbh_gl 5		4,633	Erosion	24,065	Kbh_gr 74	880
Kbh_gl 6		4,298	Cirque	61,928	Kbh_gr 75	1,010
Kbh_gl 8		4,237	Erosion	162,017	Kbh_gr 95	415
Kbh_gl 9	Chhokarbo	4,481	Erosion	34,169	Kbh_gr 97	400
Kbh_gl 14		4,968	Erosion	31,534	Kbh_gr 143	0
Kbh_gl 19		4,923	Valley	48,374	Kbh_gr 159	1,365
Kbh_gl 23		4,968	Valley	55,816	Kbh_gr 172	330
Kbh_gl 38		5,235	Erosion	38,379	Kbh_gr 183	30
Kbh_gl 43		5,014	Valley	85,477	Kbh_gr 196	265
Kbh_gl 44		5,212	Supraglacial	24,880	Kbh_gr 207	0
Kbh_gl 58		5,532	Valley	64,807	Kbh_gr 239	365
Kbh_gl 84		5,532	Erosion	29,035	Kbh_gr 253	40
Kbh_gl 87		5,380	Erosion	26,374	Kbh_gr 262	165
Kbh_gl 88		5,540	Erosion	36,505	Kbh_gr 263	0
Kbh_gl 89		5,365	Erosion	40,742	Kbh_gr 264	80
Kbh_gl 92		5,593	Erosion	37,075	Kbh_gr 270	0
Kbh_gl 110		5,563	L M dammed	26,265	Kbh_gr 338	320
Kbh_gl 112		5,188	Valley	38,080	Kbh_gr 339	475
Kbh_gl 113		4,663	Valley	46,609	Kbh_gr 348	1,125
Kbh_gl 117		4,438	Valley	396,120	Kbh_gr 357	0
Kbh_gl 120		5,307	Valley	81,348	Kbh_gr 388	410
Kbh_gl 125		5,258	M dammed	29,714	Kbh_gr 407	90
Kbh_gl 129		4,984	Erosion	20,778	Kbh_gr 411	50
Kbh_gl 130		5,005	Erosion	22,299	Kbh_gr 413	85

Table 11.11: Major glacial lakes associated with glaciers in the Mugu Sub-basin						
Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kmu_gl 16	Dudhiya Tal	4,682	Erosion	94,035	Kmu_gr 3	100
Kmu_gl 17		4,404	Valley	49,879	Kmu_gr 5	1305
Kmu_gl 27		4,679	Valley	37,879	Kmu_gr 14	685
Kmu_gl 28		4,834	Erosion	70,123	Kmu_gr 14	345
Kmu_gl 29		4,822	Erosion	24,575	Kmu_gr 14	300
Kmu_gl 32		4,679	Erosion	24,641	Kmu_gr 22	685
Kmu_gl 37		4,843	Valley	42,498	Kmu_gr 26	700
Kmu_gl 39		4,929	Valley	68,576	Kmu_gr 27	715
Kmu_gl 73		5,099	Erosion	133,350	Kmu_gr 38	660
Kmu_gl 87		5,279	Valley	27,315	Kmu_gr 40	550
Kmu_gl 109		5,081	Erosion	70,056	Kmu_gr 70	330
Kmu_gl 111		5,145	Valley	63,603	Kmu_gr 71	255
Kmu_gl 113		5,276	Erosion	26,034	Kmu_gr 76	140
Kmu_gl 117		5,118	Valley	25,437	Kmu_gr 81	225
Kmu_gl 119		5,118	Supraglacial	23,315	Kmu_gr 82	0
Kmu_gl 120		5,145	Supraglacial	27,669	Kmu_gr 82	0
Kmu_gl 129		4,712	Moraine-dammed	681,094	Kmu_gr 85	0
Kmu_gl 133		5,105	Erosion	77,040	Kmu_gr 86	345
Kmu_gl 134		4,962	Valley	133,881	Kmu_gr 86	850
Kmu_gl 137		5,179	Valley	72,045	Kmu_gr 87	140
Kmu_gl 146		4,959	Valley	32,553	Kmu_gr 94	850
Kmu_gl 147		5,090	Moraine-dammed	37,791	Kmu_gr 94	40
Kmu_gl 168		5,544	Valley	20,332	Kmu_gr 97	780
Kmu_gl 232		5,044	Valley	36,288	Kmu_gr 129	75
Kmu_gl 240		5,267	Valley	77,836	Kmu_gr 132	755
Kmu_gl 245		5,560	Erosion	24,774	Kmu_gr 137	55
Kmu_gl 252		5,465	Erosion	25,194	Kmu_gr 143	225
Kmu_gl 259		5,380	Erosion	25,415	Kmu_gr 150	265
Kmu_gl 260		5,142	Erosion	30,851	Kmu_gr 151	115
Kmu_gl 262		5,270	Moraine-dammed	49,901	Kmu_gr 157	0
Kmu_gl 269		4,767	Erosion	25,923	Kmu_gr 249	415

The Humla Karnali is the extreme northwest sub-basin of Nepal. It lies in the Karnali Basin. This sub-basin consists of 345 glacial lakes, out of which 57 are major glacial lakes with an area larger than 0.02 sq.km (Table 11.12). The largest glacial lake in the Humla Sub-basin is Khu_gl 145 (Chhungsa Daha) with an area of 0.689 sq.km located at an elevation of 4,781 masl. Though there are 16 moraine-dammed lakes, with one blocked and one supraglacial lake in the sub-basin none of them fall into the category of potentially dangerous lakes.

Table 11.12: Major glacial lakes associated with glaciers in the Humla Sub-basin

Lake number	Lake name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Khu_gl 8		4962	Valley	35 544	Khu_gr 24	1505
Khu_gl 14		5177	Moraine-dammed	111 949	Khu_gr 41	375
Khu_gl 21		5742	Moraine-dammed	307 020	Khu_gr 49	0
Khu_gl 37		5493	Moraine-dammed	41 351	Khu_gr 56	70
Khu_gl 60		5505	Valley	155 224	Khu_gr 64	210
Khu_gl 63		5578	Moraine-dammed	68 044	Khu_gr 65	0
Khu_gl 64		5578	Moraine-dammed	83 717	Khu_gr 66	0
Khu_gl 65		5624	Moraine-dammed	22 460	Khu_gr 69	0
Khu_gl 71		5633	Moraine-dammed	77 665	Khu_gr 72	0
Khu_gl 73		5662	Valley	31 136	Khu_gr 73	95
Khu_gl 80		5584	Valley	50 167	Khu_gr 79	80
Khu_gl 81		5514	Erosion	137 592	Khu_gr 80	170
Khu_gl 82		5389	Moraine-dammed	80 254	Khu_gr 81	0
Khu_gl 84		5450	Moraine-dammed	88 335	Khu_gr 87	0
Khu_gl 85		5544	Erosion	31 836	Khu_gr 87	400
Khu_gl 100		5416	Valley	124 194	Khu_gr 101	35
Khu_gl 103		5483	Valley	48 663	Khu_gr 103	265
Khu_gl 104		5108	Valley	50 552	Khu_gr 105	230
Khu_gl 115		4892	Valley	77 700	Khu_gr 106	75
Khu_gl 120		4907	Moraine-dammed	124 473	Khu_gr 135	0
Khu_gl 145	Chhungsa Daha	4907	Moraine-dammed	689 887	Khu_gr 143	770
Khu_gl 168		4781	Moraine-dammed	50 867	Khu_gr 150	0
Khu_gl 171		4746	Valley	22 915	Khu_gr 153	520
Khu_gl 172		5026	Cirque	44 220	Khu_gr 156	160
Khu_gl 175		3969	Valley	81 233	Khu_gr 167	485
Khu_gl 177		4563	Valley	116 742	Khu_gr 168	60
Khu_gl 186		5105	Cirque	23 229	Khu_gr 182	10
Khu_gl 187		5099	Valley	25 818	Khu_gr 183	80
Khu_gl 188		4697	Moraine-dammed	35 824	Khu_gr 187	0
Khu_gl 192		5297	Supraglacial	35 684	Khu_gr 190	0
Khu_gl 195		4511	Valley	54 890	Khu_gr 193	760
Khu_gl 216		5166	Valley	71 822	Khu_gr 207	175
Khu_gl 217		5179	Valley	243 035	Khu_gr 207	325
Khu_gl 218		5218	Valley	47 054	Khu_gr 208	270
Khu_gl 222		5499	Valley	60 837	Khu_gr 211	555
Khu_gl 223		5599	Moraine-dammed	28 127	Khu_gr 214	0
Khu_gl 236		5383	Valley	35 229	Khu_gr 226	435
Khu_gl 238		5416	Moraine-dammed	62 167	Khu_gr 227	160
Khu_gl 247		5351	Moraine-dammed	76 405	Khu_gr 230	15
Khu_gl 251		unnamed	Valley	681 700	Khu_gr 270	425
Khu_gl 252	Lurupya	4404	Valley	180 798	Khu_gr 276	235
Khu_gl 276		4526	Block	319 370	Khu_gr 291	190
Khu_gl 279		4404	Valley	67 519	Khu_gr 294	280
Khu_gl 283		4865	Valley	160 052	Khu_gr 303	735
Khu_gl 284		4624	Valley	23 684	Khu_gr 310	335
Khu_gl 289		4831	Valley	29 317	Khu_gr 314	145
Khu_gl 291		4715	Valley	35 579	Khu_gr 333	930
Khu_gl 292		5066	Moraine-dammed	57 129	Khu_gr 328	0
Khu_gl 302		4944	Block	140 111	Khu_gr 348	110
Khu_gl 316		4145	Valley	83 542	Khu_gr 395	1540
Khu_gl 317		4621	Cirque	35 229	Khu_gr 401	290
Khu_gl 318		4627	Block	60 907	Khu_gr 412	15
Khu_gl 320		4688	Erosion	28 057	Khu_gr 412	20
Khu_gl 322		4840	Block	24 384	Khu_gr 413	120
Khu_gl 325		4356	Erosion	34 669	Khu_gr 418	265
Khu_gl 328		4648	Valley	31 346	Khu_gr 420	245
Khu_gl 336		4426	Valley	149 907	Khu_gr 424	940

The West Seti, Kawari, and Tila are smaller sub-basins in the Karnali Basin. These sub-basins have 15, 44, and 71 glacial lakes, of which only 4, 5, and 3 glacial lakes respectively have areas larger than 0.02 sq.km and fall into the major glacial lake category. The lakes are located at an elevation below 5,000 masl. The largest lake has an area of 0.6 sq.km. The supraglacial lakes and moraine-dammed lakes in the West Seti, Kawari, and Tila Sub-basins of the Karnali basin are smaller than 0.062 sq.km and hence none of them are potentially dangerous.

Table 11.13: Major glacial lakes associated with the glaciers in West Seti, Kawari, and Tila Sub-basins

Lake number	Sub-basin	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Kse_gl 5	West Seti	4648	Supraglacial	21 497	Kse_gr 23	0

The Mahakali River Basin consists of only 16 glacial lakes in the Nepalese portion of its catchment, out of which only 5 lakes are major glacial lakes with an area larger than 0.02 sq.km (Table 11.14). Due to unavailability of some topographic maps of that area, some elevations of lakes are unknown. The known elevations of the lakes are below 5,000 masl. Though there are three major supraglacial lakes and one blocked glacial lake, none of them is in the category of potentially dangerous lakes.

Table 11.14: Major glacial lakes associated with the glaciers in the Mahakali Basin

Lake Number	Sub-basin Name	Elevation (masl)	Type	Area (m^2)	Associated glacier No.	Distance to glacier (m)
Mkali_gl 5			Supraglacial	24 209	Mkali_gr 43	0
Mkali_gl 6			Supraglacial	52 804	Mkali_gr 43	0
Mkali_gl 7			Supraglacial	25 998	Mkali_gr 43	0
Mkali_gl 9		4206	Block	55 603	Mkali_gr 58	0
Mkali_gl 16		4724	Valley	22 507	Mkali_gr 85	100

11.3 Potentially Dangerous Glacial Lakes

Based on the analysis of inventory data using different criteria and the study of satellite images and aerial photographs, 20 glacial lakes are identified as potentially dangerous lakes in Nepal. Out of these there are three glacial lakes (i.e. Nagma, Tam Pokhari, and Dig Tsho) with past outburst events and 17 glacial lakes without a record of past GLOF events. The identified potentially dangerous lakes are recommended for further detailed investigation and field survey to understand their activity (Figure 11.1 and Table 11.15). As well as these, there are six other potentially dangerous lakes identified in the inventory, which have past GLOF events seen in the satellite images and no more danger and or existence in the present topographic maps and satellite images Table 11.16.

Beside those nine outbursts in total, two more (Nare and Chhubung) outburst events were noted in satellite images, which were not formed or mapped during topographic map preparation in the 1960s and are hence not included in the inventory.

11.4 Categorisation of Potentially Dangerous Glacial Lakes

Based on the identification and description of potentially dangerous lakes given in the sections above, potentially dangerous glacial lakes can be classified into the following three categories.

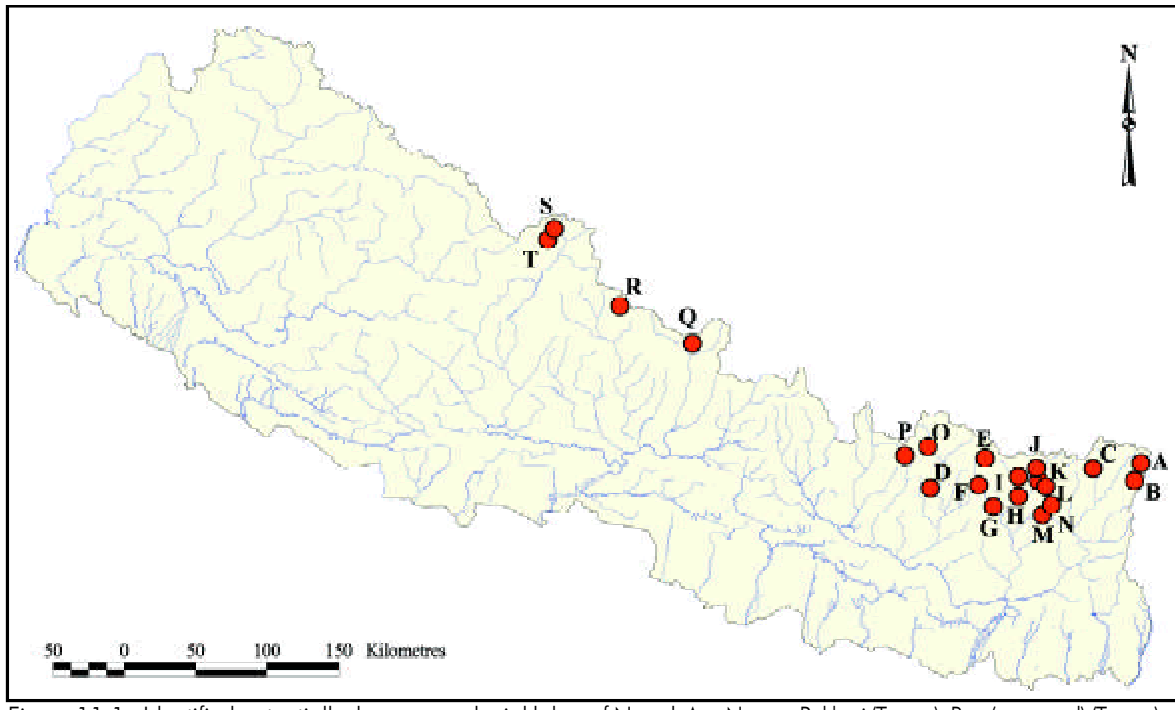

Figure 11.1: Identified potentially dangerous glacial lakes of Nepal: A = Nagma Pokhari (Tamor); B = (unnamed) (Tamor); C = Lower Barun (Arun); D = Lumding (Dudh Koshi); E = Imja (Dudh Koshi); F = Tam Pokhari (Dudh Koshi); G = Dudh Pokhari (Dudh Koshi); H = (unnamed) (Dudh Koshi); I = (unnamed) (Dudh Koshi); J = Hungu (Dudh Koshi); K = East Hungu 1 (Dudh Koshi); L = East Hungu 2 (Dudh Koshi); M = (unnamed) (Dudh Koshi); N = West Chamjang (Dudh Koshi);O = Dig Tsho (Dudh Koshi); P = Tsho Rolpa (Tama Koshi); Q = (unnamed) (Budhi Gandaki); R = Thulagi (Marsysngdi); S = (unnamed) (Kali Gandaki); T = (unnamed) (Kali Gandaki)

Table 11.15: Potentially dangerous glacial lakes of Nepal identified from the inventory and recommended for further investigation and field survey

Lake number	Lake name	Latitude	Longitude	Altitude (masl)	Length (m)	Area (m^2)	Remarks
Tamor Sub-basin							
Ktr_gl 192 (A)	Nagma Pokhari	27° 52.10'	87° 52.02'	4,907	210	149,689	Burst on 23 June 1980 and wing
Ktr_gl 146 (B)	unnamed	27° 48.83'	87° 45.09'	4,876	830	181,147	
Arun Sub-basin							
(C)	Lower Barun	27° 45.31'	87° 06.31'	4,550	1,100	666,000	Growing in size
Dudh Koshi Sub-basin							
Kdu_gl 28 (D)	Lumding Tsho	27° 46.51'	86° 37.53'	4,846	625	104,944	
Kdu_gl 350 (E)	Imja Tsho	27° 54.00'	86° 55.40'	5,023	410	48,811	
Kdu_gl 399 (F)	Tam Pokhari	27° 44.33'	86° 50.76'	4,431	515	138,846	GLOF on 3 September 1998
Kdu_gl 422 (G)	Dudh Pokhari	27° 41.21'	86° 51.68'	4,760	1,120	274,297	
Kdu_gl 442 (H)	Unnamed	27° 47.70'	86° 54.81'	5,266	840	133,753	
Kdu_gl 444 (I)	Unnamed	27° 48.23'	86° 56.61'	5,056	420	112,398	
Kdu_gl 449 (J)	Hungu	27° 50.17'	86° 56.26'	5,181	875	198,905	
Kdu_gl 459 (K)	East Hungu 1	27° 47.92'	86° 57.95'	5,379	465	78,761	
Kdu_gl 462 (L)	East Hungu 2	27° 48.30'	86° 58.65'	5,483	640	211,877	
Kdu_gl 464 (M)	Unnamed	27° 46.86'	86° 57.22'	5,205	1,100	349,397	Growing in size
Kdu_gl 466 (N)	West Chamjang	27° 45.24'	86° 57.33'	4,983	125	6,446	Kdu-gl 465 to 469 merged into one
Kdu_gl 55 (O)	Dig Tsho	27° 52.41'	86° 36.61'	4,364	605	143,250	GLOF on 4 August 1985
Tama Koshi Sub-basin							
Kta_gl 26 (P)	Tsho Rolpa	27° 52.03'	86° 28.41'	4,556	1,070	231,693	Kta_gl 26 to 32 merged
Budhi Gandaki Sub-basin							
Gbu_gl 9 (Q)	Unnamed	28° 35.79'	84° 38.09'	3,590	230	81,545	
Marsyangdi River Sub-basin							
Gmar_gl 70 (R)	Thulagi	28° 29.69'	84° 29.01'	3,825	420	223,385	Growing in size
Kali Gandaki Sub-basin							
Gka_gl 38 (S)	Unnamed	29° 2.76'	83° 40.52'	5,419	600	149,202	
Gka_gl 67 (T)	Unnamed	29° 12.79'	83° 41.79'	5,452	3,610	1,013,344	Growing in size

Table 11.16: Potentially dangerous lakes identified from the inventory but past GLOF events seen on the satellite images and pose no danger							
Lake number	**Sub-basin**	**Latitude**	**Longitude**	**Altitude (masl)**	**Length (m)**	**Area (m^2)**	**Remarks**
Kar_gl 29	Arun	27° 50.50'	87° 5.01'	4862	600	119 114	
Kar_gl 30	Arun	27° 49.73'	87° 5.89'	5273	615	117 190	
Kdu_gl 349	Dudh Koshi	27° 54.33'	86°54.80'	4986	460	52 790	Chokarma Cho
Gka_gl 41	Kali Gandaki	29° 04.55'	83°39.39'	5483	260	21 583	
Gka_gl 42	Kali Gandaki	29° 04.62'	83° 38.23'	5449	195	26 829	
Kmu_gl 129	Mugu Karnali	29° 39.70'	82° 47.76'	4712	2020	681 094	

Category 1: Potentially dangerous glacial lakes without a record of past GLOF events
Category 2: Potentially dangerous glacial lakes with past outburst events
Category 3: Potentially dangerous glacial lakes identified in the inventory but posing no danger at present based on GLOF events in the past

The basin-wise distribution of these three categories of lake is as follows.

Koshi River Basin

Category 1: Ktr_gl 146, Lower Barun, Kdu_gl 28 (Lumding Tsho), Kdu_gl 350 (Imja Tsho), Kdu_gl 422 (Dudh Pokhari), Kdu_gl 442, Kdu_gl 444, Kdu_gl 449 (Hungu Lake), Kdu_gl 459 (East Hungu 1), Kdu_gl 462 (East Hungu 2), Kdu_gl 464, Kdu_gl 466 (West Chamjang), and Tsho Rolpa
Category 2: Ktr_gl 191 (Nagma Pokhari), Kdu_gl 55 (Dig Tsho), and Kdu_gl 399 (Tam Pokhari)
Category 3: Chhubung, Kar_gl 29, Kar_gl 30, and Kdu_gl 349 (Chokarma Cho)

Gandaki River Basin

Category 1: Gbu_gl 9, Gmar_gl 70 (Thulagi), Gka_gl 38, and Gka_gl 67
Category 3: Gka_gl 41 and Gka_gl 42

Karnali River Basin

Category 3: Kmu_gl 129