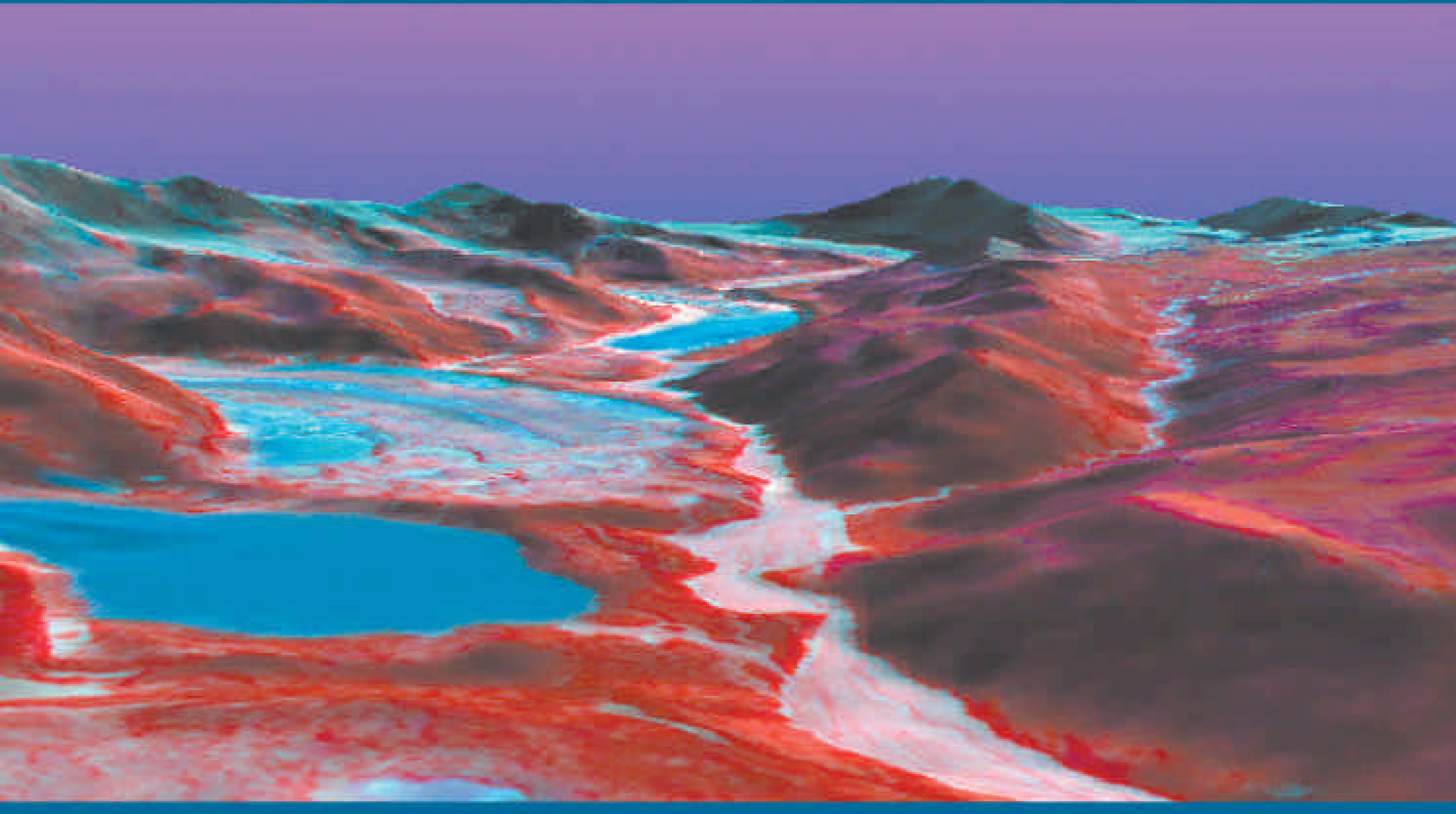
Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods

Monitoring and Early Warning Systems in the Hindu Kush-Himalayan Region

Bhutan



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Pradeep K. Mool, Dorji Wangda, Samjwal R. Bajracharya, Karma Kunzang, Deo Raj Gurung, Sharad P. Joshi

In cooperation with
United Nations Environment Programme
Regional Resource Centre — Asia and the Pacific
(UNEP/RRC-AP)

International Centre for Integrated Mountain Development
Mountain Environment and Natural Resources' Information Systems
August 2001

Cover plate:

Front: *Three-dimensional perspective computer-generated view of Raphstreng Tsho showing the Thorthomi glacier and Lugge Tsho area, and the effect of the Lugge Tsho GLOF in the Pho Chu area (1999 IRS1D LISS3 and PAN data)*

Back plates:

The Pho Chu basin area in Bhutan which includes the Lugge Tsho, Raphstreng Tsho, and their associated glaciers

Top: *Lugge Tsho Glacial Lake two weeks after the GLOF of 7 October 1994*
— Yeshi Dorji

Bottom clockwise:

Satellite image (IRS1C PAN) of 3 January 1999 draped on a digital elevation model (DEM) derived from topographic maps showing the breached area of Lugge Tsho Lake

Field photo of Thorthormi Glacier and Lugge Tsho showing the breach point of Lugge Tsho
— *Phuntso Norbu*

Satellite image (IRS1D PAN) of 3 December 2000 showing Punakha Dzong, the impact area of the GLOF

Field photo of Punakha Dzong three days after the disaster of 1994
— *Phuntso Norbu*

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Foreword

The glaciers of the Hindu Kush-Himalayas (HKH) are nature's renewable storehouse of fresh water from which hundreds of millions of people downstream benefit just when it is most needed – in the dry hot season before the monsoons. While the total number of glaciers in the region is still unknown, this study has for the first time documented that there are 677 glaciers in Bhutan alone. Covering an area of 1,317 square kilometres, these high frozen reservoirs release their water at the top of their watersheds. They serve as the perennial sources of rivers that wind their way through grazing, agricultural, and forest lands and are used as renewable sources of irrigation, drinking water, energy, and industry.

However, these glaciers are retreating in the face of accelerating global warming. They are particularly vulnerable to climate change, and the resultant long-term loss of natural fresh water storage will have as yet uncalculated effects on communities downstream. More immediately, as glaciers retreat, glacial lakes form behind some of the now exposed terminal moraines. Rapid accumulation of water in glacial lakes, particularly in those adjacent to receding glaciers, can lead to a sudden breaching of the unstable 'dam' behind which they have formed. The resultant discharges of huge amounts of water and debris – a **glacial lake outburst flood** or **GLOF** – often have catastrophic effects downstream.

Many glacial lakes are known to have formed in the HKH in the last half century and a number of GLOFs have been reported in the region, including in Bhutan, in the last few decades. These GLOFs have resulted in many deaths, as well as the destruction of houses, bridges, fields, forests and roads. The lakes at risk, however, are situated in remote and inaccessible areas. When they burst, the local communities may have been devastated, while those in far away cities were largely unaware of the event.

In Bhutan, the catastrophic Lugge Tsho glacial lake flood in 1994, which followed a similar event in nearby Nepal in 1985, raised awareness of the problem considerably. As described in this publication, a partial burst from this lake caused loss of life and property along the Punakha-Wangdue valley, damaged part of the Dzongchung of Punakha Dzong, and washed away or covered nearly 1,000 acres of pastureland.

Despite numerous studies of individual cases, there is still no detailed inventory of glaciers and glacial lakes, of GLOF events or of potential GLOF sites, in the HKH region – let alone of their impact on downstream populations and investments. This publication, along with the sister publication on the glaciers and glacial lakes of Nepal, is designed to begin filling this pressing need. The research upon which it is based started in 1999, when the United Nations Environment Programme Regional Resource Centre for Asia and the Pacific (UNEP/RRC-AP) provided ICIMOD with the opportunity of using its expertise in the area of geographic information systems (GIS) to create a comprehensive inventory and GIS database of glaciers and glacial lakes in Nepal and Bhutan using available maps, satellite images, aerial photographs, reports, and field data on different scales. It built on ICIMOD's experience and long-standing concern with collecting and distributing material on the means to identify and mitigate mountain disasters and safeguard the livelihoods of vulnerable mountain people and their downstream neighbours.

One of the study's major objectives was to identify areas where GLOF events had occurred and lakes that could pose a potential threat of a GLOF in the near future. Out of a surprisingly large total of 2,674 glacial lakes, the researchers found 24 lakes that are potentially dangerous. These results thus provide the basis for development of a monitoring and early warning system and for the planning and prioritisation of disaster mitigation efforts that could save many lives and properties situated downstream, as well as guide infrastructure planning. In addition, it is anticipated that this study will provide useful information for many of those concerned with water resources and land-use planning.

As a presentation of the first results of the UNEP/RRC-AP supported study, this publication also includes a description of the methods used to identify glaciers, glacial lakes, and glacial lakes that may pose a threat; as well as an inventory (and maps) of the glaciers and glacial lakes in Bhutan. It includes a summary of the results of studies of various glacial lakes, and a brief review of the causes and effects of known GLOF events in Bhutan. The database and analysis are the first to cover the whole of the country on a large scale.
We are thus confident that this comprehensive report and digital database will be of service to scientists, planners, and decision-makers in many areas. Through their informed actions, we hope it will contribute to improving the lives of those living in the mountains, and help safeguard future investments for the benefit of many people in the region.

ICIMOD is grateful to UNEP/RRC-AP for its support to this work and the strong support and advice given while carrying out the project. We are also pleased that this project has enabled us to continue to strengthen our collaboration with the Department of Geology and Mines of the Royal Government of Bhutan and to continue to assist in developing regional capacity and co-operation.

J Gabriel Campbell
Director General
ICIMOD

Acknowledgements

We express our sincere thanks to the Department of Geology and Mines of the Royal Government of Bhutan, which has been closely affiliated with the present study and made available important information on maps, satellite images, reports and data. We thank Dr. Hari Man Shrestha, the former executive secretary of WECS, who carried out a technical review of the study and Dr. V. Galay and Dr. M. Zimmerman for their valuable comments and suggestions on the draft report. Mr. Basanta Shrestha, Acting Head, MENRIS, coordinated and made valuable inputs to the study. Other ICIMOD staff members who have assisted in the study include Ms. Monica Moktan, Ms. Rajani Bajracharya, Prof. Li Tianchi, Mr. Sushil Pradhan, Mr. Birendra Bajracharya, Mr. Sushil Pandey, Mr. Saisab Pradhan, Mr. Anirudra M. Shrestha, and Mr. Govinda Joshi. We would like to thank them all for their contributions. We would also like to thank Mr. Dharma Ratna Maharjan for the layout design and Mr. Asha Kaji Thaku for cartographic work. Mr. Pramod Pradhan, former Head of the MENRIS division of ICIMOD, is thanked for his valuable inputs and for coordinating the project process. Last but not least we wish to thank Mr. Surendra Shrestha, Regional Coordinator, Mr. Dola Govinda Pradhan, Dr. Chandra Giri, Mr. Mylvakanam Iyngararasan, Ms. May Ann E. Mamicpic, and Ms. Kritiya Gajesani of UNEP/RRC-AP for their timely and strong support and advice while implementing the project.

Editor's note

The terms glacier lake and glacial lake are often used interchangeably to refer to any lake associated with a glacier, regardless of the means of formation, although some investigators restrict their definitions to particular types of lake. For the purposes of this document, all lakes in contact with or near a glacier, or formed by recent glacial morphology, are referred to as 'glacial lakes'. In practice, most are of the type produced on a glacier's perimeter by meltwater from the glacier, by many termed a 'proglacial lake'.

The terms 'Himalaya' and 'Himalayas' are use to refer to the geological formation and the geographical region, respectively.

Abbreviations and Acronyms

CD	compact disk
DEM	digital elevation model
DGM	Department of Geology and Mines
DOR	Department of Roads
EAP-AP	Environment Assessment Programme – Asia Pacific
EMS	electromagnetic spectrum
ERTS	Earth Resources Technology Satellite
ESCAP	Economic and Social Commission for Asia and Pacific
ETH	Swiss Federal Institute of Technology
FCC	false colour composite
GDP	gross domestic product
Gl	glacial lake
GIS	geographic information system
GLOF	glacial lake outburst flood
Gr	glacier
GSB	Geological Survey of Bhutan
GSI	Geological Survey of India
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
HKH	Hindu Kush-Himalayas
HRV	High Resolution Visible sensor (SPOT)
ICIMOD	International Centre for Integrated Mountain Development
ILWIS	Integrated Land and Water Information Systems
IR	Infrared
IRS1C	Indian Remote Sensing Satellite series 1C
IRS1D	Indian Remote Sensing Satellite series 1D
Landsat	Land Resources Satellite
LIGG	Lanzhou Institute of Glaciology and Geocryology
LISS	Linear Imaging and Self Scanning sensor
masl	metres above sea level
MBT	Main Boundary Thrust
MCC	Meteor Communication Corporation
MCT	Main Central Thrust
MENRIS	Mountain Environment and Natural Resources' Information System
MOS	Marine Observation Satellite
MSS	Multi Spectral Scanner (Landsat)
NEA	Nepal Electricity Authority
NRSA	National Remote Sensing Agency
PAN	Panchromatic Mode sensor system (SPOT)

RRC	Regional Resource Centre
RBA	Royal Bhutan Army
RGB	red green blue
RGOB	Royal Government of Bhutan
RS	remote sensing
SPOT	Système Probatoire Pour l'Observation de la Terre / Satellite Pour l'Observation de la Terre
SWIR	Short Wave Infra Red sensor
TM	Thematic Mapper (Landsat)
TTS	Temporary Technical Secretary
UNDP	United Nations Development Project
UNEP	United Nations Environment Programme
VNIR	Visible and Near Infra Red (AVNIR)
WAPCOS	Water and Power Consultancy Services (India) Limited
WECS	Water and Energy Commission Secretariat
WGI	World Glacier Inventory
WGMS	World Glacier Monitoring Service
WWW	World Wide Web
XS	Multispectral Mode sensor system (SPOT)

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Chapter 1
Introduction to Inventory of Glaciers and Glacial Lakes

1.1 Introduction

Bhutan is a mountainous country, where mountains and hills occupy most of the land. Out of the 2,400 km long Himalayan range, the Bhutan Himalayas extend up to 340 km. The country is vulnerable to various hazards due to fragile geological conditions, great elevation differences, and steep sloping terrain. Apart from landslides and river erosion, the mountainous region is also quite susceptible to disastrous hazards due to glacial lake outburst floods (GLOFs). In general, the area above an elevation of 4,000 masl is mostly covered by snow and ice throughout the year. The glaciers, some of which consist of a huge amount of perpetual snow and ice, create many glacial lakes. These glaciers, as well as the glacial lakes, are the sources of the headwaters of many great rivers in the region. Most of these lakes are located in the down valleys close to the glaciers. They are formed by accumulation of a huge amount of water from the melting of snow and ice cover and by blockage of end moraines. The sudden break of the moraine may generate a discharge of large volumes of water and debris causing flooding.

In the last half-century, several glacial lakes have developed in the Hindu Kush-Himalayas and Tibetan Himalayas. This may be attributed to the effect of recent global warming. The glacial lakes are formed on the glacier terminus due to the recent retreating processes of the glaciers. The majority of these glacial lakes are dammed by unstable moraines, which were formed by the glaciations of the Little Ice Age. Occasionally, the lake happens to burst and suddenly releases an enormous amount of its stored water, which causes serious floods downstream along the river channel. This phenomenon, generally known as glacial lake outburst flood (GLOF), is recognised to be a common problem in Hindu Kush-Himalayan countries such as Nepal, India, Pakistan, Bhutan, and China (Tibet).

In Bhutan, the sources of its major rivers and the bulk of its freshwater resources are locked up in ice and snow. The advance of glaciers during the Little Ice Age has built up prominent end moraines in the Higher Himalaya of Bhutan in the headwaters of Mo Chu, Pho Chu, Mangde Chu, Chamkhar Chu, Kuri Chu, and Pa Chu. During the last few decades there has been a rapid retreat of glaciers creating many dangerous moraine-dammed lakes. In some glaciers (e.g. Thorthormi Glacier) small isolated lakes/ponds have formed. They are increasing in size at a very fast rate. It has been observed that some of the glaciers in Bhutan are retreating by about 20–30m in a year.

The first study on glacial lakes of Bhutan was done in the 1960s. However, until the GLOF of 7 October 1994 in Punakha–Wangdue Valley, the general public had little or no knowledge about the potential dangers of GLOFs. After an investigation into the causes of the 1994 GLOF, it was found that the moraine dam of the large Raphstreng Tsho was damaged due to a breach of Lugi Tsho Glacial Lake. As a result, the study of glaciers and glacial lakes in the Lunana region had to be taken up immediately. A number of teams were fielded to the area to find ways to mitigate the GLOF hazard. Subsequently, mitigation measures on Raphstreng Tsho were taken up to reduce the hydrostatic pressure on the weakened barrier. The work commenced in 1996 and was completed in 1998. In 1998 a Japan–Bhutan joint research team carried out an assessment of GLOFs in Bhutan. In 1999 an Austria–Bhutan expedition carried out integrated geophysical, hydrological, and geological investigations in the Lunana area with special emphasis on Raphstreng Tsho and Thorthormi Tsho.

One should be fully aware of the dangerous nature of large glacial lakes, especially if they happen to exist at the headwaters of rivers that flow through inhabited valleys or are harnessed for the generation of hydropower and/or for other purposes. It is an utter necessity to identify such lakes initially from the study of satellite images (and aerial photographs if available) and to assess their field conditions without delay. Some of these lakes may need only regular monitoring whereas a few may really need structural counter measures to reduce the inherent hazards they pose. As the Department of Geology and Mines of Bhutan (DGM) neither has the expertise nor the facility, DGM and the International Centre for Integrated Mountain Development (ICIMOD) held discussions and decided to update the publication of the Geological Survey of Bhutan (GSB) entitled 'Glaciers and Glacial Lakes in Bhutan 1999' using remote sensing (RS) and geographic information systems (GIS).

For the mapping and inventory of the glaciers and glacial lakes, the methodology used in this study is based on the research study of the Temporary Technical Secretary for the World Glacier Inventory of the Swiss Federal Institute of Technology (ETH), Zurich (Muller et al. 1977; World Glacier Monitoring Service (WGMS) 1989).

1.2 Objectives

- To understand the GLOF phenomenon by creating an inventory of existing glacial lakes and monitoring the GLOF events on a regular basis
- To establish an effective early warning mechanism to monitor GLOF hazards using RS and GIS in the Hindu Kush-Himalayan region
- To develop the capacity building of national institutions to assess and monitor the GLOF phenomenon
- To disseminate the results and outputs to the relevant organisations in the region that could make use of this information for GLOF hazard prevention and mitigation planning

1.3 Outputs

- An inventory of glaciers and glacial lakes of Nepal and Bhutan
- Identification of potential risk lakes
- Recommendations for the establishment of a system for monitoring potential risk lakes using RS and GIS
- Strengthening of capabilities of the national institutions to implement an early warning system for GLOF hazard monitoring
- Dissemination of the results and outputs to relevant institutions

1.4 Activities

a) Glacier and glacial lake inventory

- Acquisition of Land Observation Satellite (LANDSAT) Thematic Mapper (TM) images for 1999 covering the northern part of Bhutan

- Collection of GIS data layers including digital elevation models (DEM), geology, soils, hydrology (rivers), land use, infrastructure (roads), settlements, forest, administrative boundaries (districts and villages), urban areas, and tourist spots on a scale of 1:50,000
- Data analysis and report writing

b) Monitoring potential risk lakes

- Acquisition of LANDSAT TM/ Système Probatoire Pour l'Observation de la Terre (SPOT)/RS images of 1990 and 1995 for four glacial lakes
- Acquisition of time series satellite images for 1990 and 1995
- Field checking and validation of results.
- Report writing

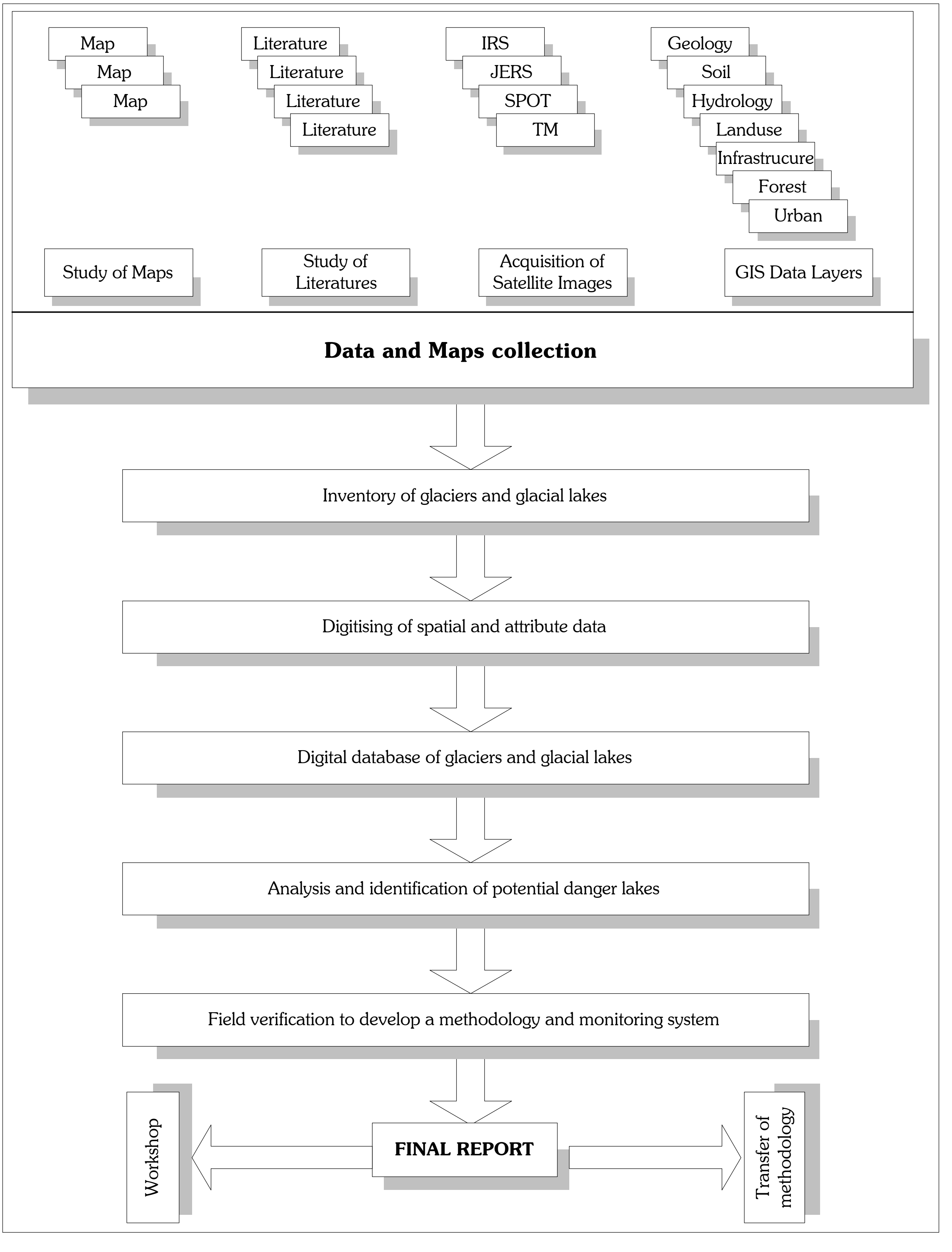
c) Establishment of an early warning system

- Developing the methodology using RS and GIS techniques for the inventory of glaciers and glacial lakes and for the GLOF monitoring and early warning system
- Training two participants each from Nepal and Bhutan

d) Results dissemination/publication

- Publication of a comprehensive report including (1) to (3) above
- Dissemination of results and outputs in the form of reports, on CD, and through the Internet
- Organisation of a workshop to release the results and outputs

1.5 Flow Chart



Chapter 2
General Characteristics of the Country

2.1 Physical Features

Bhutan is situated in the eastern Himalayas between the latitudes 26° 45' N to 28° 10' N and longitudes 88°45' E to 92°10' E. It is 340 km in length with an approximate area of 40,077 sq.km. It is bordered by the Tibetan plateau of China in the north and the Indian States of Sikkim in the west, West Bengal, and Assam in the south, and Arunachal Pradesh in the east. The terrain is mostly rugged and mountainous with elevations ranging from 200 masl to above 7,000 masl (Figure 2.1) within a distance of less than 175 km. The area above 4,200 masl covers 20.5% of the total land (MoA 1997) and is covered by the perpetual snow and ice forming the glaciers and glacial lakes. The variation of the climate is extremely dependent on the altitude.

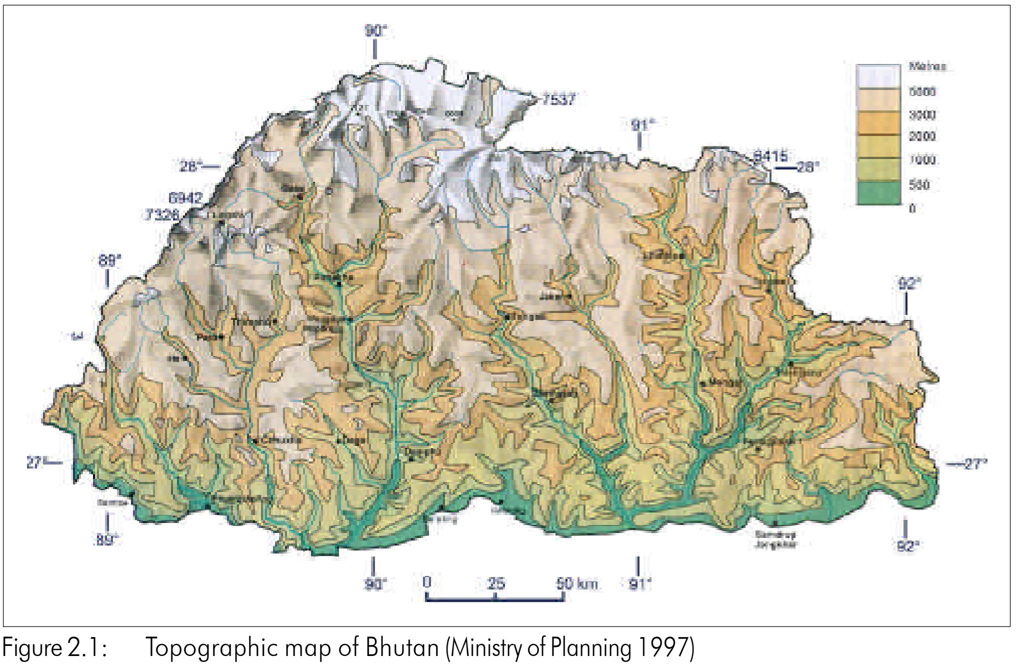


Figure 2.1: Topographic map of Bhutan (Ministry of Planning 1997)

2.2 Climate

The climate in Bhutan is dominated by a southwestern monsoon, which originates from the Bay of Bengal. Generally the monsoon starts from the month of June and lasts until the first week of September. Occasionally during the months of October and November post monsoon rain occurs and can be quite severe. The period from November to March is usually dry, although small showers may occur at any time due to the westerly wind that brings winter rains in the foothills of the Himalayas. During the months of April and May the pre-monsoon occurs with light showers accompanied by hailstorms and thunder. From past records the mean annual rainfall varies approximately from 2,500 to 5,500 mm in the southern foothills, from 1,000 to 2,500 mm in the inner valleys, and from 500 to 1,000 mm in the northern part of the country.

Climatically Bhutan can be divided into three broad zones: subtropical in the southern foothills, temperate in the middle valleys or inner hills, and alpine in the northern part. Generally, southern foothills are hot and humid during the summer months and quite cool in winter. The middle valleys are cold in winter and warm in summer with a pleasant spring and autumn with mild temperatures.

2.3 River System

The river system of Bhutan can be divided into six major river basins mostly flowing from north to south in Bhutan except for the northern basin (Figure 2.2). The rivers of northern basin flow from south to north and are not shown in the figure.

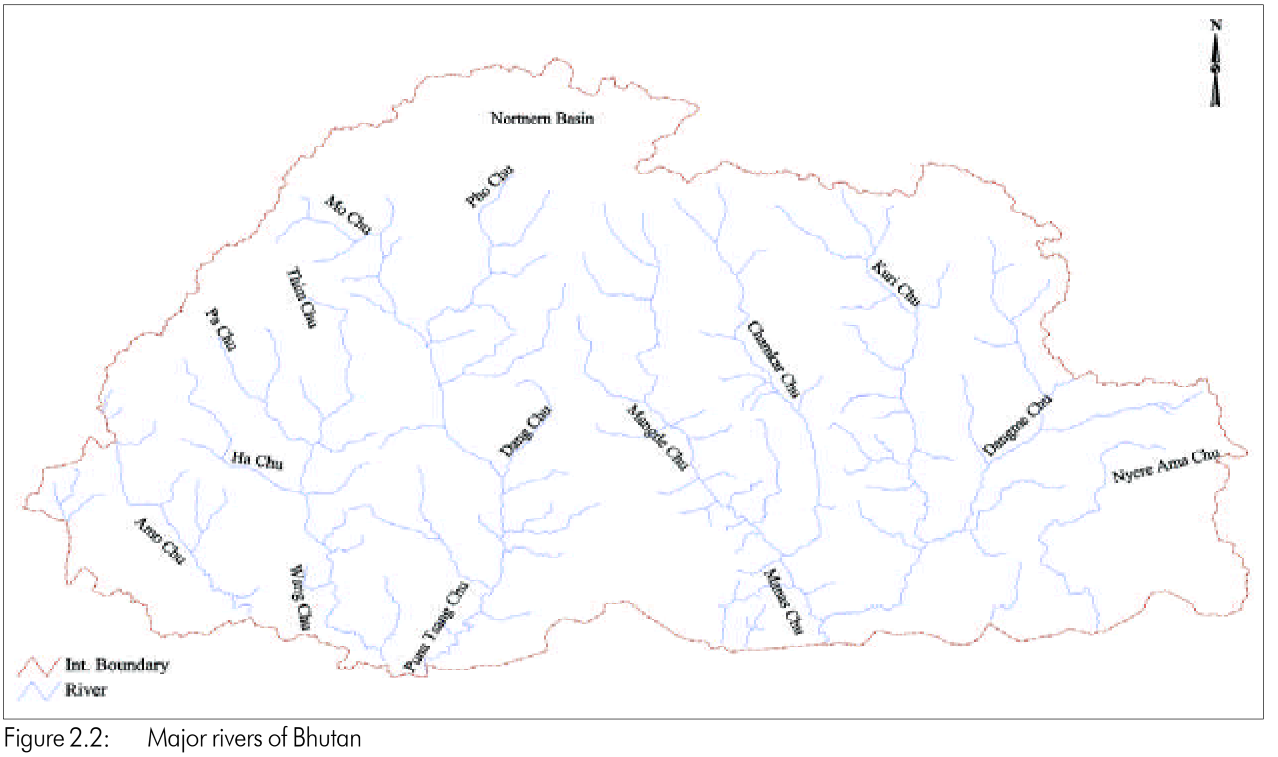


Figure 2.2: Major rivers of Bhutan

To date, a detailed inventory of the rivers in Bhutan is not available. The Puna Tsang Chu or The Sankosh is the longest river measured in Bhutan. It has a length of about 250 km. The south flowing river systems from west to east are the Amo Chu, Wang Chu, Puna Tsang Chu, Manas, and Nyere Ama Chu rivers respectively. Except for the Amo Chu and the Nyere Ama Chu, the river systems are joined by tributaries of appreciable size. These major tributaries are the Ha Chu, the Pa Chu, the Thim Chu, the Mo Chu, the Pho Chu, the Dang Chu, the Mangde Chu, the Chamkhar Chu, the Kuri Chu, and the Dangme Chu. Of these tributaries, the first three belong to the Wang Chu, the second three belong to the Puna Tsang Chu, and the remaining four belong to the Manas River system.

2.4 Geology and Geomorphology

Geology

Only about 30% of the country has been geologically mapped and the following three main geo-tectonic units have been recognised (ESCAP 1991).

- Frontal Belt, making up the foothills and parts of the Lesser or Lower Himalaya
- Central Crystalline Belt, occupying portions of the Lesser and Higher Himalaya
- Tethyan Belt, covering the Higher Himalaya and isolated but large portions of the Lesser Himalaya

These three belts have been affected by at least three successive cycles of deformation. The first main deformation took place under a north–south stress field resulting in a tight east–west striking, overturned fold with a generally north dipping axial plane cleavage. Towards the final stage of tectonic activities, shearing and over thrusting took place resulting in the main central thrust (MCT). The second deformation was also under the north–south stress field producing upright open folds; this is associated with the main boundary fault and thrusting of Paleozoic rocks over the Tertiary Siwalik Group of rocks. The third phase of deformation operated under an east–west stress field resulting in north–south trending round hinged upright open folding. In the southern foothills it has been observed that terraces have been affected by over thrusting by Quaternary to sub-recent morphogenic uplift.

Frontal belt

Rocks in the southern foothills consist of recent deposits of sand, gravel, and boulders in the foothill terraces of southwestern and south central parts of the country at about 300 masl. The Siwalik group of rocks consists of sedimentary and metasedimentary rocks extending in an east–west direction and dipping north. They are exposed in the south central part of Bhutan extending from the east of Raidak River to the west of Sarpang town and in eastern Bhutan stretching from the east of Manas River to the eastern boundary with the Indian State of Arunachal Pradesh. The Damuda and Diuri Formations are exposed in the eastern part of Bhutan. The Damuda (Gondwana) rocks of Permian age consist of sandstone, shale, and coal seams, they overlie the Siwalik rocks along the MBT. The Diuri Formation, at times considered part of the Damuda, comprises grey slate boulders, made up of pebbles of quartzite, phyllite, dolomite, and gneiss in a slaty matrix. The Buxa group of rocks consists of dolomite, variegated phyllites, quartzites, and conglomerates. This group of rocks stretches from the westernmost part of Bhutan to the east along the foothills. The Shumar Formation overlies the Buxa Group of rocks and consists of metasedimentary phyllite, quartzite, and thin marble bands.

Central crystalline belt

The two main lithological groups of metamorphic thrust sheets of this belt are the Thimphu Gneissic Complex and the Paro Formation. The Thimphu Gneissic Complex is characterised by migmatites and biotite-granite-gneisses with thin beds of quartzite, quartz mica schists, cal-silicate rocks, and marble, and it is the major rock type covering Bhutan. The Paro Formation is characterised by quartz mica schist, quartzites, calc-silicates, marble, and a thin bed of graphitic schist, and this is exposed in and around Paro. The Central Crystalline Belt is affected by intrusion of tourmaline bearing granites and pegmatites in the form of dykes, sills, laccoliths, and larger intrusions. The larger intrusive bodies are concentrated in the northern ranges.

Tethyan belt

The metamorphic and granitised contact of the Tethyan rocks with the underlying Thimphu Gneissic Complex is gradational. The Tethyan rocks are exposed in the extreme north of the country and the central area of the Black Mountains and their surroundings. This rock type basically comprises quartzites, siltstones, sandstones, phyllites, calcareous phyllites, slates, limestone, and conglomerates.

Geomorphology

Bhutan lies on the southern face of the eastern part of the Great Himalayan Range. It is divided broadly into three physiographic zones, viz., Southern Foothills, Lesser Himalaya, and Higher Himalaya.

One conspicuous feature of the Bhutan Himalayas is their abrupt rise in altitude from south to north in comparison to the other parts of the Himalayas.

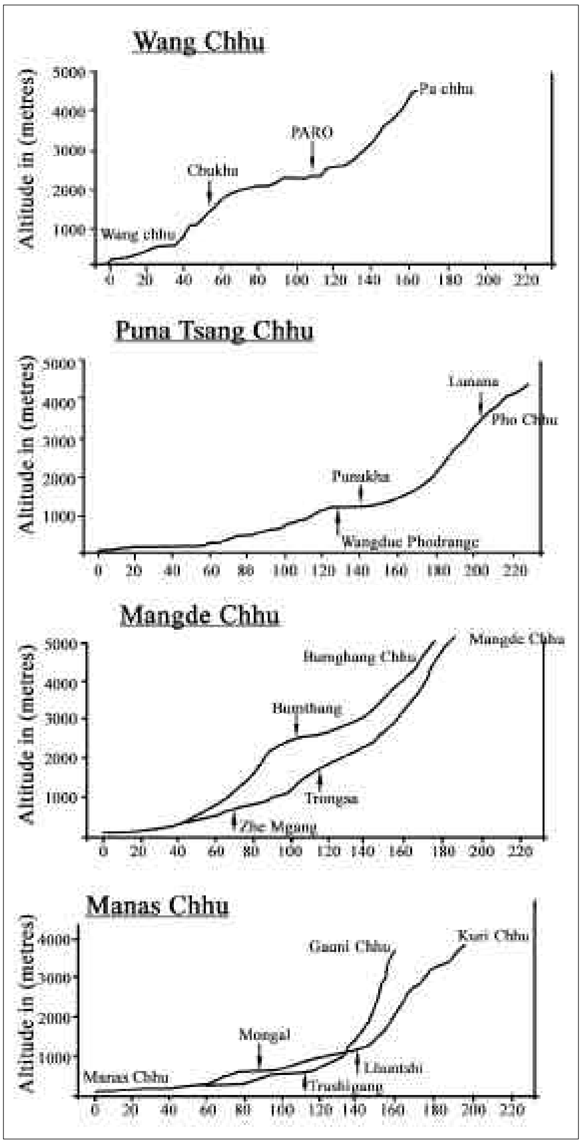


Figure 2.3: Profiles of the major rivers of Bhutan

Table 2.1: Land cover of Bhutan 1997*			
S. No.	Land use	Area (km²)	Percentage of total area
1	Forest	29045	72.5
1a	The conifer forest	10616	26.5
1b	Broad leaf forest	15107	37.7
1c	Forest plantation	64	0.2
1d	Shrub forest	3258	8.1
2	Agriculture	3088	7.7
2a	Wetland cultivation	388	1.0
2b	Dry land cultivation	977	2.4
2c	Mixed cultivated land	840	2.1
2d	Tseri (Slash & burn)	883	2.2
3	Pasture	1564	3.9
4	Horticulture	58	0.1
5	Settlement	31	0.1
6	Snow/glaciers	2989	7.5
7	Others	3301	8.2
	Total	40 076	100
*Source: Atlas of Bhutan, Land use planning section)			

All the inventoried rivers except Amo Chu and Kuri Chu have their origins within Bhutan and all flow north to south as individual major basins. This explains how the upheaval of the Siwaliks was not enough to block the river system forcing them to breach as one outlet. The longitudinal sections of major rivers presented in Figure 2.3 show nick points in two places, midway and further up, which indicate the uplift in two phases.

2.5 Seismicity

Bhutan is prone to earthquakes. It lies in zones 4–5 on the Richter scale. There is no seismic station in Bhutan. Although there have been earthquakes in the past, there are no documented records of magnitude or damage caused.

2.6 Land Use/Land Cover

Bhutan's total area deduced from Système Probatoire Pour l'Observation de la Terre (SPOT) imagery is approximately 40,077 sq.km (Ministry of Agriculture 1997). The dominant land cover of Bhutan is forest, and it occupies 72.5% of the total area (Table 2.1). Agricultural land constitutes 7.7% of the total land. The dominating land uses for agriculture are 'kamzhing' (dry land), 'chhuzhing' (irrigated/wet land), and 'tseri' (slash and burn cultivation). The horticultural area is expanding. The main crops grown are rice, maize, wheat, barley, millet, potato, mustard, beans, ginger, chilli, and other green vegetables. Cash crops grown are oranges, apples, and cardamom. 'Tsamdo' (pasture) land is another land use where livestock are sent for grazing. 'Sokshing' is also a form of land use where dry leaf litter is used to make farmyard manure for use in the fields. Although the area under sokshing is small, it plays a very important role in maintaining soil fertility.

2.7 Economy

Bhutan's economy is dominated by agriculture and the majority of the population depends on agriculture for their livelihood. In 1985 the contribution to the gross domestic product (GDP) from agriculture was 54.9%. The construction sector contributed 11.1%, financial services contributed 7.2%, and the transport/ communication and manufacturing sectors contributed 5.2 and 4.9% respectively. The other sectors that contributed significantly to the GDP were community and social services and trade and related activities, each contributing more than 8%. Prior to the commissioning of the Chukha Power Project (1986–87) the contribution from the power sector was negligible. During the period from 1985 to 1995, Bhutan's economy experienced a growth rate of 6.8% per annum almost doubling the real GDP from Nu 1,519.8 million to Nu 2,946 million. This was mainly due to the commissioning of the Chukha Power Project, which gave rise to other allied activities. During that period the agricultural contribution to the GDP decreased to 38%. Table 2.2 shows the change that occurred in the sector-wise share of the GDP in the period from 1985 to 1995.

Table 2.2: Sector-wise share of GDP in 1985 and 1995 (1980 prices)*

Sectors	1985		1995		Average growth (%)
	Product (million Nu)	%	Product (million Nu)	%	
Agriculture	834	54.9	1119	38.0	2.9
Mining/quarrying	13	0.8	38	1.3	11.6
Manufacturing	75	4.9	268	9.1	13.5
Electricity	6	0.4	245	8.3	48.2
Construction	169	11.1	317	10.8	6.5
Trade and other activities	132	8.7	178	6.0	3.0
Transport and communication	79	5.2	242	8.2	11.8
Financial services	110	7.2	281	9.5	9.8
Community and social services	126	8.2	322	10.9	9.8
Less imputed bank service changes	–25	–1.6	–63	–2.1	
Total GDP	1520	100	2946	100	

*Source: Eighth Five-year Plan 1997–2002 (Ministry of Planning 1997)

2.8 Natural Resources

Flora and fauna

Bhutan has an exceptionally diverse range of flora due to a wide range in altitude, climatic conditions, and 72% of the country being covered by forest. Bhutan's rich flora includes 50 species of rhododendron and over 300 species of medicinal plants. About 60% of the endemic species of the eastern Himalayan region can be found in Bhutan and as a result it has been declared one of the ten global 'hot-spots' for conservation of biological diversity.

Since Bhutan's flora have remained undisturbed a number of rare animals can be found in the country. Over 165 species of animals have been reported which include the golden langur, takin, blue sheep, snow leopard, red panda, Himalayan black bear, wild pig, and musk deer. These are found widely distributed within the country. The rare black-necked crane can be seen in Phobjikha Valley in Wangdue Dzongkhag and in Bomdiling in Yangtse.

Mineral resources

Most of the mineral deposits are extracted in the southern foothills. This is basically because of easy access compared to the northern region, which is very rugged. The minerals that are being exploited are dolomite, limestone, gypsum, marble, coal, quartzite, and talc.

In 1980 there were only 8 mines operating in the country. In 1996 the number of mining leases had risen to 33 with 29 mines in actual operation. There are at present eight mineral-based industries, which are fully dependent on indigenous raw materials. In 1980 the revenue generation from the mines was only Nu 2.1 million. In the 1995–1996 fiscal year the revenue figure was Nu. 32 million.

Hydropower resources

Most of the rivers are fed by glaciers and glacial lakes located at the source of these rivers. The altitude difference provides huge scope for hydropower development (Figure 2.4). The Power Master Plan estimated a theoretical hydropower potential of 20,000 MW from the rivers in the country (Ministry of Planning 1997).

The Department of Power of the Ministry of Trade and Industry is responsible for the supply of power in the Kingdom. It draws most of its power from the Chukha Project Authority. The Department of Power also operates some isolated systems (small/micro hydro and diesel generators) in central and eastern parts of the country. The power in the border towns of Geylephug and Samdrup Jongkhar is supplied from India. At present the installed hydropower capacity of Bhutan is 344 MW in 23 hydropower plants. Within the eighth five year plan period (1997–2002) an additional 105.8 MW from two new hydropower plants is expected (Ministry of Planning 1997).

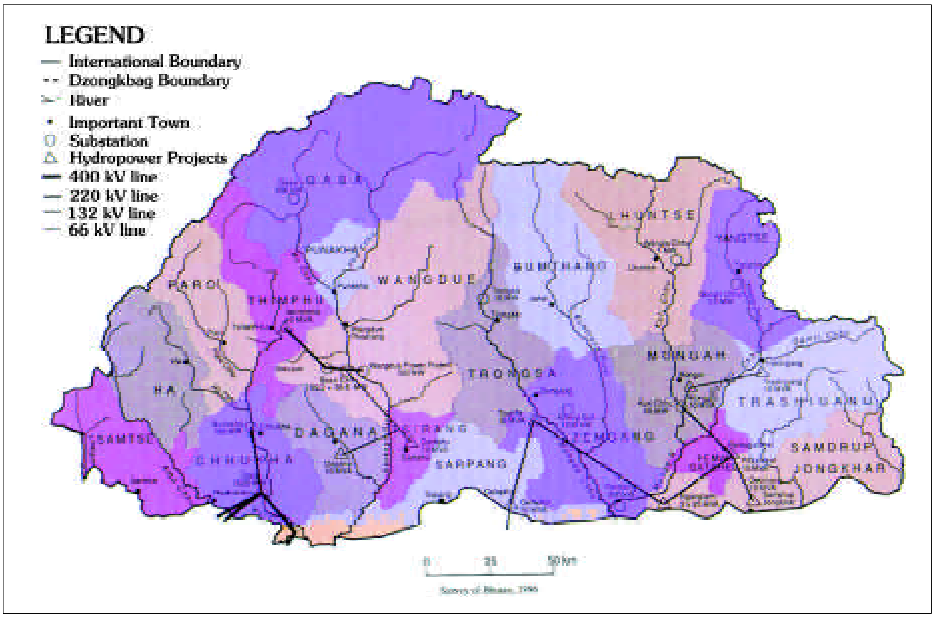


Figure 2.4: Map showing existing hydropower plants and transmission grid of Bhutan

2.9 Population

Bhutan is one of the least populated countries in South Asia. Its population is estimated to be 600,000. The population growth rate is estimated at 3.1%, the fertility rate is 5.6 (Ministry of Planning 1997).

Bhutan has achieved universal coverage of health services. Health coverage has increased from 50% in 1985 to over 90% in 1996. Life expectancy has increased from 48 years in 1985 to 66 years in 1994 and infant mortality rate has decreased from 142 per 1,000 in 1985 to 70.7 per 1,000 in 1994.

Enrollment in education and the literacy rate have shown a dramatic increase. In 1985 there were 183 schools and institutes with 52,835 students. Now there are 301 schools and institutes with 85,000 students. Total enrolment is over 72% and the literacy rate has increased from 23% in 1980 to 54% in 1996.

All the district headquarters have digital telephone and facsimile services. There are 6,074 telephones and 103 post offices in the country. Various parts of the country are connected by 3,284 km of road.

2.10 Glaciers

A glacier is a huge flowing ice mass. The flow is an essential property in defining a glacier. Usually a glacier develops under conditions of low temperature caused by the cold climate, which in itself is not sufficient to create a glacier. There are regions in which the amount of the total depositing mass of snow exceeds the total mass of snow melting during a year in both the polar and high mountain regions. A stretch of such an area is defined as an accumulation area. Thus, snow layers are piled up year after year in the accumulation area because of the fact that the annual net mass balance is positive. As a result of the overburden pressure due to their own weight, compression occurs in the deeper snow layers. As a consequence, the density of the snow layers increases whereby snow finally changes to ice below a certain depth. At the critical density of approximately 0.83 g cm^{-3}, snow becomes impermeable to air. The impermeable snow is called ice. Its density ranges from 0.83 to a pure ice density of 0.917 g cm^{-3}. Snow has a density range from 0.01 g cm^{-3} for fresh snow layers just after snowfall to ice at a density of 0.83 g cm^{-3}. Perennial snow with high density is called firn. When the thickness of ice exceeds a certain critical depth, the ice mass starts to flow down along the slope by a plastic deformation and slides along the ground driven by its own weight. The lower the altitude, the warmer the climate. Below a critical altitude, the annual mass of deposited snow melts completely. Snow disappears during the hot season and may not accumulate year after year. Such an area in terms of negative annual mass balance is defined as an ablation area. A glacier is divided into two such areas, the accumulation area in the upper part of the glacier and the ablation area in the lower part. The boundary line between them is defined as the **equilibrium line** where the deposited snow mass is equal to the melting mass in a year. Ice mass in the accumulation area flows down into the ablation area and melts away. Such a dynamic mass circulation system is defined as a glacier.

A glacier sometimes changes in size and shape due to the influence of climatic change. A glacier advances when the climate changes to a cool summer and a heavy snowfall in winter and the monsoon season. As the glacier advances, it expands and the terminus shifts down to a lower altitude. On the contrary, a glacier retreats when the climate changes to a warm summer and less snowfall. As the glacier retreats, it shrinks and the terminus climbs up to a higher altitude. Thus, climatic change results in a glacier shifting to another equilibrium size and shape.

Among the basins and sub-basins of the Bhutan Himalayas, Amo Chu and Nyere Ama Chu Basins as well as Ha Chu and Dang Chu Sub-basins have no glaciers. The Pho Chu Sub-basin has the highest number of glaciers and the Thim Chu Sub-basin the lowest. The northern basin, where the drainage originates in Bhutan and flows towards Tibet (China), has only 59 glaciers but the area occupied by the glaciers in this basin is largest. Altogether there are 677 glaciers with an area of around 1,317 sq.km (Figure 2.5). The estimated ice reserve is 127 km^3.

2.11 Glacial Lakes

The study of glacial lakes is very important for the planning and implementation of any water resources' development project. Past records show that glacial lakes have produced devastating floods and damage to major constructions and infrastructure. Prior to the present study, there has been no inventory of glacial lakes for the country. The present study on glacial lakes has been carried out considering all the lakes at elevations higher than 3,500 masl as glacial lakes. Some of the lakes are isolated and far behind the ice mass, which may or may not be of glacial origin. Altogether there are 2,674 glacial lakes covering an area of about 107 sq.km. The Pho Chu, Mangde Chu and Chamkhar Chu Sub-basins consist of more than 500 glacial lakes each. The distribution of glaciers and glacial lakes is shown in Figure 2.5.

2.12 Glacial Lake Outburst Flood Events

In Bhutan three glacial lake outburst flood (GLOF) events have been reported over the past few decades. Of these, the 1994 GLOF event that occurred from Lugge Tsho (eastern Lunana area) has written records of damage.

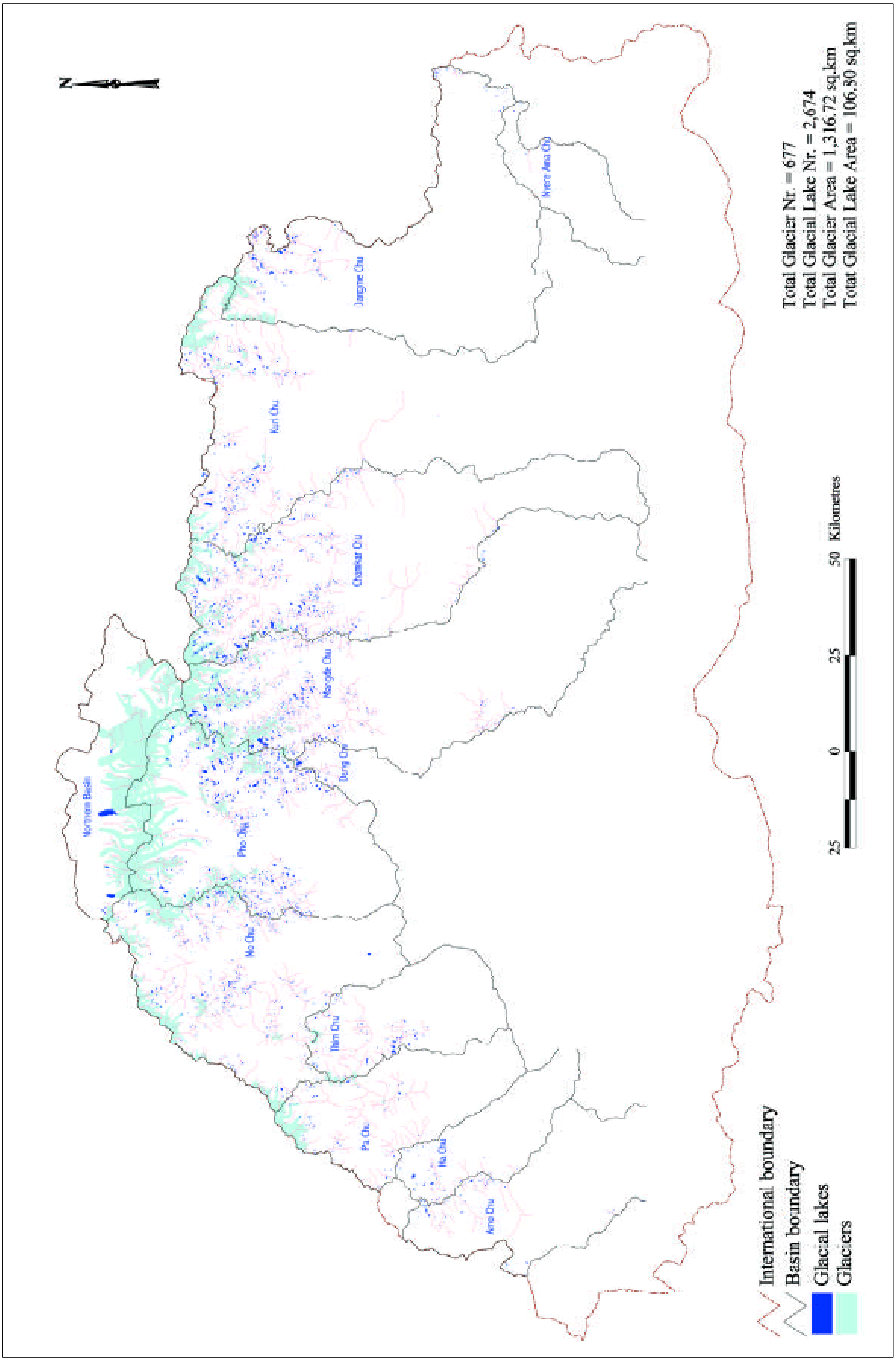


Figure 2. 5: Distribution of glaciers and glacial lakes of Bhutan

Chapter 3
Hydro-Meteorology

3.1 General Characteristics

There are six main river basins mostly flowing from north to south in Bhutan. The river basins listed from west to east are as follow:

- Amo Chu (Torsa) Basin,
- Wang Chu Basin,
- Puna Tshang Chu (Sankosh River) Basin,
- Manas River Basin,
- Nyere Ama Chu Basin, and
- Northern Basin, comprising rivers flowing from Bhutan towards Tibet (China).

General descriptions of these river basins are given below.

The Amo Chu basin

The Amo Chu or Torsa River originates in Tibet with three main tributaries, the Tangka Chu, the Khangphu Chu, and the Tromo Chu, all flowing south. The main branch of the Tromo Chu starts from the west of Phari Dzong and flows south to join the Bhutan–Tibet border at Trakarpo. This tributary then flows roughly along the border for about 0.5 km (aerial distance). It then joins with the Amo Chu at Yatung, flows eastwards and enters Bhutan 9 km southeast of Yatung. It drains about 16,000 sq.km of Tibetan territory before entering Bhutan, where it flows southeast for about 170 km and then enters the Indian flood plains of West Bengal near Phuntsholing (a border town of Bhutan). Its catchment area is about 19,650 sq.km.

This river basin is not associated with any glaciers in Bhutan. A total of 71 lakes has been identified in this river basin and the cumulative area occupied by these lakes is 1.8 sq.km (1960s map of Amo Chu area).

The Wang Chu basin

The Wang Chu Basin lies entirely within Bhutan and consists of three rivers:

- Thim Chu,
- Pa Chu, and
- Ha Chu.

The Thim Chu River flows south for about 70 km and then it becomes the Wang Chu. The Ha Chu (the western tributary) originates from south of the Masang Kyugdu Range. The Ha Chu flows southeast for about 70 km, where it joins with the Wang Chu. Its catchment area is 323 sq.km. The Pa Chu has tributaries, namely, the Chomolhari Chu, the Halun Chu, and the Thangochang Chu. The Halun Chu and the Thangochang Chu (Pa Chu Main) originate from the Chomolhari and Kang Phu Glaciers respectively. The Pa Chu flows southeast for about 80 km and joins with the Wang Chu. Its catchment area is 1,049 sq.km. The Wang Chu exits from Bhutan at Lamchey between Phuntsholing and Kalikhola. As it enters into India, it is known as Raidak.

In the Wang Chu Basin there are 36 glaciers and 217 lakes. Most of the lakes are small in size and only a few are associated with glaciers. At present these lakes do not pose any danger of glacial lake outburst floods (GLOFs).

The Puna Tshang Chu basin (Sankosh)

The Puna Tshang Chu Basin has been formed by the joining of the Mo Chu and Pho Chu Rivers. The Mo Chu originates from the northeastern slope of Chomolhari and the Pho Chu from the western slope of Kula Gangri (Lunana area). The Puna Tshang Chu is the longest river (250 km) in Bhutan. The Mo Chu Basin has boundaries of the Kangphu–Nilela–Nigilela Range in the west and the Tsenda Gang–Ganglakarchung Range in the east. The Mo Chu has two main branches, one is the western branch and the other is the eastern branch. The western branch consists of the Lingshi Chu and the Chhijethang Chu originating from Takaphu and Gangchhen Ta Glaciers respectively. The eastern branch comprises the Mo Chu Kangu, the Zamtognangi Chu, the Taksikhai Chu, and the Rodhophugi Chu. The Lingshi Chu flows northeastward and joins the Chhijethang Chu flowing south to become the Gasa Chu. The Gasa Chu then flows eastwards to join the Mo Chu near Gasa. The Mo Chu Kangu has two major tributaries, the Sinchhe Chu and the Sagchhagi Chu with its source mainly from Gangchhen Ta Glacier. Two tributaries of the Zamtognangi Chu, are the Kamgigi Chu and the Sachhuphugi originating from Masagang and Khebechen Glaciers respectively. The Taksikhai Chu flows from Phungdoh Glacier and glaciers around Droma La. The Roduphugi Chu flows from Roduphu Glacier. The Puna Tsang Chu enters India near Kalikhola and is then known as the Sankosh.

The Mo Chu Basin comprises 118 glaciers and 380 lakes. The largest glacier is Mo_gr 96 covering an area of 13.22 sq.km. The total area covered by the glaciers in the basin is 169 sq.km with an estimated ice reserve of 11.34 km^3.

The Pho Chu, the eastern branch of the Puna Tsang Chu, originates from the numerous glaciers in the Lunana Valley. The Pho Chu has two branches, a western and an eastern branch. Sources of the western branch are from the Tarina Glaciers and sources of the eastern branch are from the Lunana Glaciers. The Pho Chu flows through deep gorges and rugged terrain and joins the Mo Chu immediately south of Punakha Dzong to form Puna Tsang Chu.

A total of 154 glaciers and 549 lakes exists in the Pho Chu Basin. Among them 71 glaciers feed the western branch of the Pho Chu. The largest is the Wachey Glacier (Pho_gr 71), with a length of 20.12 km and covering an area of 38.52 sq.km. The largest glacier in the Pho Chu Basin, Tshoju Glacier (Pho_gr 79), is located in the eastern branch of the Pho Chu. The total area covered by the glaciers in the basin is 334.36 sq.km with estimated ice reserve of 32.27 km^3.

The Manas River basin

The Manas River is formed by the joining of two rivers of similar catchment area, the Mangde Chu and the Dangme Chu. The Mangde Chu is the westernmost branch of the Manas River—it starts from the Gangkar Punsum Mountain and has a length of 140 km. In the northern region the Mangde Chu has three major tributaries, out of which two have their origins from glaciers and snow covered terrain. The eastern branch of the Mangde Chu originates from a large valley glacier (Mangd_gr 117) immediately south of Kang Ri Summit (7,239 masl). The Mangde Chu western branch emerges from the glaciers south of Yaksagang and southwest of Kang Ri Summit. Further south of the Mangde Chu western branch is the Tampe Chu, another tributary of the Mangde Chu, draining southeast. The Mangde Chu flows south below the spur of Trongsa Dzong and is joined by the Chamkhar Chu a few kilometres north of Panbang in Zemgang Dzongkhag.

The Mangde Chu Basin has 140 glaciers and 521 lakes. The glaciers in the region occupy an area of 146.56 sq.km with an estimated ice reserve of 11.9 km^3.

The Chamkhar Chu emerges from the glaciated terrain south of the water divide separating Tibet from Bhutan's northern territory. It has one western branch and two eastern branches. The western branch has its source from the glaciers of the Gangkar Punsum region and the eastern branches have their sources from the glaciers south of the Monla Karchung La Range.

At the source of the Chamkhar Chu western branch, several glaciers exist. The largest glacier is a valley glacier (cham_gr 25) lying east of Kang Ri Summit (7,239 masl) at an elevation of 4,582 masl. This glacier occupies an area of 26.71 sq.km and is 8.9 km long. The Chamkhar Chu eastern branch also has many glaciers at its source, the largest again is a valley glacier—Cham_gr 71 (Chubda Glacier). Within this glacier there are several supraglacial lakes which were observed during an expedition in August 1999 (Karma 1999).

The Chamkhar Chu flows southwards almost parallel to the Mangde Chu through the Jakar Valley. It joins the Mangde Chu near Kalamti and flows as the Mangde Chu to join the Dangme Chu in the southwest of Panbang to form the Manas River.

At the source of the Chamkhar Chu, 90 glaciers have been identified, with an estimated ice reserve of 8 km^3. In the Chamkhar Chu Basin, 557 lakes exist, 306 of them are valley lakes. The largest lake is a supraglacial lake (Cham_gl 383) and is 2.6 km long.

The Dangme Chu consists of the Kuri Chu and the Gongri Chu. The Kuri Chu headwater in Tibet consists of a northern and a southern branch. The Kuri Chu flows eastwards and enters Bhutan 8 km (aerial distance) southwest of Bod La.

Within Bhutan the Kuri Chu has two main tributaries, the Bahilung Chu and the Khoma Chu. The Kuri Chu flows south through deep narrow gorges to join the Dangme Chu south of Tsegpa in Mongar. It then joins with the Mangde Chu to form the Manas River.

At the source of the Kuri Chu within Bhutan there are 51 glaciers having a cumulative surface area of 87.62 km^3. In this sub-basin 179 lakes were identified, the largest lake has a surface area of only 0.9 sq.km.

The Gong Ri, the other main tributary of the Dangme Chu also has its source in Tibet, northeast of the Karchung La-Phomeje La water divide. The Gong Ri has a western and an eastern branch in Tibet. These two branches merge near Phasinadang, where the river enters Bhutan. In Bhutan the two main tributaries of the Gong Ri are the Kholong Chu flowing south through Trashi Yangtse and the Gam Ri flowing west through the Sakteng Valley. The Kholong Chu joins the Gong Ri at Duksum and the Gam Ri further downstream to form the Dangme Chu. The Mangde Chu and the Dangme Chu merge to form the Manas River which flows out into the Indian plain near the Manas forest check post.

The Nyere Ama Chu basin

The Nyere Ama Chu is the easternmost river basin in Bhutan. This river has no glaciers associated with it. In this basin there are only 9 lakes. All these glacial lakes are small. The largest among them is only 185m long.

The Northern basin

The rivers of this basin originate from the watershed of Bhutan and flow north towards Tibetan territory. Details of the rivers of this basin are not available.

3.2 Hydro-meteorological Observation

Meteorological observation

In Bhutan there are more than 80 meteorological stations. Most of them are located in the south and central parts of the country.

- Climate stations (more than 60 in number) are spread all over the country. They measure daily rainfall, daily maximum and minimum temperatures, and relative humidity.
- Agro-meteorological stations (12 in selected sites) measure rainfall, rainfall duration and intensity, maximum and minimum temperatures, relative humidity, wind speed and direction, hours of sunshine, cloud cover, soil temperatures at 5, 15, and 30 cm depths, daily evaporation, and water temperature.
- Special stations (four in number) are installed along the mountain pass along the East–West Highway. These stations measure sunshine and rainfall intensity.
- Snow gauging stations (four in number) were established in 1995 to measure snowfall depth at four mountain passes.

The collected data are compiled in a 'Lotus' spreadsheet. Analyses as well as data validation have not yet been done.

Hydrological observations

The hydrological stations in Bhutan are established and managed by the Department of Power. The Central Water Commission (India) also has established hydrological stations under their control. The stations are mainly located at or near roads or footbridges over the main rivers from where discharge measurements are carried out by the float method.

The mean annual flows of different rivers calculated from available yearly mean data are given in Table 3.1.

Table 3.1: The mean annual flows of the major river basins of Bhutan

Name of River	Location of station		Altitude (masl)	Catchment area (km^2)	Mean annual discharge (m^3/sec)
	Latitude	Longitude			
Gongri Chu at Uzorong	27° 15' 40" N	91° 25' 03" E	570	8,569	256
Kuri Chu at Kurizampa	27° 16' 27" N	91° 11' 47" E	540	8,600	293
Chamkhar Chu at Kurijey	27° 35' 13" N	90° 44' 13" E	2,600	1,350	53.7
Mangde Chu at Tingtibi	27° 08' 44" N	90° 41' 36" E	565	3,200	150
-do- at Bji	27° 31' 31" N	90° 27' 30" E	1,860	1,390	65.7
Sankosh at Dubani	27° 00' 30" N	90° 04' 27" E	263	8,050	387
Pho Chu and Mo Chu at Wangdi	27° 27' 45" N	89° 54' 11" E	1,190	5,640	291
Mo Chu at Yebsa	27° 37' 59" N	89° 49' 03" E	1,230	2,320	116
Ha Chu at Damchuzam	27 °21' 41" N	89 ° 18' 14" E	2,690	336	10.6
Wang Chu at Tamchhu			1,990	2,520	65.7

Chapter 4
Materials and Methodology

The basic materials required for the compilation of an inventory of glaciers and glacial lakes are large-scale topographic maps and aerial photographs. Remote sensing data like those from the Land Observation Satellite (LANDSAT) Thematic Mapper (TM), Indian Remote Sensing satellite series 1D (IRS1D) Linear Imaging and Self Scanning Sensor (LISS3), and the Système Probatoire Pour l'Observation de la Terre (SPOT) multispectral (XS) for different dates are also used to study the activity of glaciers and for the identification of potentially dangerous glacial lakes. The combination of digital satellite data and the digital elevation model (DEM) of the area is also used for better and more accurate results for the inventory of glaciers and glacial lakes.

4.1 Topographic Maps

Glaciers and glacial lakes are mostly concentrated in the northern part of Bhutan. The spatial distribution of glaciers and glacial lakes was identified from topographic maps and verified by satellite images for the activity of the glaciers and glacial lakes. The topographic map series of the 1960s on a scale of 1:50,000 was based on vertical aerial photographs of the 1950s and field verification in the 1960s. The Survey of India published these topographic maps of Bhutan.

The coordinate system parameters for the maps of the Bhutan are as follows:

- Projection: Polyconic
- Ellipsoid: Everest (India 1956)
- Datum: Indian (India, Nepal)
- False easting: 2,743,196.4
- False northing: 914,398.80
- Central meridian: 90° 0' 00" E
- Central parallel: 26° 0' 00" N
- Scale factor: 0.998786

Altogether 78 topographic map sheets cover the whole of Bhutan (Figure 4.1). The maps required for the study of the glaciers and glacial lakes fall within 42 sheets (Table 4.1). Not all the original print copies were available for the present work. The topographic maps of the major part of the glacier and glacial lake area are not available; only photocopied map sheets were available for the northern part covering the glaciated area of the country. For some map sheets copies are not even available. For the areas without topographic map sheets and where the original topographic map sheets were not available, false colour composite satellite images on a scale of 1:50,000 of different dates (1993–99) were used for the present study.

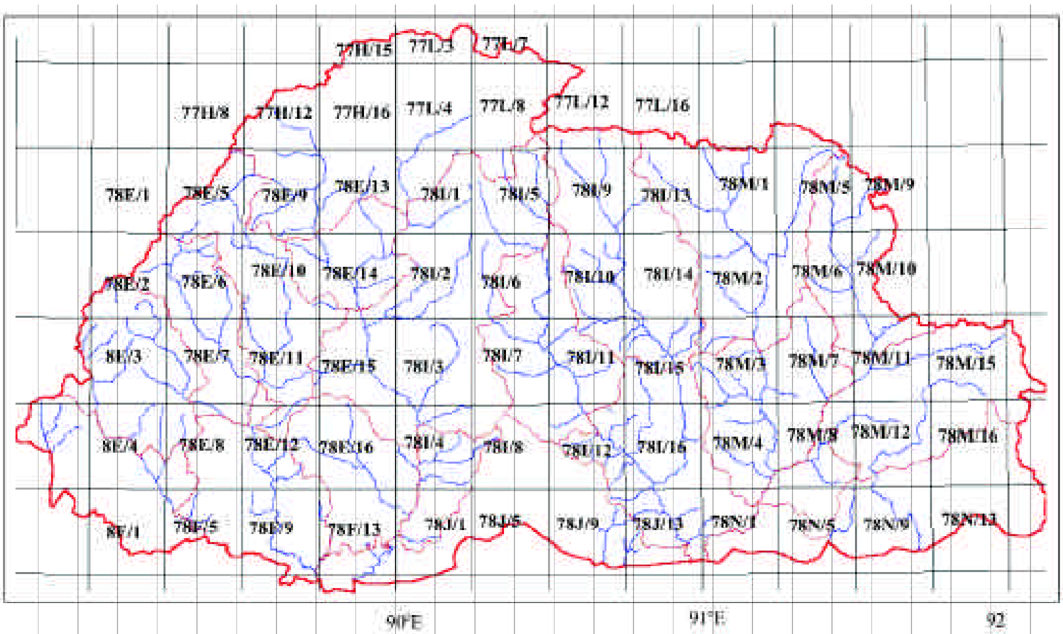


Figure 4.1: Index map for the 1:50,000 scale topographic maps of the Kingdom of Bhutan

Table 4.1: List of topographic maps of Bhutan

Grid number	Sheet number (total 78 sheets)*	Remarks
78E	**2, 3, 4, 5, 6**, 7, 8, **9, 10**, 11, 12, **13**, 14, 15, and 16	Original map sheets
78I	**1, 2**, 3, 4, **5, 6, 7**, 8, **9, 10, 11**, 12, **14, 15,** and **16**	
78M	**2, 3**, 4, **5, 6**, 7, 8, 11, 12, 15, and16	
78F	1, 5, and 13	
78J	1, 5, 9, and 13	
78N	1, 5, and 13	
83A	**3**	
83B	1	
77H	**16**	Photocopied map sheets
77L	**4, 8, 12,** and **16**	
77P	**8**	
78M	**1, 9,** and 10	
78A	16	
78N	9	
77H	**8, 12,** and **15**	Unavailable map sheets
77L	**3,7,** and **11**	
77P	**4**	
78E	**1**	
78I	**13**	
78A	14 and **15**	
78B	13	
78F	9	
83A	**3**	

*Sheet numbers in bold are the topographic maps required for the study.

4.2 Aerial Photographs

Aerial photographs of Bhutan were not available for the present study.

4.3 Satellite Images

Various types of satellite image suitable for the present study are available from different data providers. The LANDSAT TM images covering the whole of Bhutan are shown in Figure 4.2 and Table 4.2. LANDSAT multi-spectral scanning (MSS) data in digital format from 1993, 1994, 1998, and 1999 were acquired for the present study. The LANDSAT TM satellite image scenes used are two full scenes of December 1993, five full scenes of December 1994, one full scene of November 1998, one full scene of December 1998, and one full scene of January 1999 (Table 4.3).

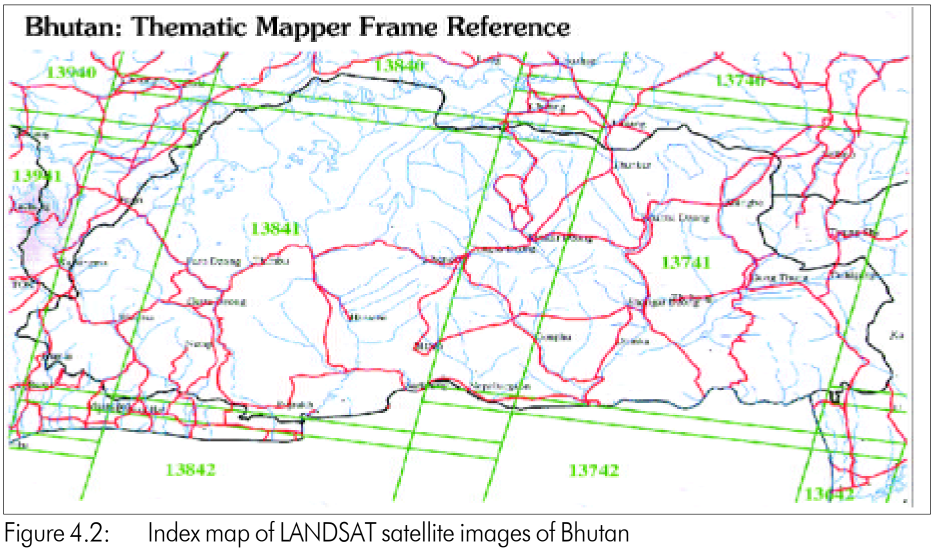


Figure 4.2: Index map of LANDSAT satellite images of Bhutan

Table 4.2: Index of LANDSAT TM images for Bhutan			
S. No	Path	Row	If not full scene
1	136	041	Q3
1	137	041	full scene
2	138	041	full scene
3	139	041	Q4
4	138	040	Q3 and Q4

Quadrants of the scenes	
Q1	Q2
Q3	Q4

Besides LANDSAT TM images, the satellite images of IRS1D LISS3 and SPOT as given below were also acquired.

Table 4.3: Acquired LANDSAT TM images used for the study				
S.Nr.	Path	Row	If not full scene	Year
1	136	041	Full scene	26 December 1993
2	138	040	Full scene	24 December 1993
3	137	040	Full scene	4 December 1994
4	137	041	Full scene	4 December 1994
5	138	040	Full scene	27 December 1994
6	138	041	Full scene	27 December 1994
7	139	040	Full scene	2 December 1994
8	138	041	Full scene	4 November 1998
9	139	041	Full scene	29 December 1998
10	137	041	Full scene	16 January 1999

IRS1D LISS3 images

Due to time constraints and relative costs in acquiring cloud free data, instead of LANDSAT TM, IRS1D LISS3 images of 1999–2000 with least cloud cover were acquired. Three scenes cover all the northern parts and the glaciated area of Bhutan (Table 4.4). The images acquired are of November and December 1999. To avoid the unnecessary area the scenes are shifted 30% up along the track (Table 4.4). The scene of 6 January 1999 covers 70% of 108/052 and 30% of 108/051. The scene of 16 December covers 70% of 110/052 and 30% of 110/051, and the scene of 19 December 1999 covers 70% of 109/052 and 30% of 109/051.

Table 4.4: IRS1D LISS3 satellite images of Bhutan acquired for the study				
S.Nr.	Path	Row	Date	Shift along track
1	108	052	6 Jan 1999	30% shift up to row 051
3	109	052	19 Dec 1999	30% shift up to row 051
5	110	052	16 Dec 1999	30% shift up to row 051

Table 4.5: Index of SPOT images of Bhutan required for the study		
S.Nr.	Path	Rows
1	K232	J295
2	K233	J295
3	K234	J295
4	K235	J295
5	K236	J295
6	K237	J295
7	K233	J294
8	K232	J294
9	K234	J294
10	K235	J294
11	K236	J294
12	K237	J294

SPOT images

Twenty scenes of SPOT images cover the whole of Bhutan. Out of these, only 12 are of the glaciated region. These are shown in Table 4.5.

The following high resolution images were also used for the study:

- One scene of SPOT3 high resolution visibility (HRV)1 panchromatic (PAN) of 25 December 1994 of Path/Row: 234/294
- One scene of IRS1D PAN of 3 January 1999 of Path/Row: 108/51

4.4 Inventory Method

The methodology for the mapping and inventory of the glaciers is based on instructions for compilation and assemblage of data for the World Glacier Inventory (WGI), developed by the Temporary Technical Secretary (TTS) at the Swiss Federal Institute of Technology, Zurich (Muller et al. 1977) and the methodology for the inventory of glacial lakes is based on that developed by the Lanzhou Institute of Glaciology and Geocryology, the Water and Energy Commission Secretariat, and the Nepal Electricity Authority (LIGG/WECS/NEA 1988). The inventory of glaciers and glacial lakes has been systematically carried out for the drainage basins on the basis of topographic maps and satellite images. Topographic maps on a scale of 1:50,000 published by the Survey of India during the period from the 1950s to the 1970s are used. The following sections describe how the compilation of the inventories for both the glaciers and glacial lakes have been carried out.

Inventory of glaciers

The glacier margins on each map are delineated and compared with satellite images, and the exact boundaries between glaciers and seasonal snow cover are determined. The coding system is based on the subordinate relation and direction of river progression according to the World Glacier Inventory. The description of attributes for the inventory of glaciers are as given below

Numbering of glaciers

The lettering and numbering start from the mouth of the major stream and proceed clockwise round the basin. The inventory of glaciers is carried out throughout the river basins of Bhutan. For convenience, the major river systems are further divided into sub-basins.

Registration of snow and ice masses

All perennial snow and ice masses are registered in the inventory. Measurements of glacier dimensions are made with respect to the carefully delineated drainage area for each 'ice stream'. Tributaries are included in main streams when they are not differentiated from one another. If no flow takes place between separate parts of a continuous ice mass, they are treated as separate units.

Delineation of visible ice, firn, and snow from rock and debris surfaces for an individual glacier does affect various inventory measurements. Marginal and terminal moraines are also included if they contain ice. The 'inactive' ice apron, which is frequently found above the head of the valley glacier, is regarded as part of the valley glacier. Perennial snow patches of large enough size are also included in the inventory. Rock glaciers are included if there is evidence of large ice content.

Snow line

In the present study, the snow line specially refers to the **firn line** of a glacier, not the equilibrium line. The elevation of the firn line of most glaciers was not measured directly but estimated by indirect methods. For the regular valley and cirque glaciers from topographical maps, Hoss's method (i.e. studying changes in the shape of the contour lines from convex in the **ablation area** to concave in the **accumulation area**) was used to assess the snow line.

Accuracy rating table

The accuracy rating table proposed by Muller et al. (1977) on the basis of actual measurements (Table 4.6) is used in the present study. For the snow line an error range of 50–100m in altitude is entered as an **accuracy rating** of '3'. In the glacier inventory, different methods or a combination of methods are usually chosen for comparison with aerial photographs in order to assess the elevation of the firn line for different forms of glacier.

Table 4.6: Accuracy rating adopted from Muller et al. (1977)

Index	Area/length (%)	Altitude (m)	Depth (%)
1	0–5	0–25	0–5
2	5–10	25–50	5–10
3	10–15	50–100	10–20
4	15–25	100–200	20–30
5	>25	>200	>30

Mean glacier thickness and ice reserves

There are no measurements of glacial ice thickness for the Bhutan Himalayas. Measurements of glacial ice thickness in the Tianshan Mountains, China, show that the glacial thickness increases with the increase of its area (LIGG/WECS/NEA 1988). The relationship between ice thickness (*H*) and glacial area (*F*) was obtained there as

$$H = -11.32 + 53.21\, F^{0.3}$$

This formula has been used to estimate the mean ice thickness in the glacier inventory of the Arun and Bhote-Sunkoshi Basins of Nepal. The same method is also used here to find the ice thickness. The ice reserves are estimated by mean ice thickness multiplied by the glacial area.

Muller et al. (1977) roughly estimated the ice thickness values for Khumbu Valley in Nepal using the relationship between glacier type, form, and area (see Table 4.7). This method was used by WECS to calculate the thickness values for Rolwaling Valley in Nepal. The same method can also be used for the glaciers of the Bhutan Himalaya.

According to Muller et al. (1977), mean depth can be estimated with the appropriate model developed for each area by local investigators. For example, the following model was used for the Swiss Alps

$$\bar{h} = a + b\sqrt{F}$$

where $\bar{h}$ is the mean depth, F is the total surface area, and a and b are arbitrary parameters that are empirically determined.

Table 4.7: Relationship between glacier type, form, area, and depth given by Muller et al. (1977)

Glacier type	Form	Area (km^2)	Depth (m)
Valley glacier	Compound basin	1–10	50
		10–20	70
		20–50	100
		50–100	120
	Compound basins	1–5	30
		5–10	60
		10–20	80
		20–50	120
		50–100	120
	Simple basins	1–5	40
		5–10	75
		10–20	100
Mountain glacier	Cirque	0–1	20
		1–2	30
		2–5	50
		5–10	90
		10–20	120

Measured depth

The measured depth is shown on the data sheet only if the depths of large parts of the glacier bed are known from literature and field measurements.

Area of the glacier

The area of the glacier is divided into accumulation area and ablation area (the area below the firn line). The area is given in square kilometres. The delineated glacier area is digitised in the integrated land and water information systems' (ILWIS) format and the database is used to calculate the total area.

Length of the glacier

The length of the glacier is divided into three columns: total length, length of ablation and the mean length. The total (maximum) length refers to the longest distance of the glacier along the centre line. The mean value of maximum lengths of glacier tributaries (or firn basins) is the mean length.

Mean width

The mean width is calculated by dividing the total area (km^2) by the mean length (km).

Orientation of the glacier

The orientation of accumulation and ablation areas is represented in eight cardinal directions (N, NE, E, SE, S, SW, W, and NW). Some of the glaciers are capping just in the form of an apron on the peak, which is inert and sloping in all directions, is represented as 'open'. The orientations of both the areas (accumulation and ablation) are the same for most of the glaciers.

Elevation of the glacier

Glacier elevation is divided into **highest elevation** (the highest elevation of the crown of the glacier), **mean elevation** (the arithmetic mean value of the highest glacier elevation and the lowest glacier elevation), and **lowest elevation** (elevation of the glacier tongue).

Morphological classification

The morphological matrix-type classification and description is used in the study. It was proposed by Muller et al. (1977) for the TTS to the WGI. Each glacier is coded as a six-digit number, the six digits being the vertical columns of Table 4.8. The individual numbers for each digit (horizontal row numbers) must be read on the left-hand side. This scheme is a simple key for the classification of all types of glaciers all over the world.

Each glacier can be written as a six-digit number following Table 4.8. For example, '520110' represents '5' for a valley glacier in the primary classification, '2' for compound basins in Digit 2, '0' for normal or miscellaneous in frontal characteristics in Digit 3, '1' for even or regular in longitudinal profile in Digit 4,

Table 4.8: Classification and description of glaciers

	Digit 1	Digit 2	Digit 3	Digit 4	Digit 5	Digit 6
	Primary classification	Form	Frontal characteristic	Longitudinal profile	Major source of nourishment	Activity of tongue
0	Uncertain or miscellaneous	Uncertain or miscellaneous	Normal or miscellaneous	Uncertain or miscellaneous	Uncertain or miscellaneous	Uncertain
1	Continental ice sheet	Compound basins	Piedmont	Even: regular	Snow and/or drift snow	Marked retreat
2	Ice field	Compound basin	Expanded foot	Hanging	Avalanche and/or snow	Slight retreat
3	Ice cap	Simple basins	Lobed	Cascading	Superimposed ice	Stationary
4	Outlet glacier	Cirque	Calving	Ice fall		Slight advance
5	Valley glacier	Niche	Confluent	Interrupted		Marked advance
6	Mountain glacier	Crater				Possible surge
7	Glacieret and snow field	Ice apron				Known surge
8	Ice shelf	Group				Oscillating
9	Rock glacier	Remnant				

‘1’ for snow and/or drift snow in the major source of nourishment in Digit 5, and 0 for uncertain tongue activity in Digit 6.

The details for the glacier morphological code values according to TTS are explained below.

Digit 1 Primary classification

0 **Miscellaneous**: Any not listed.
1 **Continental ice sheet:** Inundates areas of continental size.
2 **Ice field**: More or less horizontal ice mass of sheet or blanket type of a thickness not sufficient to obscure the sub-surface topography. It varies in size from features just larger than glacierets to those of continental size.
3 **Ice cap**: Dome-shaped ice mass with radial flow.
4 **Outlet glacier**: Drains an ice field or ice cap, usually of valley glacier form; the catchment area may not be clearly delineated (Figure 4.3a).
5 **Valley glacier**: Flows down a valley; the catchment area is in most cases well defined.
6 **Mountain glacier**: Any shape, sometimes similar to a valley glacier, but much smaller; frequently located in a cirque or niche.
7 **Glacieret** and **snowfield**: A glacieret is a small ice mass of indefinite shape in hollows, river beds, and on protected slopes developed from snow drifting, avalanching and/or especially heavy accumulation in certain years; usually no marked flow pattern is visible, no clear distinction from the snowfield is possible, and it exists for at least two consecutive summers.
8 **Ice shelf**: A floating ice sheet of considerable thickness attached to a coast, nourished by glacier(s), with snow accumulation on its surface or bottom freezing (Figure 4.3b).
9 **Rock glacier**: A glacier-shaped mass of angular rock either with interstitial ice, firn, and snow or covering the remnants of a glacier, moving slowly downslope. If in doubt about the ice content, the frequently present surface firn fields should be classified as ‘glacieret and snowfield’.

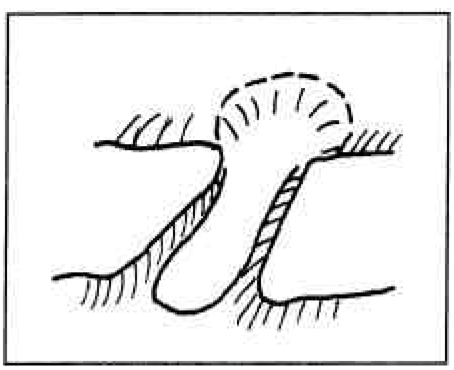


Figure 4.3a: Outlet

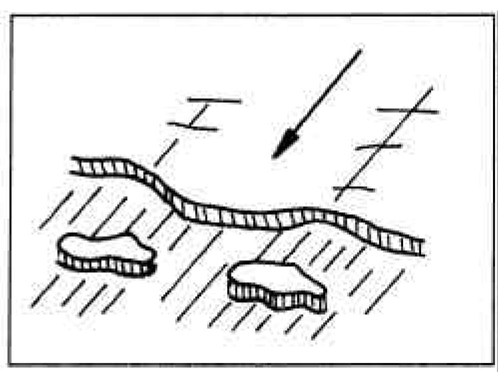


Figure 4.3b: Ice shelf

Digit 2 Form

1 **Compound basins**: Two or more tributaries of a valley glacier, coalescing (Figure 4.4a).
2 **Compound basin**: Two or more accumulation basins feeding one glacier (Figure 4.4b).
3 **Simple basin**: Single accumulation area (Figure 4.4c).
4 **Cirque**: Occupies a separate, rounded, steep-walled recess on a mountain (Figure 4.4d).
5 **Niche**: Small glacier formed in initially a V-shaped gully or depression on a mountain slope (Figure 4.4e).
6 **Crater**: Occurring in and /or on a volcanic crater.
7 **Ice apron**: An irregular, usually thin ice mass plastered along a mountain slope.
8 **Group**: A number of similar ice masses occurring in close proximity and too small to be assessed individually.
9 **Remnant**: An inactive, usually small ice mass left by a receding glacier.

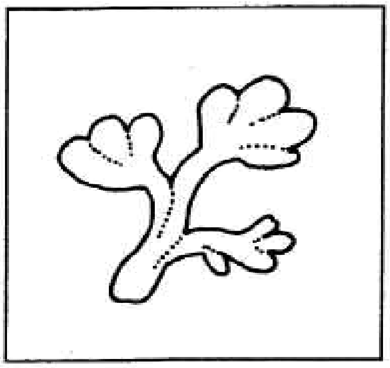


Figure 4.4a: Compound basins

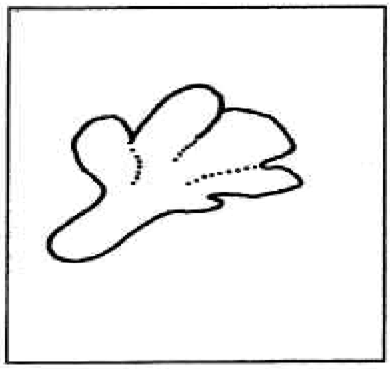


Figure 4.4b: Compound basin

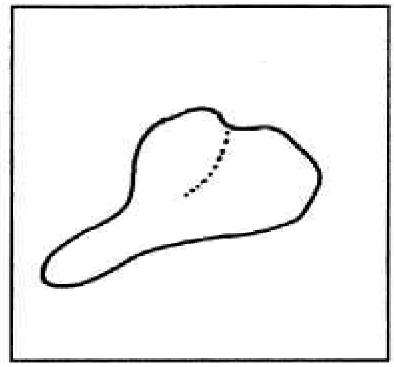


Figure 4.4c: Simple basin

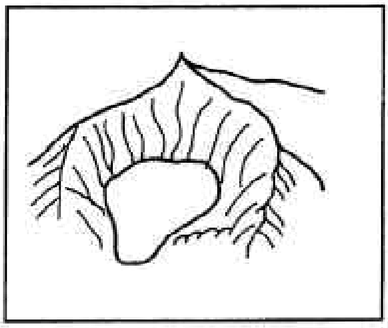


Figure 4.4d: Cirque

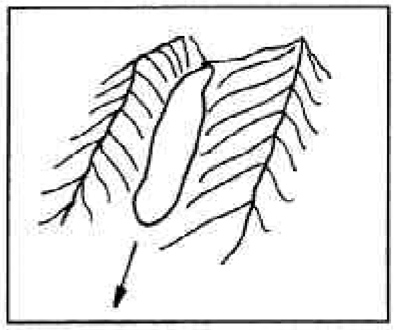


Figure 4.4e: Niche

Digit 3 Frontal characteristics

1 **Piedmont**: Ice field formed on low land with the lateral expansion of one or the coalescence of several glaciers (Figures 4.5a and b).
2 **Expanded foot**: Lobe or fan of ice formed where the lower portion of the glacier leaves the confining wall of a valley and extends on to a less restricted and more level surface. Lateral expansion markedly less than for Piedmont (Figure 4.5c).
3 **Lobed**: Tongue-like form of an ice field or ice cap (see Figure 4.5d).
4 **Calving**: Terminus of glacier sufficiently extending into sea or occasionally lake water to produce icebergs.
5 **Confluent**: Glaciers whose tongues come together and flow in parallel without coalescing (Figure 4.5e).

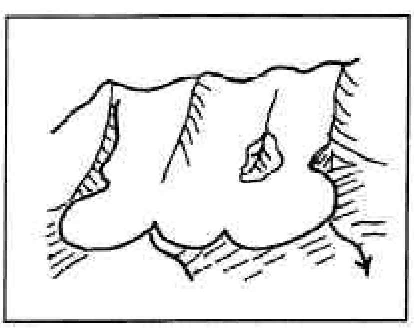


Figure 4.5a: Piedmont

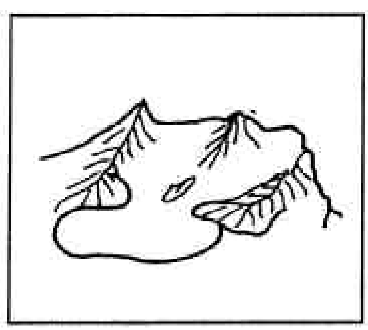


Figure 4.5b: Piedmont

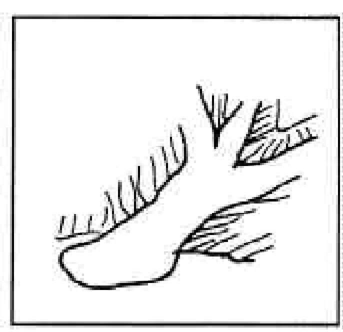


Figure 4.5c: Expanded

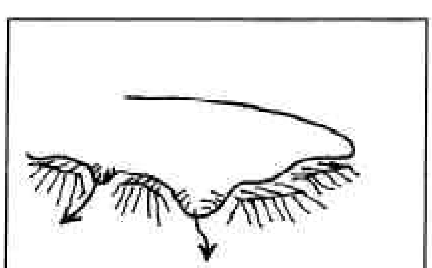


Figure 4.5d: Lobed

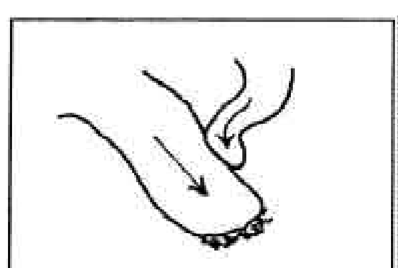


Figure 4.5e: Confluent

Digit 4 Longitudinal profile

1 **Even /regular**: Includes the regular or slightly irregular and stepped longitudinal profile.
2 **Hanging**: Perched on a steep mountain slope, or in some cases issuing from a steep hanging valley.
3 **Cascading**: Descending in a series of marked steps with some crevasses and seracs.
4 **Ice fall**: A glacier with a considerable drop in the longitudinal profile at one point causing a heavily broken surface.
5 **Interrupted**: Glacier that breaks off over a cliff and reconstitutes below.

Digit 5 Major source of nourishment

The sources of nourishment could be uncertain or miscellaneous (0), snow and/or drift snow (1), avalanche and/or snow (2), or superimposed ice (3) as indicated in Table 4.8.

Digit 6 Activity of tongue

A simple-point qualitative statement regarding advance or retreat of the glacier tongue in recent years, if made for all glaciers on Earth, would provide the most useful information. The assessment of an individual glacier (strongly or slightly advancing or retreating etc) should be made in terms of the world picture and not just that of the local area; however, it seems very difficult to establish the quantitative basis for the assessment of the tongue activity. A change of frontal position of up to 20m per year might be classed as 'slight' advance or retreat. If the frontal change takes place at a greater rate it would be called 'marked'. Very strong advances or surges might shift the glacier front by more than 500m per year. Digit 6 expresses qualitatively the annual tongue activity. If observations are not available on an annual basis then an average annual activity is given.

Moraines: Two digits to be given.
Digit 1: moraines in contact with present-day glacier.
Digit 2: moraines further downstream.

0 no moraines
1 terminal moraine
2 lateral and/or medial moraine
3 push moraine
4 combination of 1 and 2
5 combination of 1 and 3
6 combination of 2 and 3
7 combination of 1, 2, and 3
8 debris, uncertain if morainic
9 moraines, type uncertain or not listed.

Remarks: The remarks can, for instance, consist of the following information.

- Critical comments on any of the parameters listed on the data sheet (e.g. how close is the snow line to the firn line, comparison of year concerned with other years).
- Special glacier types and glacier characteristics which, because of the nature of the classification scheme, are not described in sufficient detail (e.g. 'melt structures', glacier-dammed lakes).
- Additional parameters of special interest to the basins concerned (e.g. area of altitudinal zones, inclination etc).
- It is often useful to divide the snow line into several sections (because of different exposition or nourishment). In such cases, the snow line data of each section can be recorded separately.
- Literature on the glacier concerned.
- Any other remarks

The inventory database form (see Annex I) used for compilation of the inventory of glaciers includes map/satellite codes, aerial photographs, and basin numbers, as well as the glacier parameters described above.

Inventory of glacial lakes

The attributes used for the present inventory and their details are given in the lake inventory form (Annex II). Similar lake inventories were done in the Pumqu (Arun) and Poiqu (Bhote/Sunkoshi) Basins in Tibet (China) by LIGG/WECS/NEA (1988).

The permanent snow line in the northern belt of the Himalayas is higher than 4,000 masl. All the glacial lake boundaries are demarcated in the topographic maps.

Changes in climatic conditions have had an impact on the high mountain glacial environment. Many of the big glaciers have melted rapidly and given birth to a large number of glacial lakes. Due to the rapid rate of ice and snow melt, possibly caused by global warming, the accumulation of water in these lakes has been increasing rapidly. The isolated lakes above 3,500 masl are assumed to be remnants of the glacial lakes left due to the retreat of the glaciers.

The glacial lake inventory has been systematically compiled for the drainage basins on the basis of topographic maps and satellite images.

Brief descriptions of major attributes for the lake inventory are given below.

Numbering of glacial lakes

The numbering of lakes starts from the outlet of the major stream and proceeds clockwise round the basin.

Longitude and latitude

Reference longitude and latitude are designated for the approximate centre of the glacial lake.

Area

The area of the glacial lake is determined from the digital database after digitisation of the lake from the topographic maps and satellite images.

Length

The length is measured along the long axis of the lake, and estimated to one decimal place in km units (0.1 km).

Width

The width is normally calculated by dividing the area by the length of the lake, down to one decimal place in km units (0.1 km).

Depth

The depth is measured along the axis of the cross section of the lake. On the basis of the depth along the cross section the average depth and maximum depth are estimated. The data are collected from the literature.

Orientation

The drainage direction of the glacial lake is specified as one of eight cardinal directions (N, NE, E, SE, S, SW, W, and NW). For a closed glacial lake, the orientation is specified according to the direction of its longer axis.

Altitude

The altitude is registered by the water surface level of the lake in masl.

Classification of lakes

Genetically glacial lakes can be divided into the following.

- Glacial erosion lakes, including cirque lakes, trough valley lakes, and erosion lakes.
- Moraine-dammed lakes, including end moraine lakes and lateral moraine lakes.
- Blocking lakes formed through glaciers and other factors, including the main glacier blocking the branch valley, the glacier branch blocking the main valley, and the lakes formed through snow avalanche, collapse, and debris flow blockade.
- Ice surface and sub-glacial lakes.

In the glacial lake inventory, end moraine-dammed lakes, lateral moraine lakes, trough valley lakes, glacial erosion lakes, and cirque lakes are represented by the letters M, L, V, E, and C respectively; B represents blocking lakes.

Activity

According to their stability, the glacial lakes are divided into three types: stable, potential danger, and outburst (when there have been previous bursts). The letters S, D, and O represent these types respectively.

Types of water drainage

Glacial lakes are divided into drainage lakes and closed lakes according to the drainage pattern. The former refers to lakes from which water flows to the river and joins the river system. In the latter, water does not flow into the river. Ds and Cs represent those two kinds of glacial lakes respectively.

Chemical properties

This attribute is represented by the degree of mineralisation of the water, mg l^{-1}.

Other indices

One important index for evaluating the stability of a glacial lake is its contact relation with the glacier. So an item of distance from the upper edge of the lake to the terminus of the glacier has been added and the code of the corresponding glacier registered. Since an end moraine-dammed lake is related to its originating glacier, this index is only referred to end moraine dammed lakes. As not enough field data exist, the average depth of glacial lakes is difficult to establish in most cases. Based on field data, and as an indication only, the average depth of a glacial lake formed by different causes can be roughly estimated as follows: cirque lake, 10m; lateral moraine lake, 30m; trough valley lake, 25m; blocking lake and glacier erosion lake, 40m; lateral moraine lake, 20m. The water reserves of different types of glacial lakes can be obtained by multiplying their average depth by their area (LIGG/WECS/NEA 1988).

The inventory database form (see Annex II) used for compilation of the inventory of glacial lakes includes map/satellite image codes, aerial photographs, and basin numbers, as well as the lake parameters (attributes) described above.

Chapter 5
Spatial Data Input and Attribute Data Handling

One of the main objectives of the present study is to develop a digital database of glaciers and glacial lakes using geographic information systems (GIS). A digital database is necessary for the monitoring of glaciers and glacial lakes and to identify the potentially dangerous lakes. GIS is the most appropriate tool for spatial data input and attribute data handling. It is a computer-based system that provides the following four sets of capabilities to handle geo-referenced data: data input, data management (data storage and retrieval), data manipulation and analysis, and data output can be found in Arnoff (1989).

Any spatial features of the Earth's surface are represented in GIS by the following:

- **area/polygons**: features which occupy a certain area, e.g. glacier units, lake units, land use units, geological units etc;
- **lines/segments**: linear features, e.g. drainage lines, contour lines, boundaries of glaciers and lakes etc; and
- **points**: points define the discrete locations of geographic features, the areas of which are too small to illustrate as lines or polygons, e.g. mountain peaks or discrete elevation points, sampling points for field observations, identification points for polygon features, centres of glaciers and lakes etc, and attribute data refer to the properties of spatial entities.

The spatial entities described above can be represented in digital form by two data models: vector or raster models. In a vector model the position of each spatial feature is defined by a series of *X* and *Y* coordinates. Besides the location, the meaning of the feature is given by a 'code'. In a raster model, spatial data are organised in grid cells or pixels, a term derived for a picture element. Pixels are the basic units for which information is explicitly recorded. Each pixel is assigned only one value.

For the present study, integrated land and water information system (ILWIS) 2.23 for Windows is used for the spatial and attribute database development and analysis. ILWIS for Windows is an object oriented image processing and geographic information system. Analysis and modelling in a GIS requires input of relevant data. The topographic maps of the 1960s on a scale of 1:50,000 published by the Survey of India were used as the baseline for the spatial data of glaciers and glacial lakes. The list of topographic maps used for the study is given in Chapter 4. Delineation of all the glaciers and glacial lakes was done on the topographic maps. All the glaciers and glacial lakes were numbered and their attributes were noted. The details of the methodology for the delineation and attributes are also given in Chapter 4.

The most common method of entering spatial data is by manual digitising using a digitiser board. Before starting digitisation one should know the map projection system. Map projection defines the relationship between the map coordinates and the geographic coordinates (latitude and longitude). Bhutan is situated between 88° 45' to 92° 10' E longitude and 26° 45' to 28° 10' N latitude. The coordinate system parameters for Bhutan are as follows.

- Projection: Polyconic
- Ellipsoid: Everest (India 1956)
- Datum: Indian (India, Nepal)
- False easting: 2 743 196.40
- False northing: 914 398.80
- Central meridian: 90° 0' 00" E
- Central parallel: 26° 0' 00" N
- Scale factor: 0.998786

The minimum and maximum *X* and *Y* values required in the above geo-reference system in the Bhutan area falling in Grid Zone IIB are:

- minimum *X* = 2,605,000
- maximum *X* = 2,950,000
- minimum *Y* = 985,000
- maximum *Y* = 1,185,000

It is always necessary to maintain the details, smoothness, and accuracy of the input spatial data of all the required information as in the maps of the given map scale. They are defined by the snap and tunnel tolerances in the system. The snap and tunnel tolerances in the system are defined by the extent of the minimum and maximum *X* and *Y* values. To increase the detail and accuracy, the coordinate system with the required *X* and *Y* extents for each one degree area was created to digitise all the topographic maps. These sub-coordinate systems were very useful and made the input and handling of the data easy.

After the delineation of the glaciers, glacial lakes, and ridges on the maps the segments were digitised using the following codes.

1 = lake boundary
2 = glacier boundary
3 = ridge line
5 = basin or international boundary
10 = dry lake
11 = drainage line
12 = lake attached to glacier common boundary
20 = rock glacier boundary only
23 = glacier attached to ridge line common boundary
25 = glacier attached to basin boundary common boundary
100 = tic points reference lines

The segment code values are necessary for data retrieval and analysis in GIS. All the polygons representing glaciers and glacial lakes are numbered as mentioned in Chapter 4. Points showing the location of glaciers and glacial lakes were digitised. They were used later for identification of the polygons of the glaciers and glacial lakes. After digitisation, the segments were checked and the glaciers and glacial lakes were numbered using point identifiers. Basin-wise polygon maps of glaciers and glacial lakes are presented in Chapters 7 and 8.

In an object oriented GIS, polygon maps with identifier domains of the objects have a related attribute table with the same domain. The domain defines the possible contents of a map, a table, or a column in a table (attribute). Some examples of 'domain' are class domain (a list of class names), value domain (measured, calculated, or interpolated values), image domain (reflectance values in a satellite image or scanned aerial photograph), identifier domain (a unique code for each item in the map), string domain (columns in a table that contain text), bit domain (value 0 and 1), bool domain (yes or no) etc. An attribute table is linked to a map through its domain. An attribute table can only be linked to maps with a class or identifier domain. An attribute table may contain several columns.

Required attributes of the glaciers and glacial lakes as explained in Chapter 4 were derived or entered in the attribute database in the GIS. Most of the attributes were derived from the topographic maps, aerial photographs, satellite images, reports, field data, etc. Attributes such as area, location (latitude, longitude) etc were derived from the spatial database. If other necessary digital spatial data layers, such as digital elevation models (DEM), are available, it is possible to generate terrain parameters such as elevation, slope, length etc as measuring units for glaciers and glacial lakes. Other attributes such as aspect, mean length, elevation, map code, name, etc, were manually entered in the attribute database. Additional attributes, such as mean elevation, volume etc were derived using logical calculations. For each basin, attribute tables were developed for glaciers and glacial lakes. Some of the attributes were also derived from the results of an aggregation in the same table or from another table using the table joining operations, such as glaciers associated with the glacial lakes, etc.

The criteria for the identification of potentially dangerous glacial lakes are explained in Chapter 11. Using the logical calculation in the GIS, the potentially dangerous glacial lakes were determined. To study the geomorphic characteristics of these potentially dangerous lakes, the available time-series satellite images and topographic maps were also used.

Chapter 6
Application of Remote Sensing

Glaciers and glacial lakes are generally located in remote areas, where access is through tough and difficult terrain. The study of glaciers and glacial lakes, as well as carrying out glacial lake outburst flood (GLOF) inventories and field investigations using conventional methods, requires, extensive time and resources together with undergoing hardship in the field. Creating inventories and monitoring of the glaciers, glacial lakes, and extent of GLOF impact downstream can be done quickly and correctly using satellite images and aerial photographs. Use of these images and photographs for the evaluation of physical conditions of the area provides greater accuracy. The multi-stage approach using remotely sensed data and field investigation increases the ability and accuracy of the work. Visual and digital image analysis techniques integrated with techniques of geographic information systems (GIS) are very useful for the study of glaciers, glacial lakes, and GLOFs.

At first the inventory and evaluation of the glaciers, glacial lakes, and GLOFs were carried out based on topographic maps. The topographic maps of the higher terrain, which houses glaciers and glacial lakes, are not as reliable as those of hills and lowland areas. As a complementary data and tool, various remote sensing techniques and satellite images were used.

Remote sensing is the science and art of acquiring information (spectral, spatial, temporal) about material objects, areas, or phenomena through the analysis of data acquired by a device from measurements made at a distance, without coming into physical contact with the objects, area, or phenomena under investigation.

Remote sensing technology makes use of the wide range of the electro-magnetic spectrum (EMS). Most of the commercially available remote-sensing data are acquired in the visible, infrared, and microwave wavelength portion of the EMS. For the present study, the data acquired within the visible and infrared wavelength ranges were used.

There are different types of commercial satellite data available. Digital data sets of the Land Observation Satellite (LANDSAT)-5 Thematic Mapper (TM) and Indian Remote Sensing Satellite Series 1D (IRS1D) Linear Imaging and Self Scanning Sensor (LISS)3 were used mostly for the present study. Some data sets of Système Probatoire Pour l'Observation de la Terre (SPOT) Multi-Spectral (XS) and SPOT Panchromatic (PAN) were also used. The list of the images and aerial photographs relevant to the present study are given in Chapter 4.

A scene of a LANDSAT TM image gives the synoptic view of an area of 185 km by 170 km of the Earth's surface sensed by the American LANDSAT satellite from an altitude of 705 km. There are seven spectral bands of electromagnetic spectrum in LANDSAT TM data, ranging from the blue to far infrared wave length (Figure 6.1). The individual bands are 0.45–0.52, 0.53–0.60, 0.62 –0.69, 0.78–0.90, 1.57–1.78, and 2.10–2.35 μm with the spatial resolution of 30m in the visible, near infrared and middle infrared bands, and 10.45–11.66 μm in the far infrared band with 120m resolution. Some of the potential applications of different spectral bands of LANDSAT TM are given in Table 6.1. The TM sensors greatly facilitate the multi-temporal data availability (repeated coverage of 16 days) for studying the temporal changes of glaciers, lakes, and other features.

Table 6.1: Spectral band ranges (µm) used in TM on board LANDSAT's 4 and 5 sensor system and their potential applications

Band number	Band range (µm)	Potential applications
1	0.45–0.52	Coastal water mapping; soil/vegetation differentiation; deciduous/coniferous differentiation (sensitive to chlorophyll concentration) etc
2	0.52–0.62	Green reflectance by healthy vegetation etc
3	0.63–0.69	Chlorophyll absorption for plant species' differentiation
4	0.78–0.90	Biomass surveys; water body delineation
5	1.55–1.75	Vegetation moisture measurement; snow/cloud differentiation; snow/ice quality study
6	10.4–12.5	Plant heat stress management; other thermal mapping; soil moisture discrimination
7	2.08–2.35	Hydro-thermal mapping; discrimination of mineral and rock types; snow/cloud differentiation; snow/ice quality study

The SPOT series of French satellites and recent series of IRS satellites have more advantages for the study of glaciers, glacial lakes, and GLOFs due to their stereo data acquisition capacity (±26° off-nadir viewing capability of the system) and higher spatial resolutions of 6 (IRS1C/IRSID PAN data) to 10m (SPOT PAN data).

LISS3 sensors on board IRS1C/D satellites provide multi-spectral data collected in four bands of VNIR (visible and the near infrared) and SWIR (short wave infrared) regions (Tables 6.2 and 6.3). LISS3 images cover an area of 124 by 141 km for the VNIR bands (B2, B3, B4) and 133 by 148 km for the SWIR band (B5) sensed from an altitude of 817 km (IRS1C) to 780 km (IRS1D) with repetitive coverage of 25 days. The spatial resolution of VNIR bands is 24m and that of SWIR is 71m.

The spatial resolution of LISS3 of the IRS satellite series and XS of the SPOT satellite series are greater than that of LANDSAT TM. With a greater number of spectral bands and spatial resolution of 30 by 30m close to the former two data types, cloud free LANDSAT TM data are equally good for the inventory and evaluation of glaciers, glacial lakes, and GLOFs in the medium scale (1:100,000 to 1:25,000). One can compare the amount of detail in different images covering the same area of Lunana region in Figures 6.4 and 6.5.

When electro-magnetic energy is incident on any given Earth surface feature, three fundamental energy interactions with the feature are possible. Various fractions of energy incident on the element are reflected, absorbed, and/or transmitted. All components of incident, reflected, absorbed, and/or transmitted energy are a function of the wavelength. The proportions of energy reflected, absorbed, and transmitted vary for different Earth features, depending on their material types and conditions. These differences permit us to distinguish different features on an image. Thus, two features may be distinguishable in one spectral range and may be very different on another wavelength band. Within the visible portion of the spectrum, these spectral variations result in the visual effect called **colour**. For example, blue objects reflect highly in the blue portion of the spectrum, likewise green reflects highly in the 'green' spectral region, and so on. Thus, the eye uses spectral variations in the magnitude of reflected energy to discriminate between various objects.

Satellite data are digital records of the spectral reflectance of the Earth's surface features. These digital values of spectral reflectance are used for image processing and image interpretations. A graph of the spectral reflectance of an object as a function of wavelength is called a spectral reflectance curve. The

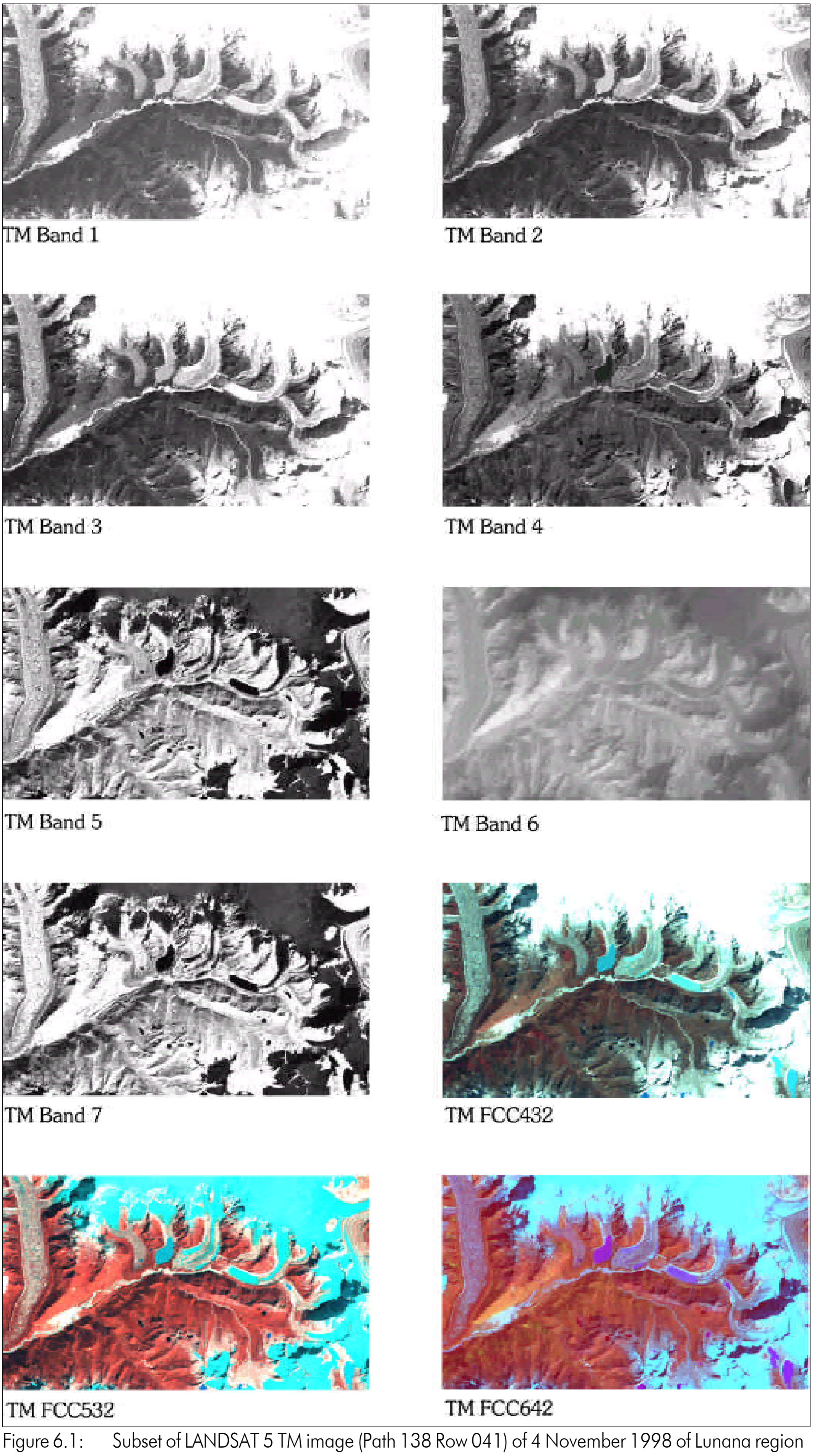


Figure 6.1: Subset of LANDSAT 5 TM image (Path 138 Row 041) of 4 November 1998 of Lunana region in the Pho Chu Basin of Bhutan

Table 6.2: Some optical sensor system characteristics of Earth resources satellites used in the study				
Satellite system Optical sensor system (Launch dates)	**LANDSAT 4/5 MSS (1982 LANDSAT-4) (1985 LANDSAT -5)**	**LANDSAT 4/5 TM (1982 LANDSAT-4) (1984 LANDSAt-5) (1999 LANDSAT -7)**	**SPOT XS (1986 SPOT-1) (1990 SPOT-2) (1993 SPOT-3) (1999 SPOT-4)**	**IRS-1C LISS-III (1995 IRS-1C) (1997 IRS-1D)**
Sensor altitude	LANDSAT 1,2,3 = 900 km LANDSAT 4, 5 = 705 km	705 km	832 km	817 km
Spatial resolution	80m	30m	20m	24m
Temporal resolution (revisit cycle in days)	16	16	20 (nadir)	24 (nadir)
Radiometric resolution (bits per pixel)	6-bit (scaled to 7 or 8-bit during ground processing)	8-bit	8-bit	7-bit
Swath width	185 km scene area = 185*170	185 km scene area = 185*170	60 km	141 km 124*141 133*148
Off-nadir viewing (side-look) capability for PAN mode for stereo image data acquisition (±26° off-nadir viewing)			SPOT PAN (10 m resolution) 0.51–0.73 µm 3 days revisit capability	IRS-1C PAN (6 m resolution) (70 km swath width) 0.50–0.70 µm (6-bit) 3 days revisit capability
Spectral resolution (number of bands)	4	7	3	4

Table 6.3:	Wavelength ranges of the optical sensor system of Earth resources satellites used in the present study			
Satellites system	**LANDSAT 4/5**	**LANDSAT 4/5**	**SPOT**	**IRS-1C/1D**
Optical sensor system	**MSS**	**TM**	**XS**	**LISS-III**
Blue		0.45–0.52 µm (B1)		
Green	0.50–0.60 µm (Ch1 or B4)	0.53–0.61 µm (B2)	0.50–0.59 m (XS1)	0.52–0.59 µm (B2)
Red	0.60–0.70 µm (Ch2 or B5)	0.62–0.69 µm (B3)	0.62–0.68 µm (XS3)	0.62–0.68 µm (B3)
NIR	0.70–0.80 µm (Ch3 or B6)	0.78–0.90 µm (B4)	0.78–0.88 µm (XS3)	0.77–0.86 µm (B4)
NIR	0.80–1.10 µm (Ch4 or B7)			
IIR		1.57–1.78 µm (B5)		1.55–1.75 µm (B5)
IIR		2.10–2.35 µm (B7)		
IIR (MIR)				
ThIR		10.45–11.66 µm (B6)		
FIR				

configuration of spectral reflectance curves provides insight into the characteristics of an object and has a strong influence on the choice of wavelength region(s) in which remote-sensing data are acquired for a particular application.

Figure 6.2 (over page) shows the typical spectral reflectance curves for three basic types of Earth feature: green vegetation, soil, and water. The lines in this figure represent average reflectance curves compiled by measuring large sample features. It should be noted how distinctive the curves are for each feature. In general, the configuration of these curves is an indicator of the type and condition of the features to

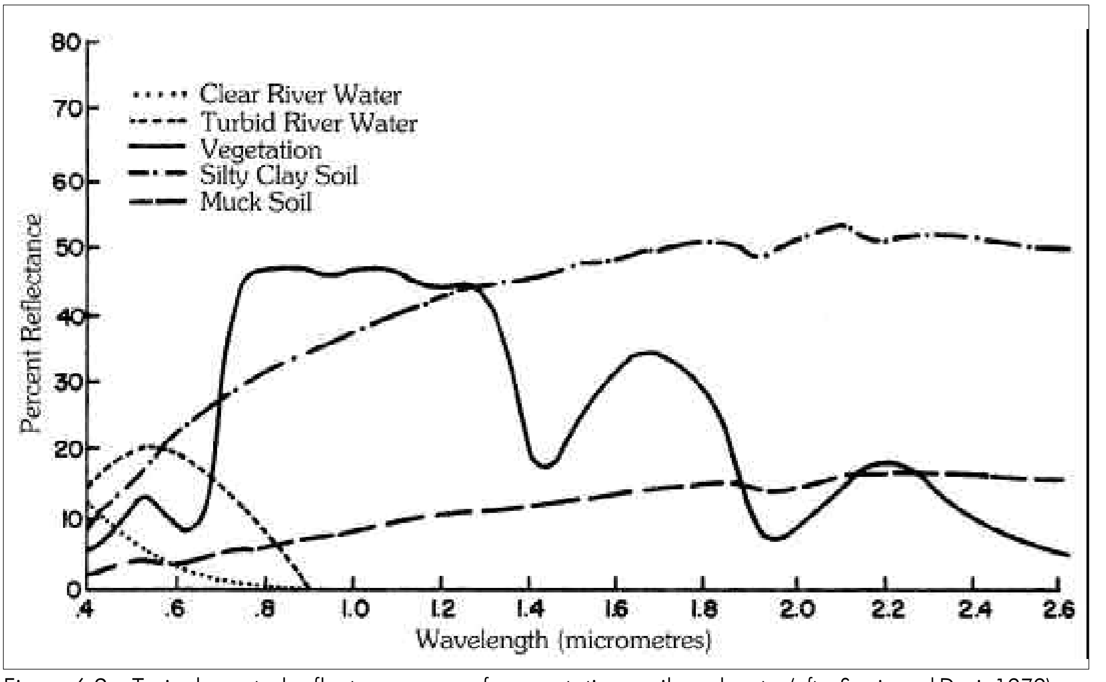


Figure 6.2: Typical spectral reflectance curves for vegetation, soil, and water (after Swain and Davis 1979)

which they apply. Although the reflectance of individual features may vary considerably above and below the average, these curves demonstrate some fundamental points concerning spectral reflectance.

Spectral reflectance curves for vegetation almost always manifest the 'peak-and-valley' configuration (Figure 6.2). Valleys in the different parts of the spectral reflectance curve are the result of the absorption of energy due to plants, leaves, pigments, and chlorophyll content at 0.45 and 0.67 μm wavelength bands and water content at 1.4, 1.9, and 2.7 μm wavelength bands. In near infrared spectrum wavelength bands ranging from about 0.7–1.3 μm, plants reflect 40–50% of energy incident upon them. The reflectance is due to plant leaf structure and is highly variable among plant species, which permits discrimination between species. Different plant species reflect differently in different portions of wavelength.

The soil curve in Figure 6.2 shows considerably less peak-and-valley variation in reflectance. This is because the factors that influence soil reflectance act over less specific spectral bands. Some of the factors affecting soil reflectance are moisture content, soil texture (proportion of sand, silt, and clay), surface roughness, presence of iron oxide, and organic matter content. These factors are complex, variable, and inter-related. For example, the presence of moisture in soil will decrease its reflectance. As with vegetation, this effect is greatest in the water absorption bands at about 1.4, 1.9, and 2.7 μm (clay soils also have hydroxyl absorption bands at about 1.4 and 2.2 μm). Soil moisture content is strongly related to soil texture; coarse and sandy soils are usually well drained, resulting in low moisture content and relatively high reflectance; poorly drained and fine-textured soils will generally have lower reflectance. In the absence of water, however, the soil may exhibit the reverse tendency, that is, coarse-textured soils may appear darker than fine-textured soils. Thus, the reflectance properties of soil are consistent only within a particular range of conditions. Two other factors that reduce soil reflectance are surface roughness and organic matter content. Soil reflectance normally decreases when surface roughness and organic matter content increases. The presence of iron oxide in soil also significantly decreases reflectance, at least in the visible wavelengths. In any case, it is essential that the analyst be familiar with the existing conditions.

When considering the spectral reflectance of water, probably the most distinctive characteristic is the energy absorption at near infrared wavelengths. Water absorbs energy in these wavelengths, whether considering water features per se (such as lakes and streams) or water contained in vegetation or soil. Locating and delineating water bodies with remote-sensing data are carried out easily in near infrared wavelengths because of this absorption property. However, various conditions of water bodies manifest themselves primarily in visible wavelengths. The energy/matter interactions at these wavelengths are very complex and depend on a number of inter-related factors. For example, the reflectance from a water body can stem from an interaction with the water surface (specula reflection), with material suspended in the water, or with the bottom of the water body. Even in deep water where bottom effects are negligible, the reflectance properties of a water body are not only a function of the water per se but also of the material in the water.

Clear water absorbs relatively little energy with wavelengths of less than about 0.6 μm. High transmittance typifies these wavelengths with a maximum in the blue-green portion of the spectrum. However, as the turbidity of water changes (because of the presence of organic or inorganic materials), transmittance, and therefore reflectance, changes dramatically. This is true in the case of water bodies in the same geographic area. Spectral reflectance increases as the turbidity of water increases. Likewise, the reflectance of water depends on the concentration of chlorophyll. Increases in chlorophyll concentration tend to decrease water reflectance in blue wavelengths and increase it in green wavelengths. Many important water characteristics, such as dissolved oxygen concentration, pH, and salt concentration, cannot be observed directly through changes in water reflectance. However, such parameters sometimes correlate with observed reflectance. In short, there are many complex inter-relationships between the spectral reflectance of water and its particular characteristics. One must use appropriate reference data to correctly interpret reflectance measurements made over water.

Snow and ice are the frozen state of water. Early work with satellite data indicated that snow and ice could not be reliably mapped because of the similarity in spectral response between snow and clouds due to limitations in the then available data set. Today satellite remote sensing systems' data are available in more spectral bands (e.g. LANDSAT TM in seven bands). It is now possible to differentiate snow and cloud easily in the middle infrared portion of the spectrum, particularly in the 1.55–1.75 and 2.10–2.35 μm wavelength bands (bands 5 and 7 of LANDSAT TM). As shown in Figure 6.3, in these wavelengths, the clouds have a very high reflectance and appear white on the image, while the snow has a very low reflectance and appears black on the image. In the visible, near infrared, and thermal infrared bands, spectral discrimination between snow and clouds is not possible, while in the middle infrared it is. The reflectance of snow is generally very high in the visible portions and decreases throughout the reflective infrared portions of the spectrum. The reflectance of old snow and ice is always lower than that of fresh snow and clean/fresh glacier in all the visible and reflective infrared portions of the spectrum. Compared to clean glacier and snow (fresh as well as old), debris covered glacier and very old/dirty snow have much lower reflectance in the visible portions of the spectrum and higher in the middle infrared portions of spectrum.

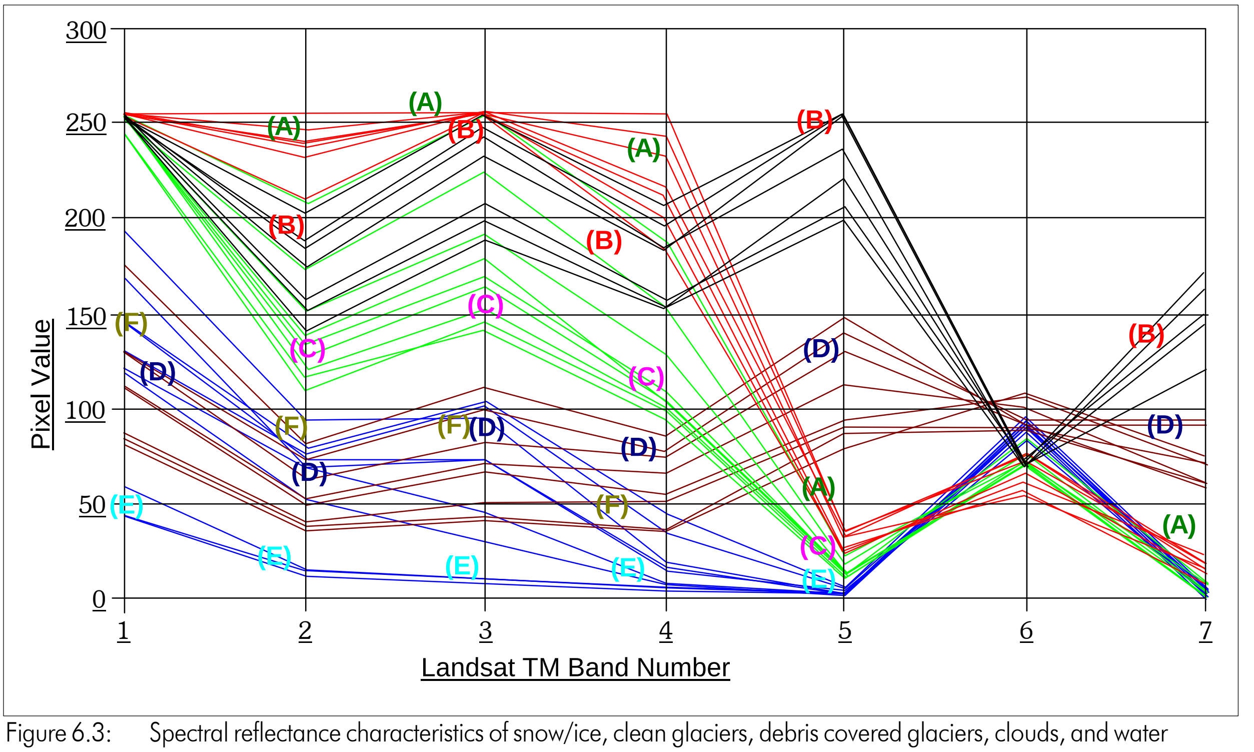


Figure 6.3: Spectral reflectance characteristics of snow/ice, clean glaciers, debris covered glaciers, clouds, and water bodies. Reflectance in terms of pixel value based on LANDSAT TM seven-band data set of the Pho Chu area of Bhutan. Red lines—clean glaciers and fresh snow (A); black lines—clouds (B); green lines—old snow/glaciers (C); maroon lines—debris covered glacier (D); blue lines—clean/melted (E) and silty and/or partly frozen water (lake/river) (F)

To identify the individual glaciers and glacial lakes, different image enhancement techniques are useful. However, complemented by the visual interpretation method (visual pattern recognition), with the knowledge and experience of the terrain conditions, glacier and glacial lake inventories and monitoring can be done. With different spectral band combinations in false colour composite (FCC) and in individual spectral bands, glaciers and glacial lakes can be identified and studied using the knowledge of image interpretation keys: colour, tone, texture, pattern, association, shape, shadow etc. Combinations of different bands can be used to prepare FCC. Different colour composite images highlight different land-cover features.

Figure 6.4 shows colour composite images R7G4B3 (red to band 7, green to band 4, blue to band 3) of a LANDSAT 4 TM image of 4 November 1998 of Lunana area in the Pho Chu Basin and R4G3B2 of an IRS1D LISS3 of 12 December 1999 of the same area. In the colour composite images of Figure 6.4 and the panchromatic images of Figure 6.5 one can identify different types of land cover, glaciers, glacial lakes, and GLOF events such as: (A) Raphstreng Tsho Glacial Lake; (B) debris covered tongue of Thorthormi Glacier with some frozen lakes; (C) Lugge Tsho Glacial Lake showing the breached area at

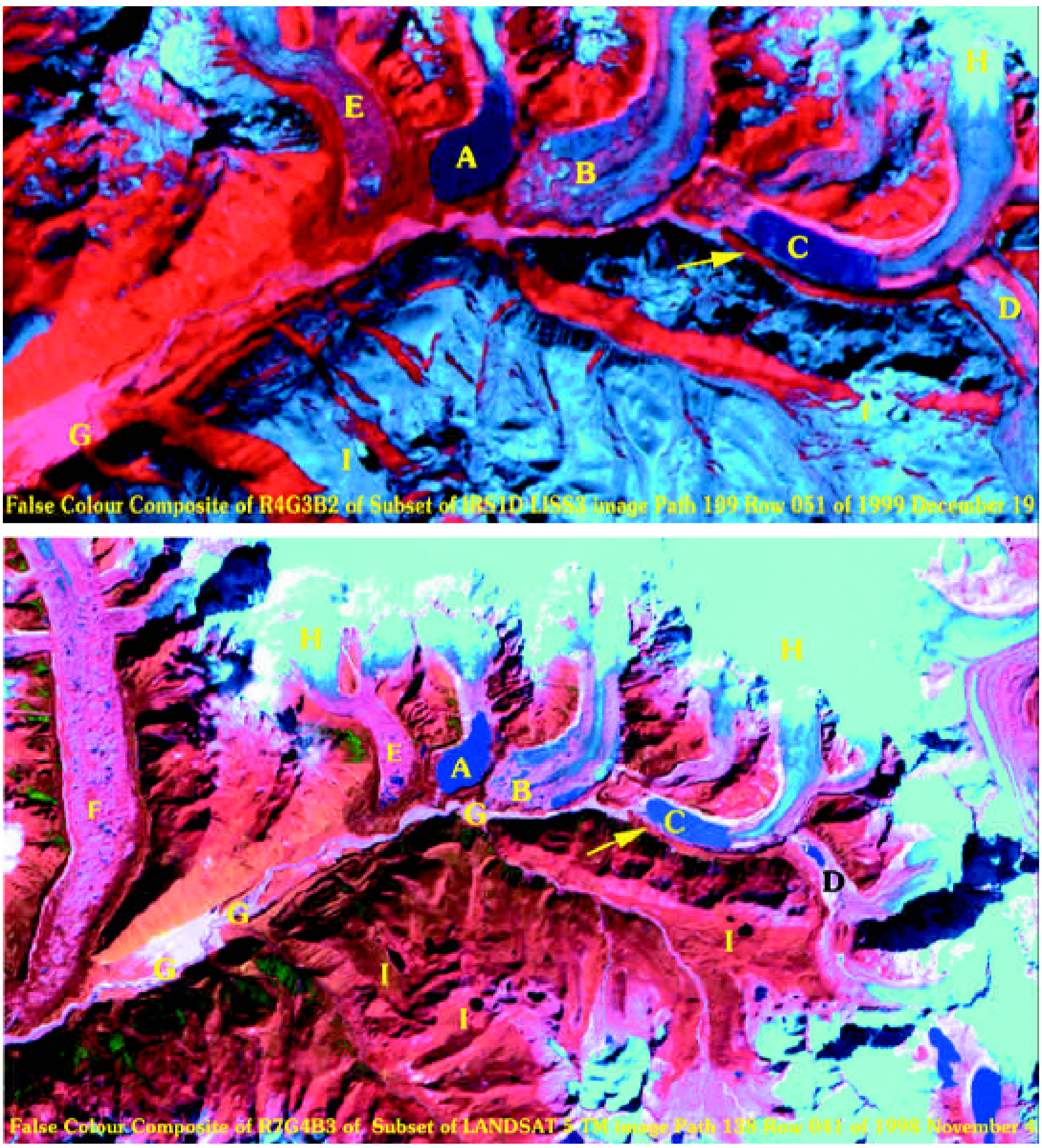
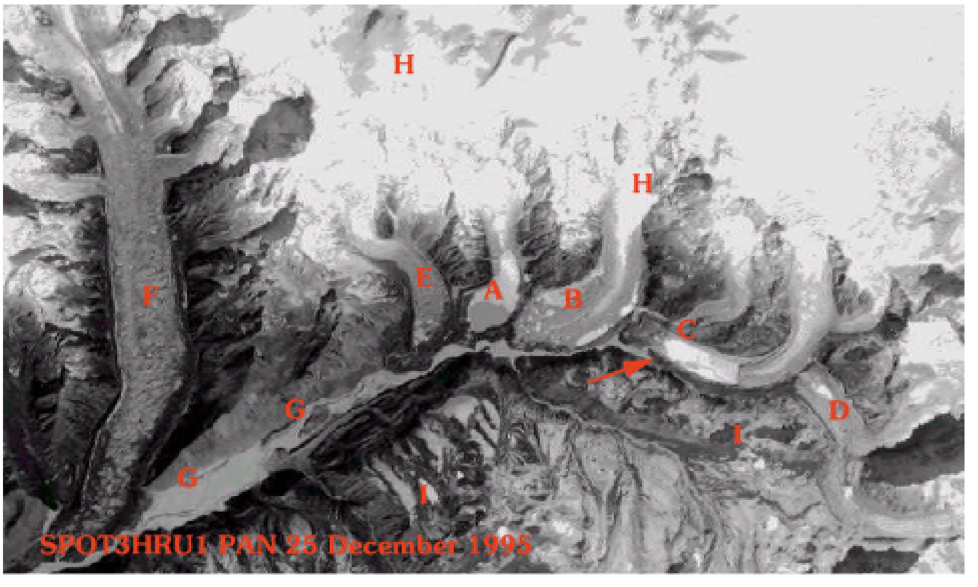


Figure 6.4: Colour composite of IRS1D LISS3 (12 December 1999) showing the Lunana region in the Pho Chu Basin of Bhutan: (A) Raphstreng Tsho Glacial Lake, the upper part of the lake near the glacier tongue is frozen; (B) debris covered tongue of Thorthormi Glacier with some frozen lakes; (C) Lugge Tsho Glacial Lake showing the breached area at the moraine; (D) Drukchang Glacier tongue with frozen lake; (E) debris covered Bechung Glacier tongue with lake; (F) debris covered Tsonglu Glacier; (G) the Pho Cho River showing the effect of debris flow from Lugge Tsho Lake on 4 October 1994; (H) clean glaciers and fresh show area; and (I) erosion lakes (showing in black)

the moraine; (D) Drukchang glacier tongue with frozen lake; (E) debris covered Bechung glacier tongue with lake; (F) debris covered Tsonglu Glacier; (G) Pho Cho showing the effect of debris flow from Lugge Tsho Lake on 4 October 1994; and (H) clean glacier and fresh snow area. Colours in the colour composite images and tones in the individual band images are the outcome of the reflectance values. Glaciers appear white (in individual bands and colour composite) to light blue (in colour composite) colour of variable sizes, with linear and regular shape having fine to medium texture, whereas, in the thermal band, they appear grey to black. The distinct linear and dendritic pattern associated with slopes and valley floors of the high mountains covered with seasonal snow can be distinguished in the glaciers in the mountains.

The lake water in colour composite images ranges in appearance from light blue to blue to black. In the case of frozen lakes, it appears white. Sizes are generally small, having circular, semi-circular, or elongated shapes with very fine texture and are generally associated with glaciers in the case of high lying areas, or rivers in the case of low lying areas. In general, erosion lakes and some cirque lakes are not necessarily associated with glaciers or rivers at present. The debris flow path along the drainage channel gives a white to light grey and bright tone.



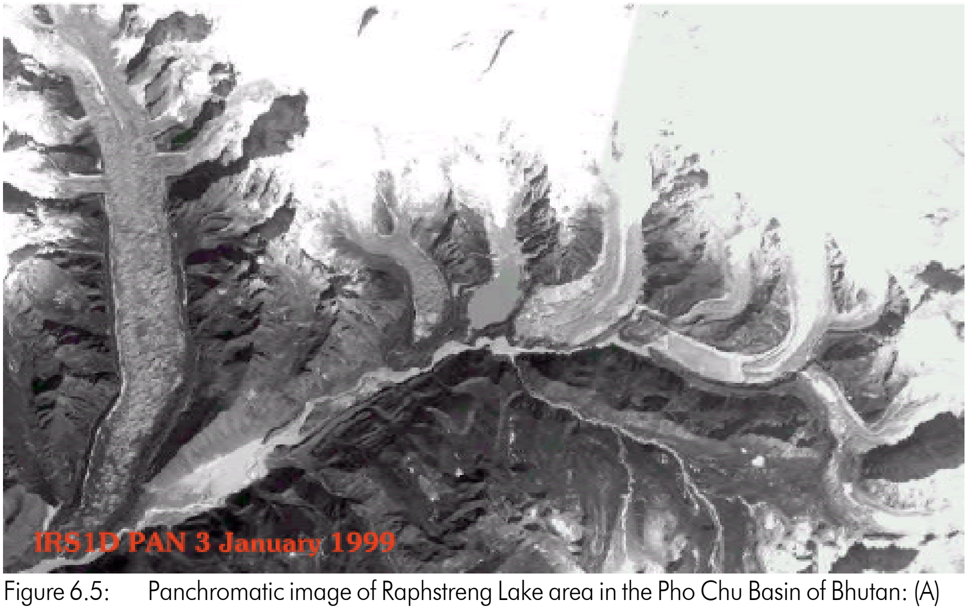


Figure 6.5: Panchromatic image of Raphstreng Lake area in the Pho Chu Basin of Bhutan: (A) Raphstreng Tsho Glacial Lake, the upper part of the lake near the glacier tongue is frozen; (B) debris covered tongue of Thorthormi Glacier with some frozen lakes; (C) Lugge Tsho Glacial Lake showing the breached area at the moraine; (D) Drukchang Glacier tongue with frozen lake; (E) debris covered Bechung Glacier tongue with lake; (F) debris covered Tsonglu Glacier; (G) the Pho Cho River showing the effect of debris flow from Lugge Tsho Lake on 4 October 1994; (H) clean glaciers and fresh show area; and (I) erosion lakes (showing in white)

For glacier and glacial lake identification from satellite images, the images should be with least snow cover and cloud free. Least snow cover in the Himalayas occurs generally in the summer season (May–September). But during this season, monsoon clouds will block the views. If snow precipitation is late in the year, winter images are also suitable except for the problem of long relief shadows in the high mountain regions. For the present study, most of the images are of the winter season under conditions of least seasonal snow cover and cloud free.

Knowledge of the physical characteristics of the glaciers, lakes, and their associated features is always necessary for the interpretation of the images. For example, the end moraine damming the lake may range from a regular curved shape to a semi-circular crescent shape. The frozen lake and glacier ice field may have the same reflectance, but the frozen lake always has a level surface and is generally situated in the ablation areas of glaciers or at the toe of the glacier tongue, and there is greater possibility of association with drainage features downstream.

The technique of digital image analysis facilitates image enhancement and spectral classification of the ground features and, hence, greatly helps in the study of glaciers and lakes. Monitoring of the lakes and glaciers can be done visually as well as digitally. In both the visual interpretation and digital feature extraction techniques, the analyst's experience and adequate field knowledge are necessary. The satellite images have to be geometrically rectified based on the appropriate geo-reference system and cell sizes. The same geo-reference system is required for the integration and analysis of the remote sensing satellite data in the GIS database. The image resolutions and geo-reference system should be the same for better results. Figure 6.6 shows an example of Raphstreng Lake area on two different dates. The images are projected in the same geo-reference system and resampled into the same size. The two-date images show the change in physical condition and the process related to the glacial lake; they indicate the fast growth of Raphstreng Glacial Lake at the tongue of Raphstreng Glacier and the enlargement of supraglacial lakes at the tongue of Thorthormi Glacier. The supra-glacial ponds at the tongue of Thorthormi glacier are enlarged and merged in the new date image to form a bigger pond (lake). This is, again, an indication of the fast development of a glacial lake at the tongue of Thorthormi Glacier.

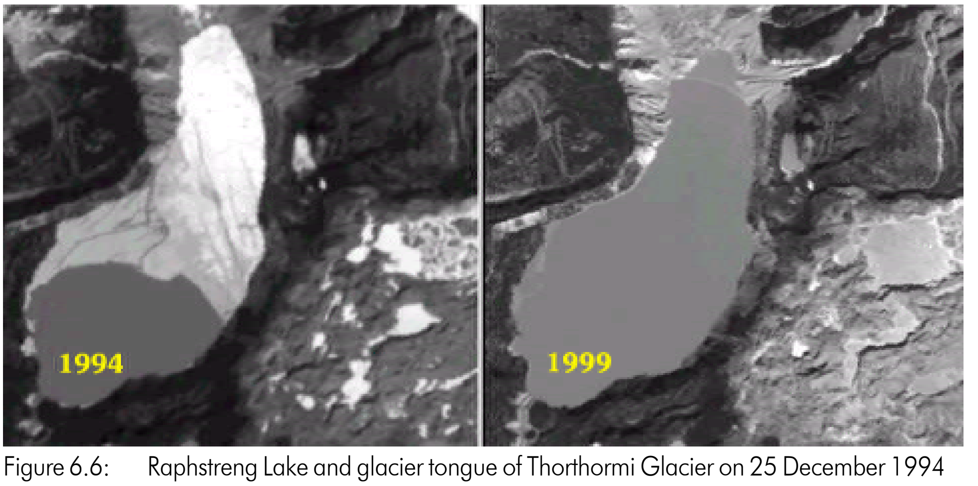


Figure 6.6: Raphstreng Lake and glacier tongue of Thorthormi Glacier on 25 December 1994 (left side) and on 3 January 1999 (right side)

The lakes that have already burst in the past can be identified from the disturbed damming materials and the drainage characteristics associated with the lake. Figure 6.7 shows the situation before and after the breaching on 4 October 1994 of Lugge Tsho Glacier at the tongue of Lugge Glacier dammed by ice cored moraine. An ice-core moraine dam usually has a hummock dissected end moraine, with smaller ponds in some cases. The lateral moraine ridges are generally of a smooth, narrow, linear appearance and are easily identifiable on the images. Figure 6.8 shows the breaching of Lugge Tsho Glacial Lake at the area of contact of lateral moraine and end moraine. Lugge Tsho Glacial Lake, which burst on 7 October 1994, carrying lots of debris along the Pho Chu, is visible on the images. The channel path along which glacial lake outburst flooding has occurred shows distinct light tone widths along the drainage channel and banks due to bank erosion and deposition at different places along the river. The loose materials transported and deposited along the streams have higher spectral reflectance compared to their surroundings and old stable river channels, which appear relatively lighter and brighter.

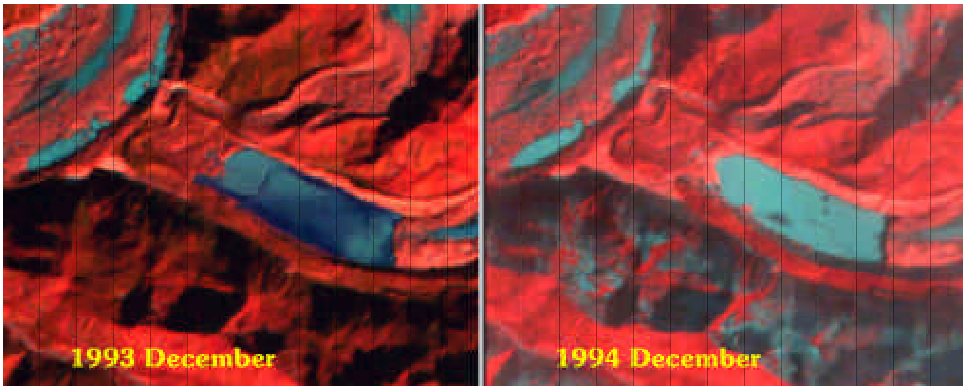


Figure 6.7: False colour composite R5G3B2 of LANDSAT TM showing Lugge Thso Lake before and after breaching on 7 October 1994

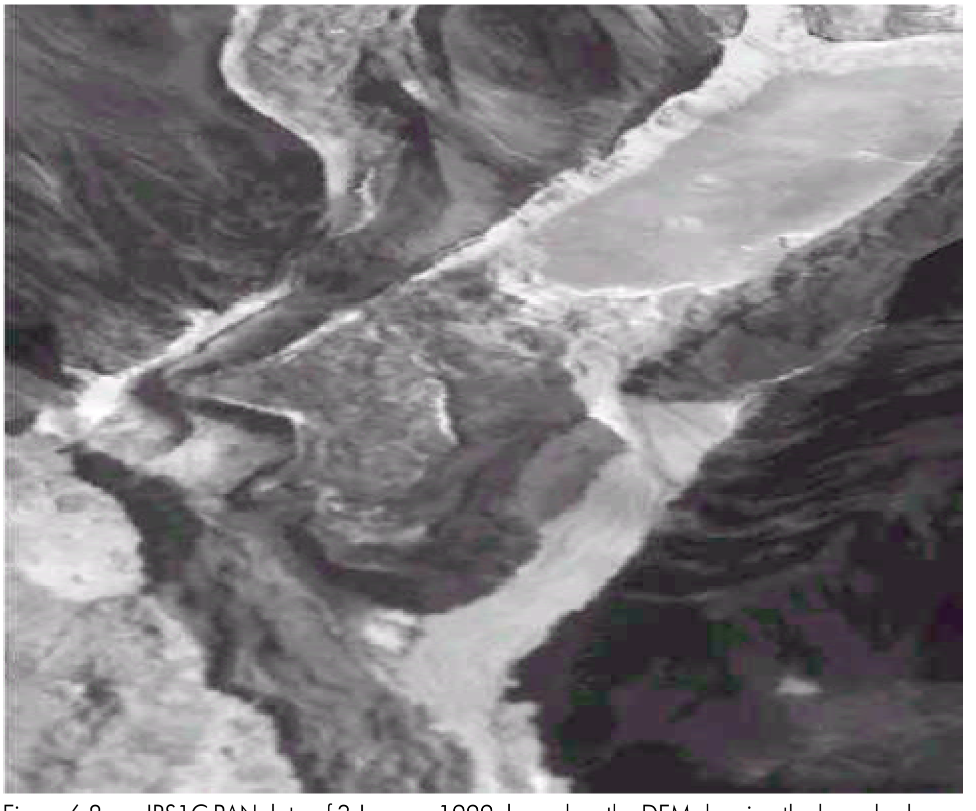


Figure 6.8: IRS1C PAN data of 3 January 1999 draped on the DEM showing the breached area of Lugge Tsho Lake on 7 October 1994

Coarse spatial resolution images have limitations when distinguishing smaller lakes and small stream paths. However, such small objects will show up in the coarse spatial resolution images averaged with reflectance values of their surrounding objects.

The technique of integrating remote sensing data with GIS does help a lot with identification and monitoring of lakes and glaciers. The DEM of an area generated either using stereo satellite images, aerial photographs, or digitisation of topographic map data can play a big role in deciding the rules for discrimination of features and land cover types in GIS techniques and for better perspective viewing and presentations. DEM itself can be used to create various data sets of the area (e.g. slope, aspect). For example, even though glacial lakes are covered by snow, the lake surfaces are flat, and glaciers, snow, and ice create slope angles. In this case, decision rules for integrated analysis in GIS can be assigned, that is, if the slope is not too pronounced and the texture smooth, then such areas are recognised as frozen glacial lakes. DEM generated from satellite images, aerial photographs, or topographic maps should be compatible with and of reliable quality to other data sets. The satellite images or orthophotos can be draped over the DEM for interpretation or presentation. Figures 6.9 and 6.10 show some examples of the use of DEM draped by satellite images.

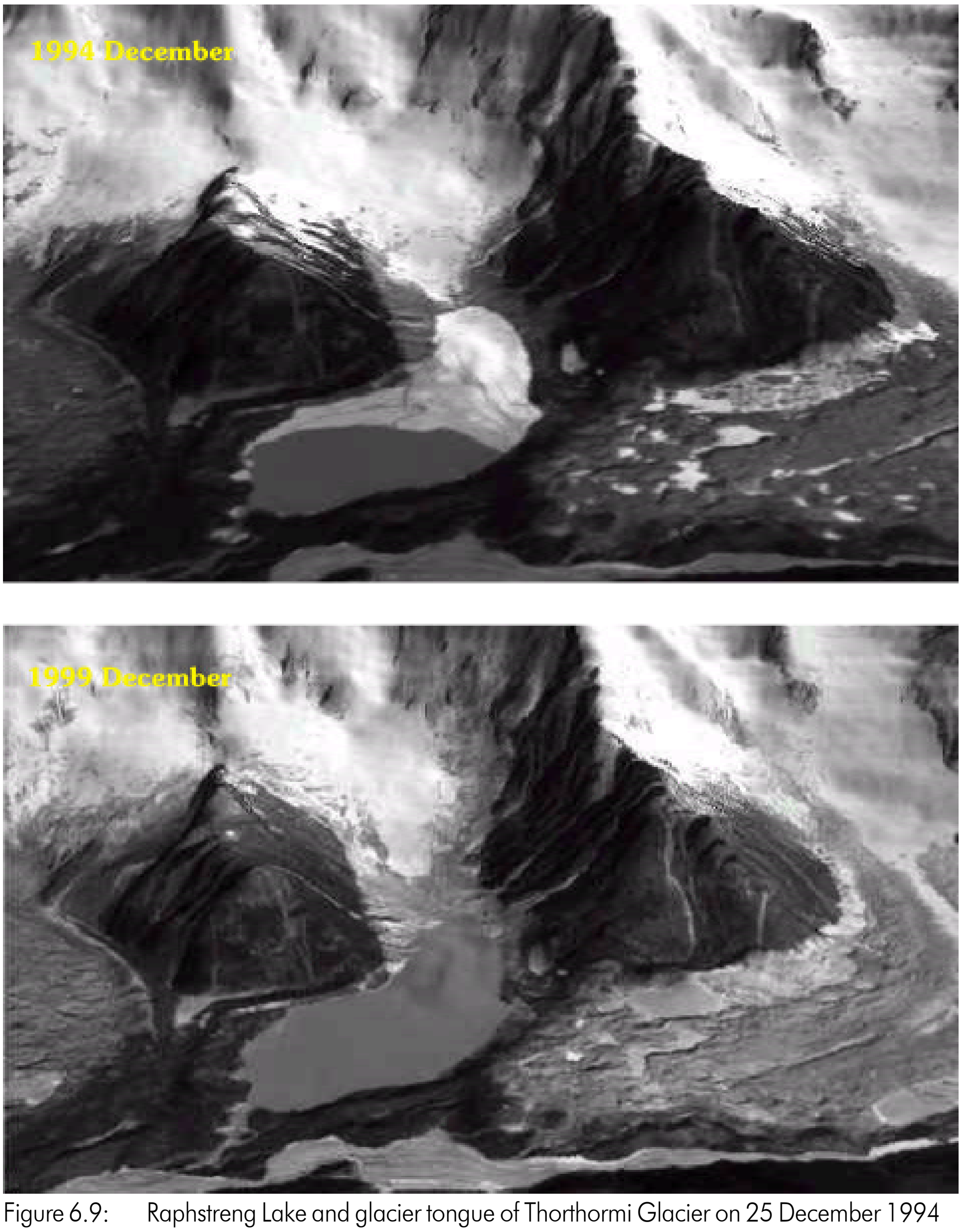


Figure 6.9: Raphstreng Lake and glacier tongue of Thorthormi Glacier on 25 December 1994 (SPOT PAN) and on 3 January 1999 (IRS1C PAN). Both the images are draped over the DEM generated from the topographic map on a scale of 1:50,000

Based on different criteria, actively retreating glaciers and potentially dangerous lakes can be determined using the developed spatial and attribute database complemented by multi-temporal remote-sensing data sets. Once the activity of glaciers and the potentially dangerous status of lakes are determined, the use of medium- to large-scale aerial photographs provides the best tool for detailed geomorphic studies and other evaluation. The photograph image characteristics, shape, shadow, tone, colour, texture, pattern, and relation to surrounding objects were used for aerial photo interpretation. Geomorphic features and processes of the area are very distinctive in their appearance on aerial photographs. Physical parameters of glaciers, glacial lakes, and associated moraines can easily be estimated by stereoscopic viewing. Aerial photographs for Bhutan are not available for the present study.

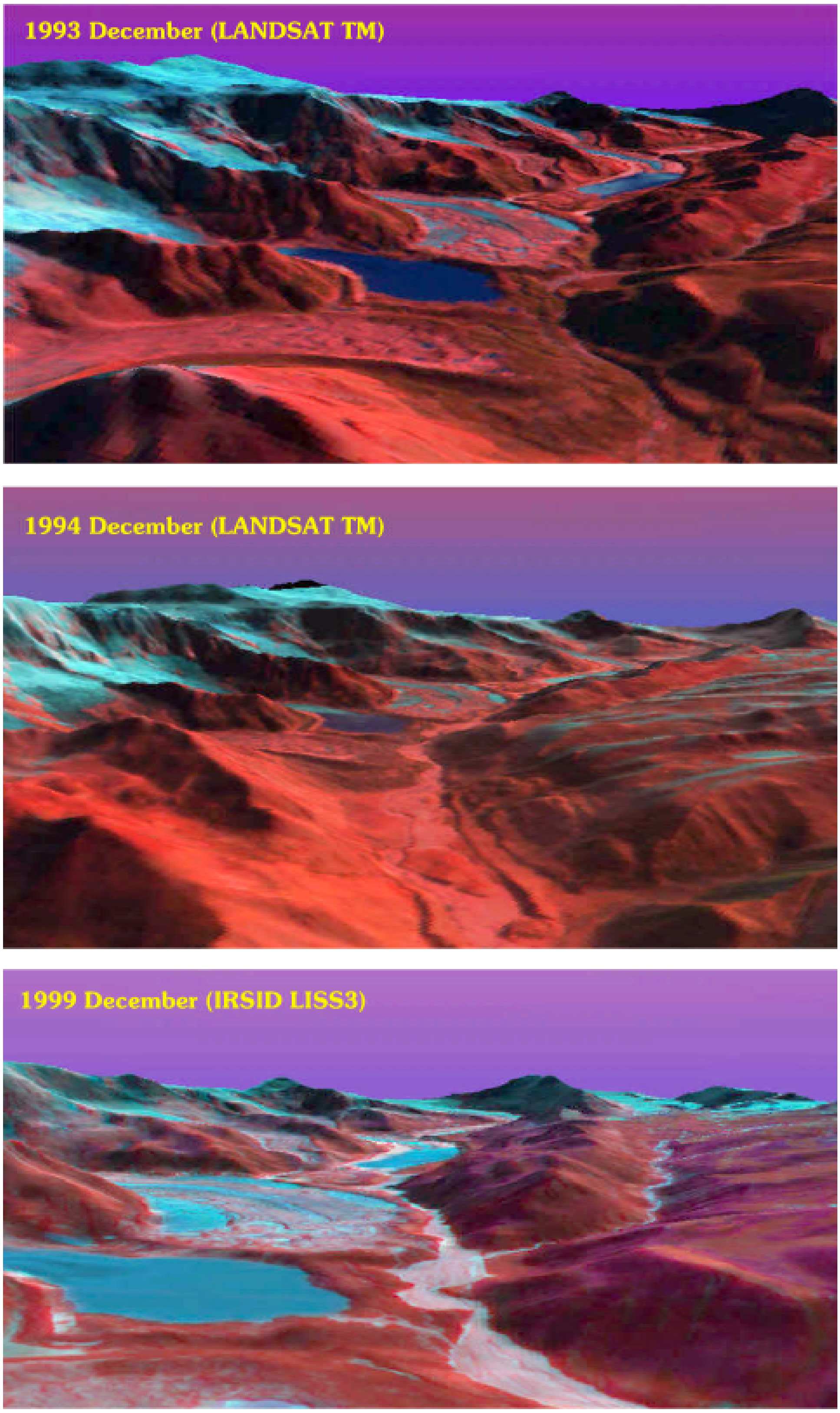


Figure 6.10: Three-dimensional perspective view of Raphstreng Tsho and Lugge Tsho area in the Pho Chu Sub-basin of Bhutan overlaid on a DEM generated from the topographic map on a scale of 1:50,000. 50° angle of field of view, –12° pitch, 90° azimuth, 1,434m above ground level of viewer position situated at x = 2762127 and y = 1147216. The effect of Lugge Tsho GLOF is clearly visible in the 1999 image

Chapter 7
The Inventory of Glaciers

7.1 Brief Description of Glacier Inventory

The inventory of glaciers has been based on topographic maps and satellite images. As not all topographic maps are available for Bhutan and most of the topographic maps of the glaciated region are poor quality photocopies, for the identification, classification, and determination of stages of glaciers, different types of satellite images were vigorously studied. The spatial inventory is based entirely on topographic maps on a scale of 1: 50,000 published in the 1950s to 1970s by the Survey of India and the prints of the land observation satellite (LANDSAT) thematic mapper (TM) images on a scale equivalent to the topographic maps. All the projection parameters of the topographic maps are incorporated in the images to make the prints compatible with the topographic maps.

For the inventory of glaciers, the area is divided into basins and further sub-divided into sub-basins. The aerial extension of the glaciers is found with the help of geographic information systems (GIS). To estimate the ice reserves, it is an utmost necessity to have the mean thickness of the glaciers. Since the mean glacier thickness data are not available, this is estimated from the equation developed for the Tianshan Mountains (Cahohai Liu and Liangfu 1986)

$H = -11.32 + 53.21F^{0.3}$

where H = mean ice thickness (m) and F = area of glacier (km^2)

The ice reserves were estimated by multiplying the mean thickness by the area of the glacier.

7.2 Types of Glacier

The classification of glaciers is adopted from the morphological classification of glaciers by the World Glacier Monitoring Service (WGMS) (Muller et al. 1977). Details of the classification are mentioned in Chapter 4. The classified glaciers are divided into different types, combining Digit 1 of 'primary classification' and Digit 2 of 'form'. Generally, six types of glacier are observed in the Bhutan Himalayas—mountain glaciers, valley glaciers, cirque glaciers, niche glaciers, ice caps, and ice aprons. Mountain glaciers are dominant in quantity and the profile shows a hanging nature. Other glaciers, except for valley glaciers, generally fall into the category of mountain glaciers but the thickness of ice is comparatively low. The number of valley glaciers is comparatively low but the corresponding areas and ice reserves are higher than those of mountain glaciers. The area and ice reserves of the valley glaciers are generally large owing to the fact that the ice thickness increases with increase in the area of the glacier.

Mountain glaciers are uncertain or miscellaneous, compound basins, compound basin, or simple basin in the form of a hanging glacier. The major source of nourishment is snow and/or drift snow. Ice caps, cirque glaciers, niche glaciers, and ice aprons are other types of hanging mountain glaciers, but they are considered to be a different type due to their significance in size, shape, form, and ice thickness. The most significant valley type glaciers are fewer in number and characterised by compound basins, compound basin, and simple basin. They are mainly nourished by snow and drift snow at the headwater and by snow and ice avalanche at the lower valley. The adjoining part of the valley glacier at the headwaters is characteristically a mountain glacier, but due to its continuation into a valley glacier, the whole ice mass will be considered to be a valley glacier. Hence, the area of the valley glacier is higher than that of the mountain glaciers.

The longitudinal profile of the valley glacier from crown to toe shows an even or regular shape. As the headwater is steeper and has a gentle slope in the lower reaches, the profile makes the curve concave upwards. Due to the gentle slope at the lower reaches and the accumulation of debris derived from the headwater, glacial lakes develop in a supra glacial and moraine dammed form. Generally, the stability of glacial lakes is poor and there is always the chance of avalanches from mountain glaciers, which may break the damming material and cause glacial lake outburst floods (GLOFs).

7.3 General Characteristics of Glaciation

The occurrence of glaciers has always been linked to climatic conditions. Climate is of fundamental importance to the inception and growth of glaciers. The form of the landscape dictates the threshold conditions for glacier occurrence and determines glacier morphology. In certain climatic conditions for glaciation, glaciers of different shapes and sizes are formed depending on the landscape. Mountain glacier regions are associated with climatic fronts, zones of maximum precipitation.

The general characteristics of glaciation in the Bhutan Himalayas is not well studied. Tshoju Glacier in Lunana Valley had advanced below Tshoju village in the past. It is recognised by the presence of lacustrine deposits in the Tshoju Plains as a result of the damming of the eastern branch of the Pho Chu by Tshoju Glacier.

Ageta and Iwata (1999) reported retreat of the glaciers in the Bhutan Himalayas with the help of satellite images, maps, and survey data from different years. The terminus of Tarina Glacier retreated around 0.7 km (30 to 35m year^{-1}) from 1967 to 1998. Raphstreng Glacier retreated about 0.5 km (35m year^{-1}) during a 14-year interval. Lugge Glacier retreated by 16m year^{-1} from 1988 to 1993. Generally, the termini of the glaciers of the Bhutan Himalayas are retreating at a rate of 30– 40m year^{-1}.

Gansser (1983) reported that the oldest stage of a glacier in Bhutan extends down to 2,900m. It was recognised from the preservation of remnants of the terminal moraine below the landslide debris in Koma Chu Valley south of Sengge Dzong. He has again distinguished the levels of the glaciers in different valleys as shown in Table 7.1.

Table 7.1: Levels of glaciation in different valleys of Bhutan

Glaciation stage	Elevation (levels)	Remarks
Present glaciers	4,200–5,000 masl	
Recent moraines	4,200–4,700 masl	
Thanza stage (Little Ice Age)	4,000–4,200 masl	150 years old (approximately)
Lingshi stage	3,800–3,900 masl	
Wachey stage	3,500–3,600 masl	
Taksaka stage	3,300–3,400 masl	
Older stages	2,600–3,100 masl	

4.4 Glaciers of Bhutan

The present inventory is based on topographic maps on a scale of 1:50,000 published by the Survey of India in the period from 1950 to 1970. For this work, the six basins of Bhutan, as indicated in Chapter 3, are divided into thirteen sub-basins as given in Table 7.2. As can be seen from the table, there are no glaciers in the Amo Chu and Nyere Ama Chu Basins and the Ha Chu and Dang Chu Sub-basins.

The majority of the glaciers in Bhutan fall into the primary classification of mountain glaciers with simple basins with their major source of recharge being from snow or avalanches with a marked rate of retreat. Glaciers in the Bhutan Himalayas generally occur above the elevation of 4,000 masl. There are 677 glaciers altogether within the territory of Bhutan (Table 7.2 and Figure 7.1). They cover an area of 1,316.71 sq.km with approximately 127.25 km^3 of ice reserves. The details of the glacier inventory for all the sub-basins are given in Annex I.

Table 7.2: Distribution of glaciers in the Bhutan Himalayas

S. No.	Sub-basin	Basin	Glacier number	Area (km^2)	Ice reserve (km^3)
1	Amo Chu	Amo Chu	0	0	0
2	Ha Chu	Wang Chu	0	0	0
3	Pa Chu		21	40.51	3.22
4	Thim Chu		15	8.41	0.33
5	Mo Chu	Puna Tsang Chu	118	169.55	11.34
6	Pho Chu		154	333.56	31.935
7	Dang Chu		0	0	0
8	Mangde Chu	Manas Chu	140	146.69	11.92
9	Chamkar Chu		94	104.10	8.11
10	Kuri Chu		51	87.62	6.48
11	Dangme Chu		25	38.54	2.26
12	Nyere Ama Chu	Nyere Ama Chu	0	0	0
13	Northern Basin	Northern Basin	59	387.73	51.72
	Total		677	1316.71	127.25

Among the glaciated sub-basins, Thim Chu has the smallest number of glaciers. Only 15 glaciers with an area of 8.41 sq.km and an ice reserve of 0.33 km^3 were found in this sub-basin. The Mo Chu, Pho Chu, and Mangde Chu Sub-basins are the biggest sub-basins consisting of 118, 154, and 140 glaciers respectively. The Northern Sub-basin and the Pho Chu Sub-basin cover areas of 387.73 and 333.56 sq.km respectively. Of the total ice reserve in the Bhutan Himalayas, around 66% is held by the Northern Sub-basin and the Pho Chu Sub-basin.

The Pa Chu Sub-basin

The Pa Chu is a sub-basin of the Wang Chu Basin. It has three major tributaries: the Chomolhari Chu, the Halun Chu, and the Thangothang Chu. The latter two originate from Chomolhari and Kang Phu Glaciers respectively.

The aspect of the glaciers is distributed in all directions except in the east. There is one glacier in the north aspect and one in the west. There are five glaciers in the northwest aspect and five in the southeast. In other aspects there are two to four glaciers (Table 7.3).

Table 7.3: Summary of glaciers in the Pa Chu Sub-basin with respect to aspect

Aspect	N	NE	NW	W	S	SE	SW
Number of glacier	1	2	5	1	4	5	3
Area (km^2)	0.20	0.79	1.61	0.24	19.49	17.18	1.00
Area (%)	0.49	1.95	3.97	0.59	48.11	42.41	2.47
Maximum area (km^2)	0.20	0.43	0.62	0.24	10.19	11.31	0.47
Minimum area (km^2)	0.20	0.40	0.20	0.24	0.50	0.30	0.10
Maximum length (m)	510	5497	1106	745	7739	6055	1398
Minimum length (m)	510	1148	725	745	965	1717	802
Highest elevation (masl)	5570	5600	5642	5340	7226	7326	5570
Mean elevation (masl)	5365	5240	5224	5180	5553	5811	5228
Tongue elevation (masl)	5160	4920	4880	5020	4200	4320	4760
Ice reserve (km^3)	0.004	0.023	0.045	0.006	1.663	1.449	0.029

The Pa Chu Sub-basin has a total of 21 glaciers and covers an area of 40.51 sq.km with ice reserves of 3.22 km^3 (Table 7.4). The two largest glaciers in the sub-basin are Pa_gr 8 and Pa_gr 10. Both of them are valley glaciers and have an area coverage of 11.31 and 10.19 sq.km respectively. Glacier Pa_gr 8 is 6.1 km long and its tongue elevation is 4,320 masl. Glacier Pa_gr 10 is 7.74 km long and its tongue elevation is 4,200 masl (Figure 7.2).

Table 7.4: Distribution of glaciers by type in the Pa Chu Sub-basin

Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	of largest glacier	of smallest glacier	km^3	%
Mountain	12	57.14	15.32	37.82	6.79	0.18	0.981	30.48
Ice apron	7	33.33	3.69	9.11	1.85	0.09	0.147	4.57
Valley	2	9.52	21.50	53.07	11.31	10.19	2.091	64.96
Total	21		40.51				3.219	

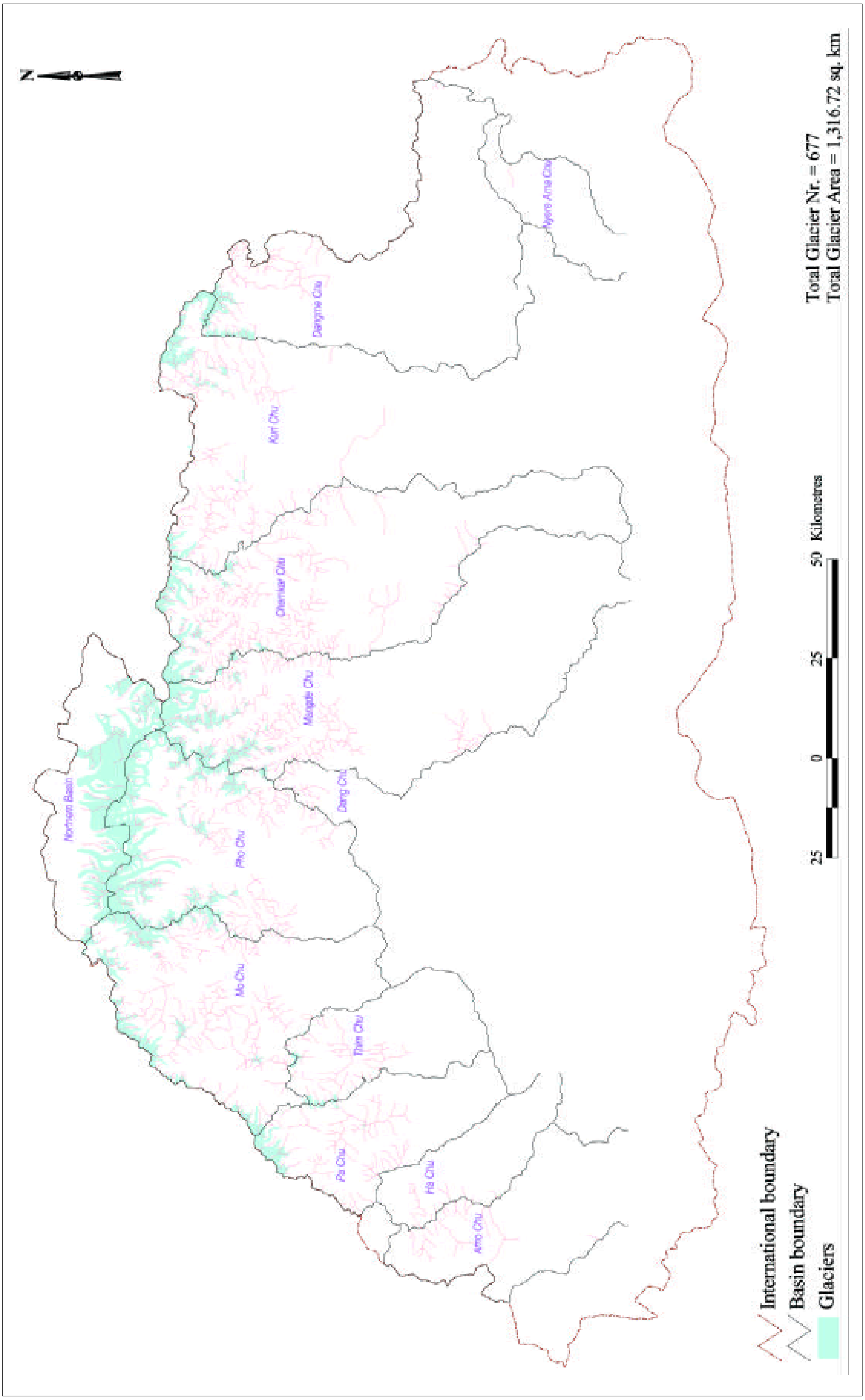


Figure 7.1: Distribution of glaciers in the Bhutan Himalayas

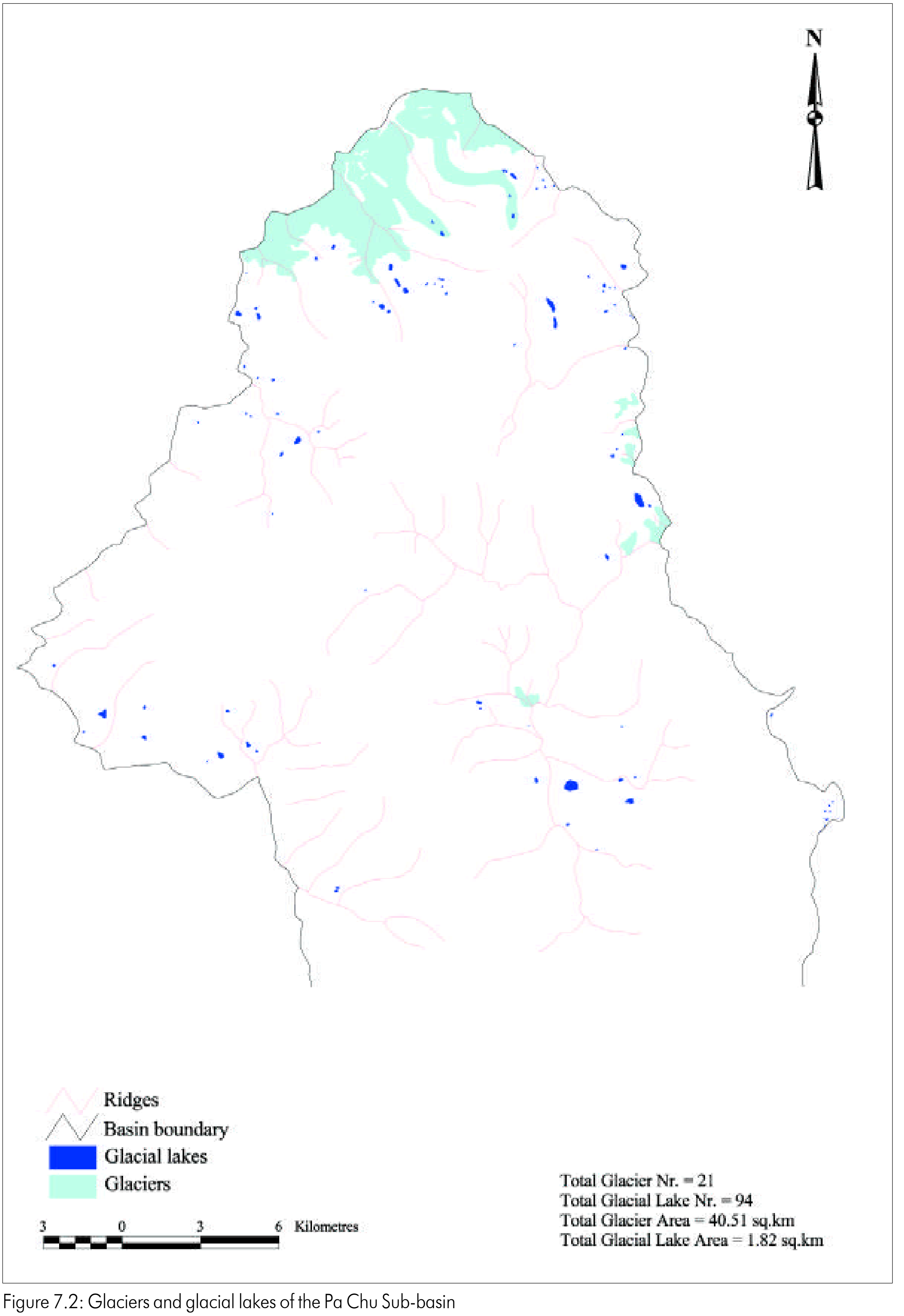


Figure 7.2: Glaciers and glacial lakes of the Pa Chu Sub-basin

There are only three types of glacier in the Pa Chu Sub-basin—mountain, ice apron, and valley. Two valley glaciers cover 53% of the area and 65% of the ice reserve (Table 7.4). The least of the area is covered by ice aprons.

The Thim Chu Sub-basin

The Thim Chu is the easternmost tributary of the Wang Chu. It consists of 15 glaciers with a cumulative area of 8.41 sq.km (Figure 7.3). A northeastern oriented glacier is dominant in the Thim Chu Sub-basin (Table 7.5). The tongue elevation of the northeastern aspect glaciers extends down to 4,840 masl. Generally the tongues of the glaciers for the four other remaining aspects are above 5,000 masl. The maximum length of the glaciers is 2.25 km and the minimum length is about 0.41 km.

There are only two types of glacier in this sub-basin—mountain glaciers and ice aprons. The largest glacier covers an area of 5.1 sq.km and the smallest 0.09 sq.km. Glacier tongue elevations range from 4,840 to 5,160 masl. The total ice reserve of all the 15 glaciers is estimated at 0.33 km^3 (Table 7.6).

Table 7.5: Summary of glaciers in the Thim Chu Sub-basin with respect to aspect

Aspect	NE	E	SE	SW	S
Number of glacier	7	2	2	3	1
Area (km^2)	3.98	2.04	0.37	1.20	0.46
Area (%)	47.32	28.54	4.40	14.27	5.47
Maximum area (km^2)	1.20	1.77	0.33	0.58	0.46
Mean area (km^2)	0.57	1.20	0.19	0.40	0.46
Minimum area (km^2)	0.10	0.60	0.00	0.20	0.50
Maximum length (m)	1808	2254	660	855	675
Minimum length (m)	415	1202	408	628	675
Highest elevation (masl)	5642	5520	5680	5280	5240
Mean elevation (masl)	5253.43	5235.00	5447.25	5184.67	5200.00
Tongue elevation (masl)	4840	5040	5120	5080	5160
Ice reserve (km^3)	0.16	0.11	0.01	0.04	0.01

Table 7.6: Distribution of glaciers by type in the Thim Chu Sub-basin.

Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	of largest glacier	of smallest glacier	km^3	%
Mountain	10	66.67	6.82	81.09	1.77	0.09	0.285	85.59
Ice apron	5	33.33	1.59	18.91	0.58	0.04	0.048	14.41
Total	15		8.41				0.333	

The Mo Chu Sub-basin

The Mo Chu is the westernmost branch of the Puna Tsang Chu. Two branches, one originating from northern Bhutan and the other originating in the west from southeast of Chomolhari Mountain, join to form the Mo Chu. The western branch comprises only 19 glaciers, while the other branch has 99 glaciers. The total area covered by these glaciers is 169.55 sq.km with an ice reserve of 11.34 km^3.

The southwestern and southeastern aspect glaciers are dominant (Table 7.7). The largest glacier, Mo_gr 96, has an area of 32.55 sq.km and is located at latitude 28° 5' 34.2" and longitude 89° 50' 27.1" at an altitude of 4,440 masl (tongue elevation of the glacier).

Four types of glacier have been recognised, out of which mountain glaciers are dominant in terms of number. There are 83 mountain glaciers and 12

Table 7.7: Summary of glaciers on the basis of aspect in the Mo Chu Sub-basin

Aspect	N	NE	NW	E	W	S	SE	SW
Number of glacier	6	15	13	8	13	12	23	28
Area (km^2)	5.20	11.41	25.38	16.47	21.12	8.94	33.62	47.41
Area (%)	3.07	6.73	14.97	9.71	12.46	5.27	19.83	27.96
Maximum area (km^2)	1.20	4.81	12.77	8.68	6.55	2.81	8.09	13.22
Mean area (km^2)	0.87	0.76	1.95	2.06	1.62	0.74	1.46	1.63
Minimum area (km^2)	0.40	0.10	0.00	0.10	0.10	0.10	0.10	0.10
Maximum length (m)	1762	5121	5597	7302	4963	4592	5291	8060
Minimum length (m)	1174	456	233	450	595	542	512	523
Highest elevation (masl)	5564	5784	6480	6789	5685	6400	6789	6790
Mean elevation (masl)	5174	5155	5290	5227	5228	5407	5412	5267
Tongue elevation (masl)	4760	4680	4520	4120	4800	4400	4120	4080
Ice reserve (km^3)	0.210	0.607	2.059	1.195	1.366	0.414	2.107	3.382

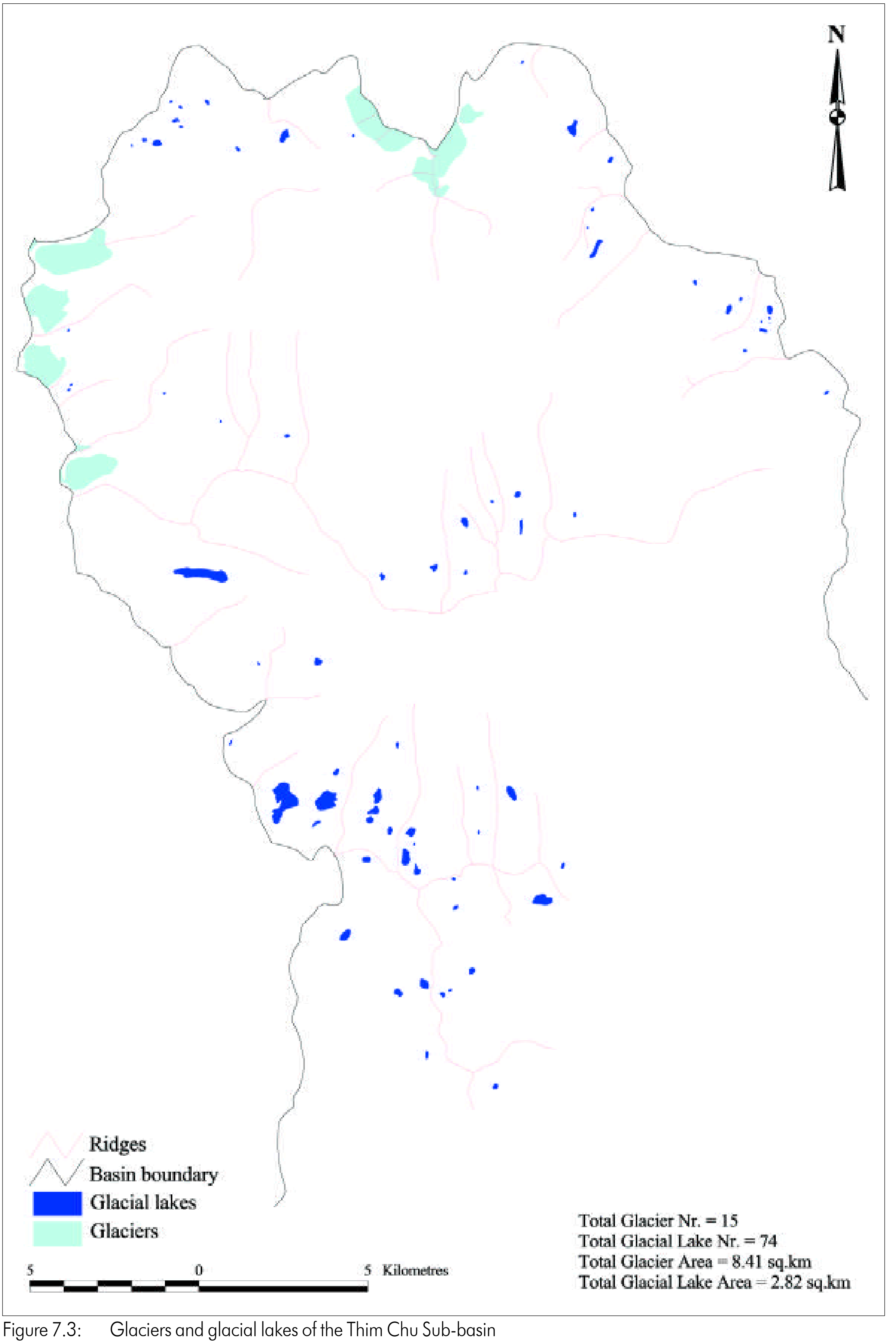


Figure 7.3: Glaciers and glacial lakes of the Thim Chu Sub-basin

valley glaciers (Figure 7.4). Areas occupied by these glaciers are 87.77 and 77.11 sq.km respectively. Out of the total ice reserves in the sub-basin the valley glaciers and mountain glaciers contain 58.84 and 40.09% respectively (Table 7.8).

Table 7.8: Distribution of glaciers by type in the Mo Chu Sub-basin

Glacier type	Number		Area				Ice reserve	
	Number	%	km²	%	of largest glacier	of smallest glacier	km³	%
Mountain	83	70.34	87.77	51.77	6.55	0.07	4.546	40.09
Ice cap	2	1.69	0.08	0.05	0.05	0.03	0.001	0.01
Ice apron	19	16.10	4.41	2.60	0.92	0.10	0.118	1.04
Cirque	2	1.69	0.18	0.11	0.09	0.09	0.002	0.02
Valley	12	10.17	77.11	45.48	13.22	2.60	6.672	58.84
Total	118		169.55				11.339	

The Pho Chu Sub-basin

The Pho Chu is a prominent tributary of the Puna Tsang Chu which is fed by numerous glaciers that exist in the extreme northern part of Bhutan. The river flows through very rugged terrain and deep gorges to join with the Mo Chu near Punakha Dzong. Compared to other parts of the northern region, the largest receding valley glaciers are found in the headwaters of the Pho Chu Sub-basin. This region is now well known as the Lunana region due to the 1994 GLOF. As many as 154 glaciers have been identified which feed the Pho Chu (Figure 7.5). The largest glacier, Tshoju Glacier (Pho_gr76), is located at the eastern branch of the Pho Chu at latitude 28° 7' 57.28" and longitude 90° 9' 57.67" at an elevation of 4,120 masl (glacier tongue elevation).

The western branch of the Pho Chu originates from the Tarina region flowing southeasterly along Tarina Valley. In total there are 71 glaciers feeding the western branch of the Pho Chu. The largest glacier on the western branch of the Pho Chu is Wachey Glacier (Pho_gr 68) with a length of 20.12 km and covering an area of 38.52 sq.km. It advanced much further south than its counterparts in eastern Lunana during the Little Ice Age. Glaciers Pho_gr 31 to 68 lie south of Tsendagang and east of Gangla Kharchung. Two prominent glacial lakes are associated with the glaciers in the region. These lakes are known to local people as Mouzom Tsho and referred to by Gansser (1970) as Tarina lakes.

The most dominant aspects of the glaciers are northeast, southeast, and southwest, in descending order. The north aspect glaciers are fewest in number (Table 7.9).

The eastern branch of the Pho Chu originates from eastern Lunana region and drains one of the remote parts of northern Bhutan. It flows through the wide inhabited valley of Thanza. There are several glaciers in this region, but the most prominent ones are Tshoju Glacier (Pho_gr 76), Chunami Glacier (Pho_gr 72), Bechung Glacier (Pho_gr 79), Raphstreng Glacier (Pho_gr 80), Thorthomi Glacier (Pho_gr 81), Lugge Glacier (Pho_gr 82), Drukchong Glacier (Pho_gr 83), and Yaksagang Glacier (Pho_gr 84). Tshoju Glacier terminates against the southwest–northeast trending Lunana Valley. In the geological past

Table 7.9: Summary of glaciers in the Pho Chu Sub-basin on the basis of aspect

Aspect	N	NE	NW	E	W	S	SE	SW
Number of glacier	5	36	24	8	13	11	29	28
Area (km²)	7.52	27.58	32.78	9.73	16.18	115.67	77.95	46.15
Area (%)	2.25	8.26	9.82	2.91	4.85	34.68	23.37	13.83
Maximum area (km²)	2.60	3.23	7.74	4.29	5.09	49.27	38.54	14.99
Minimum area (km²)	0.20	0.05	0.07	0.04	0.06	0.14	0.11	0.13
Maximum length (m)	2819	3573	6534	3792	3526	16 212	20 117	7529
Minimum length (m)	570	501	368	332	389	432	458	595
Highest elevation (masl)	5880	5855	5638	5685	5710	5471	6949	6949
Mean elevation (masl)	5387	5152	5138	5239	5225	5248	5217	5306
Tongue elevation (masl)	5120	4340	4640	4800	4960	4120	4120	4600
Ice reserve (km³)	0.396	1.346	2.142	0.542	0.891	14.434	8.711	3.410

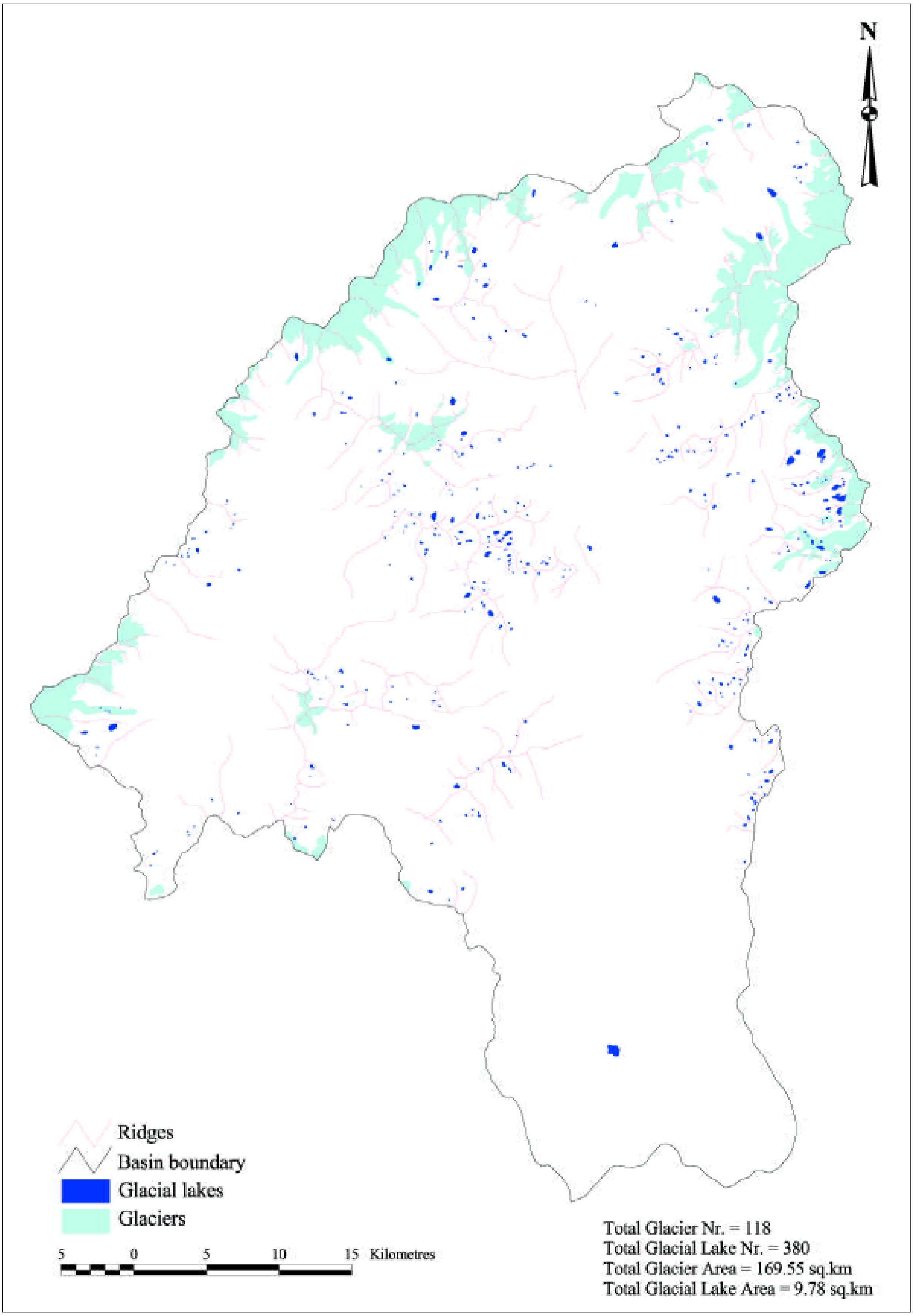


Figure 7.4: Glaciers and glacial lakes of the Mo Chu Sub-basin

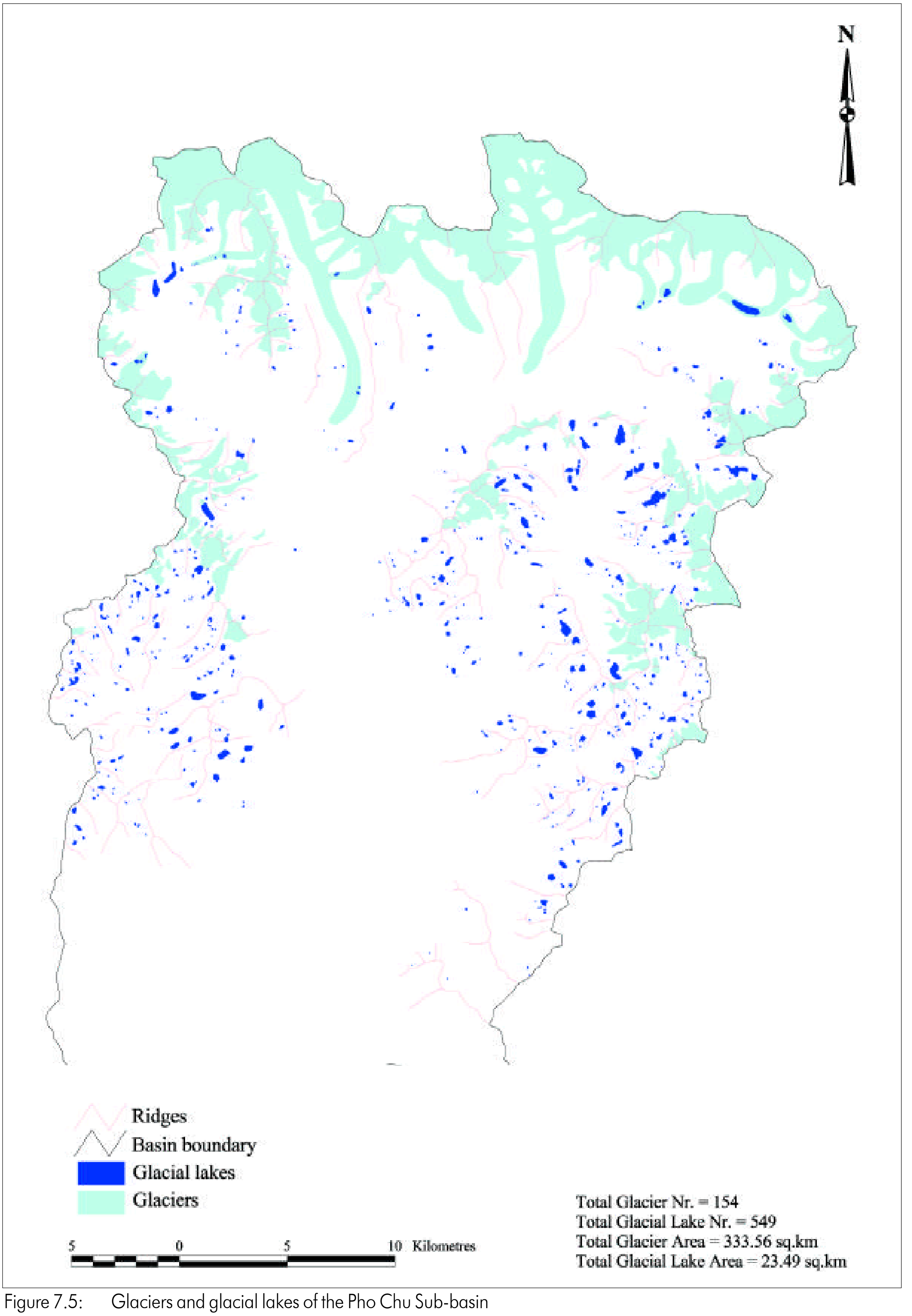


Figure 7.5: Glaciers and glacial lakes of the Pho Chu Sub-basin

the glacier advanced below Tshoju village and once dammed the eastern branch of the Pho Chu. This is evidenced by the vast lacustrine deposit in the Tshoju Plains. In the Pho Chu Sub-basin there are 115 mountain glaciers, 18 ice apron glaciers, and 11 valley glaciers; 76.03% of the ice reserve is with the valley glaciers and 23.41% with the mountain glaciers (Table 7.10).

Table 7.10: Distribution of glaciers by type in the Pho Chu Sub-basin

Glacier type	Number		Area				Ice reserve	
	Number	%	km²	%	of largest glacier	of smallest glacier	km³	%
Mountain	115	74.68	137.52	41.23	6.90	0.05	7.46	23.41
Ice cap	3	1.95	0.39	0.12	0.20	0.14	0.01	0.03
Ice apron	18	11.69	4.85	1.45	1.53	0.20	0.15	0.47
Niche	4	2.60	0.33	0.10	0.10	0.06	0.01	0.03
Cirque	3	1.95	0.51	0.15	0.24	0.12	0.01	0.03
Valley	11	7.14	189.97	56.95	49.27	1.48	24.23	76.03
Total	154		333.56				31.87	

The Mangde Chu Sub-basin

The Mangde Chu is the western branch of the Manas River. The headwaters of the Mangde Chu are separated from those of the Pho Chu eastern branch (Lunana) by the north–south trending Yaksagang-Gophula-Pele La Range. The north–south trending Gangkarpuensum-Djulela-Yuto La Ridge separates the Mangde Chu from the Chamkhar Chu. In the northern region the Mangde Chu has three branches, two of which have their origins in glaciated and snow-covered terrain. The main branch of the Mangde Chu originates from a large valley glacier south of Kang Ri Summit (7,239 masl). The aspect of the glaciers is distributed in all directions. The highest number (28) of glaciers is in the northeast aspect and the lowest number (5) of glaciers is in the north aspect (Table 7.11).

Table 7.11: Summary of glaciers in the Mangde Chu Sub-basin on the basis of aspect

Aspect	N	NE	NW	E	W	S	SE	SW
Number of glacier	5	28	19	9	13	22	15	25
Area (km²)	2.05	22.39	6.41	5.22	8.15	72.85	14.85	46.00
Area (%)	1.40	15.26	4,37	3.56	5.56	49.66	10.07	10.12
Maximum area (km²)	0.79	3.97	3.59	1.65	2.52	44.11	3.30	3.39
Mean area (km²)	0.23	0.80	0.34	0.58	0.63	3.31	0.98	0.59
Minimum area (km²)	0.10	0.00	0.00	0.10	0.10	0.00	0.00	0.00
Maximum length (m)	1788	3369	4180	2316	2358	10561	3131	3298
Minimum length (m)	424	182	276	525	241	386	305	404
Highest elevation (masl)	5710	5868	5640	5868	5868	5760	5688	6580
Mean elevation (masl)	5264	5323	5311	5429	5314	5352	5385	5325
Tongue elevation (masl)	5020	4500	4960	5080	5000	4720	4840	4950
Ice reserve (km³)	0.057	1.108	0.307	0.210	0.377	8.462	0.756	0.646

The Mangde Chu Sub-basin has a total of 140 glaciers occupying an area of 146.69 sq.km (Figure 7.6). The majority of the glaciers are mountain glaciers (Table 7.12). Only one valley glacier has been recognised in this sub-basin. This is the largest glacier of the sub-basin with a length of 10.56 km and an area of 44.11 sq.km. Glacier tongue elevations in the sub-basin range from 4,500 masl to 5,080 masl.

The Chamkhar Chu Sub-basin

The Chamkhar Chu originates from the glacier south of the water divide separating Tibet from Bhutan's northern territory. The Chamkhar Chu drains the whole of Bumthang Dzongkhag. It has one western branch and two eastern branches. The western branch has its source from the glaciers of Gangkar Punsum region and the eastern branches have their sources from the glaciers south of the Monla Karchung La Range.

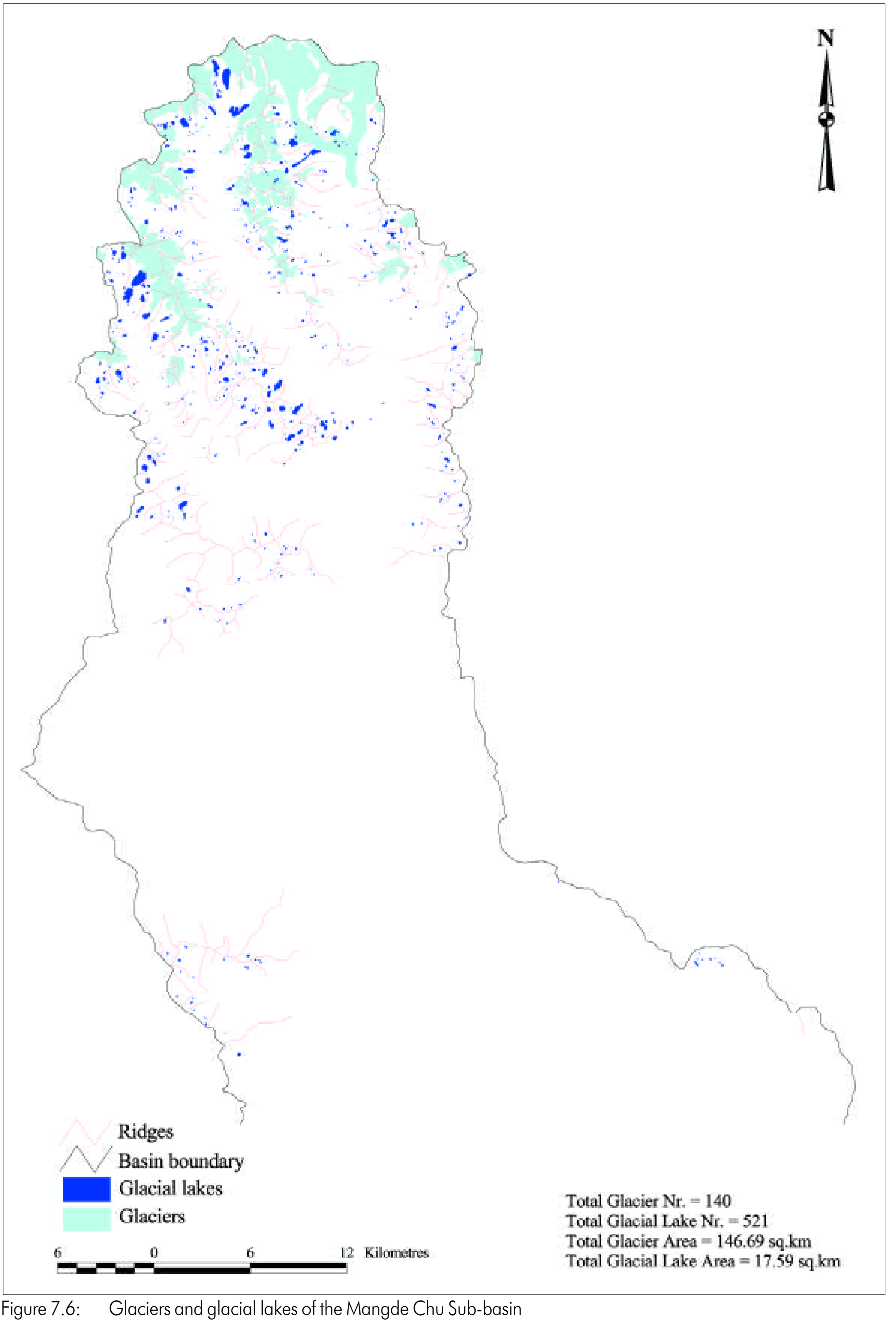


Figure 7.6: Glaciers and glacial lakes of the Mangde Chu Sub-basin

Table 7.12: Distribution of glaciers by type in the Mangde Chu Sub-basin								
Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	0f largest glacier	of smallest glacier	km^3	%
Mountain	92	65.71	96.20	65.58	4.28	0.03	4.968	41.67
Ice apron	12	8.57	1.44	0.98	0.33	0.02	0.030	0.25
Ice cap	9	6.43	2.47	1.68	0.85	0.04	0.072	0.60
Cirque	3	2.14	0.46	0.31	0.21	0.10	0.010	0.08
Niche	23	16.43	2.01	1.37	0.18	0.03	0.033	0.28
Valley	1	0.70	44.11	30.1	44.11	44.11	6.810	57.10
Total	140		146.69				11.923	

The aspect of the glaciers is distributed in all directions. The highest number (24) of glaciers is in the northeast aspect followed by the southeast (22) and southwest (20) (Table 7.13 and Figure 7.7). There is only one glacier both east and south aspects. At the source of the Chamkhar Chu western branch a number of glaciers exist, the largest being a valley glacier, Cham_gr 25, lying at an elevation of 4,582 masl (glacier tongue elevation), east of Kang Ri Summit (7,239 masl) and oriented southeast. This glacier occupies an area of 26.71 sq.km and is 8.9 km long. The Chamkhar Chu eastern branch also has many glaciers at its source, the largest is again a valley glacier, Cham_gr 71 (Chubda Glacier), oriented southwest. Within this glacier there are number of supraglacial lakes which were observed during an expedition in August 1999 (Karma 1999). Out of the 94 glaciers inventoried in this sub-basin, 70 are mountain glaciers, 16 are niche, five are ice apron, and three are valley glaciers. The three valley glaciers contain 64.53% of the ice reserve (Table 7.14).

Table 7.13: Summary of glaciers in the Chamkhar Chu Sub-basin on the basis of aspect								
Aspect	N	NE	NW	E	W	S	SE	SW
Number of glacier	3	24	18	1	5	1	22	20
Area (km^2)	0.50	8.19	6.62	0.49	3.49	0.61	47.69	36.51
Area (%)	0.48	7.87	6.36	0.47	3.35	0.59	45.81	35.07
Maximum area (km^2)	0.41	1.06	1.72	0.49	1.07	0.61	26.71	12.45
Mean area (km^2)	0.17	0.34	0.37	0.49	0.70	0.61	2.17	1.83
Minimum area (km^2)	0.00	0.10	0.10	0.50	0.40	0.61	0.10	0.10
Maximum length (m)	1155	2105	1030	665	1255	1390	8875	7985
Minimum length (m)	250	435	290	665	420	1390	165	375
Highest elevation (masl)	5550	5520	6085	5560	5550	5400	6200	6200
Mean elevation (masl)	5318	5248	5320	5380	5346	5135	5397	5428
Tongue elevation (masl)	4970	4910	4990	5200	5180	4870	4582	4800
Ice reserve (km^3)	0.013	0.249	0.234	0.016	0.134	0.021	4.717	2.728

Table 7.14: Distribution of glaciers by type in the Chamkhar Chu Sub-basin								
Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	of largest glacier	of smallest glacier	km^3	%
Mountain	70	74.47	54.36	52.22	5.95	0.08	2.727	33.62
Ice apron	5	5.32	2.59	2.49	1.72	0.17	0.107	1.32
Niche	16	17.02	2.17	2.08	0.28	0.03	0.043	0.53
Valley	3	3.19	44.98	43.21	26.71	5.82	5.235	64.53
Total	94		104.1				8.112	

The Kuri Chu Sub-basin

A large part of the Kuri Chu headwaters lie in Tibet. Within Bhutan it has two major tributaries, the Bahilung Chu flowing southeasterly and the Khoma Chu flowing southerly. The Kuri Chu joins the Khoma Chu southeast of Lhuntsi Dzong.

There are 51 glaciers that have been identified within Bhutan from satellite images in the headwaters of the Kuri Chu (Figure 7.8). They occupy a surface area of 87.62 sq.km. In terms of number southeast and northeast oriented glaciers are dominant, but in terms of area covered by glaciers the northwest and southeast aspect are significant (Table 7.15).

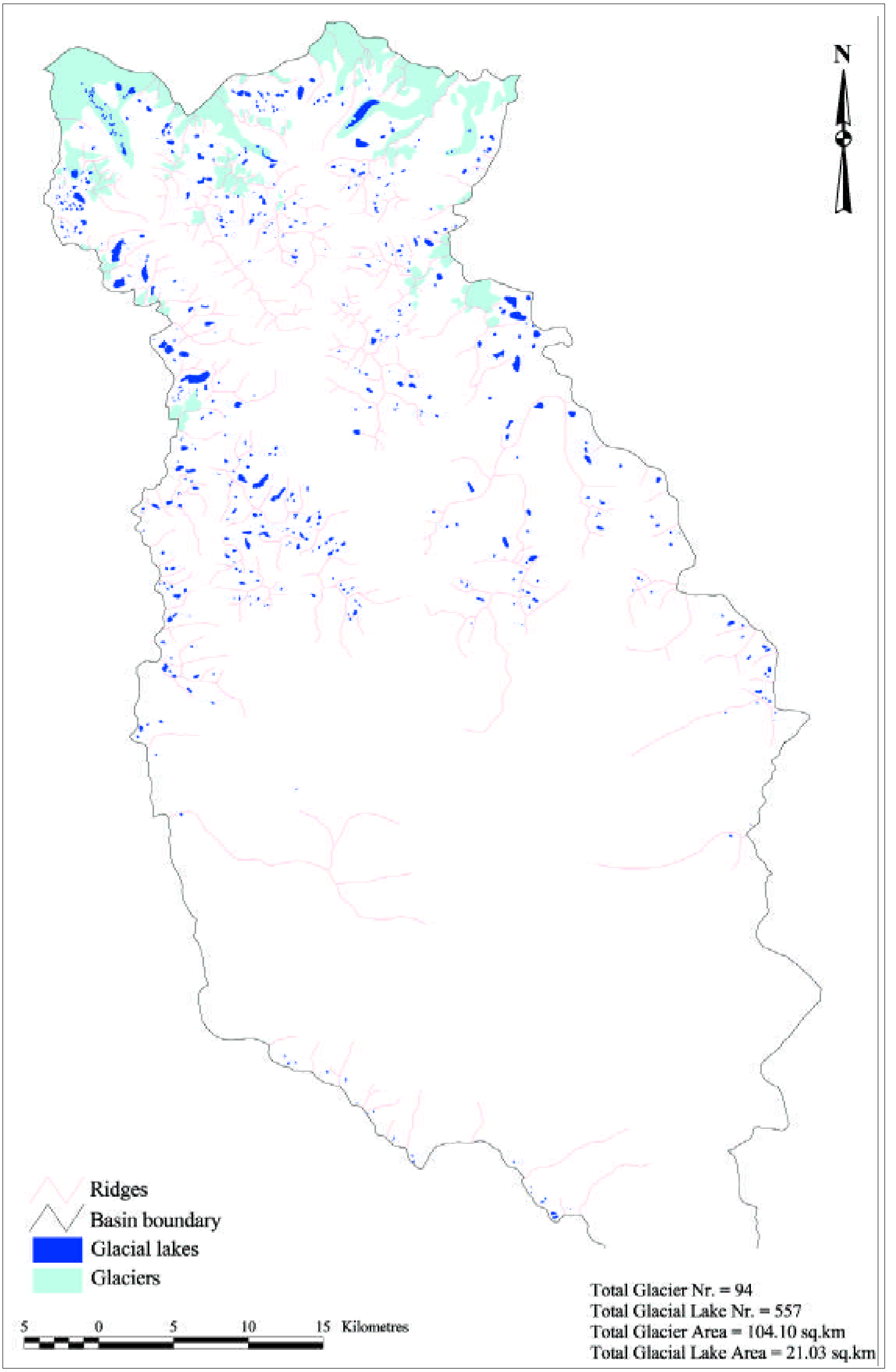


Figure 7.7: Glaciers and glacial lakes of the Chamkhar Chu Sub-basin

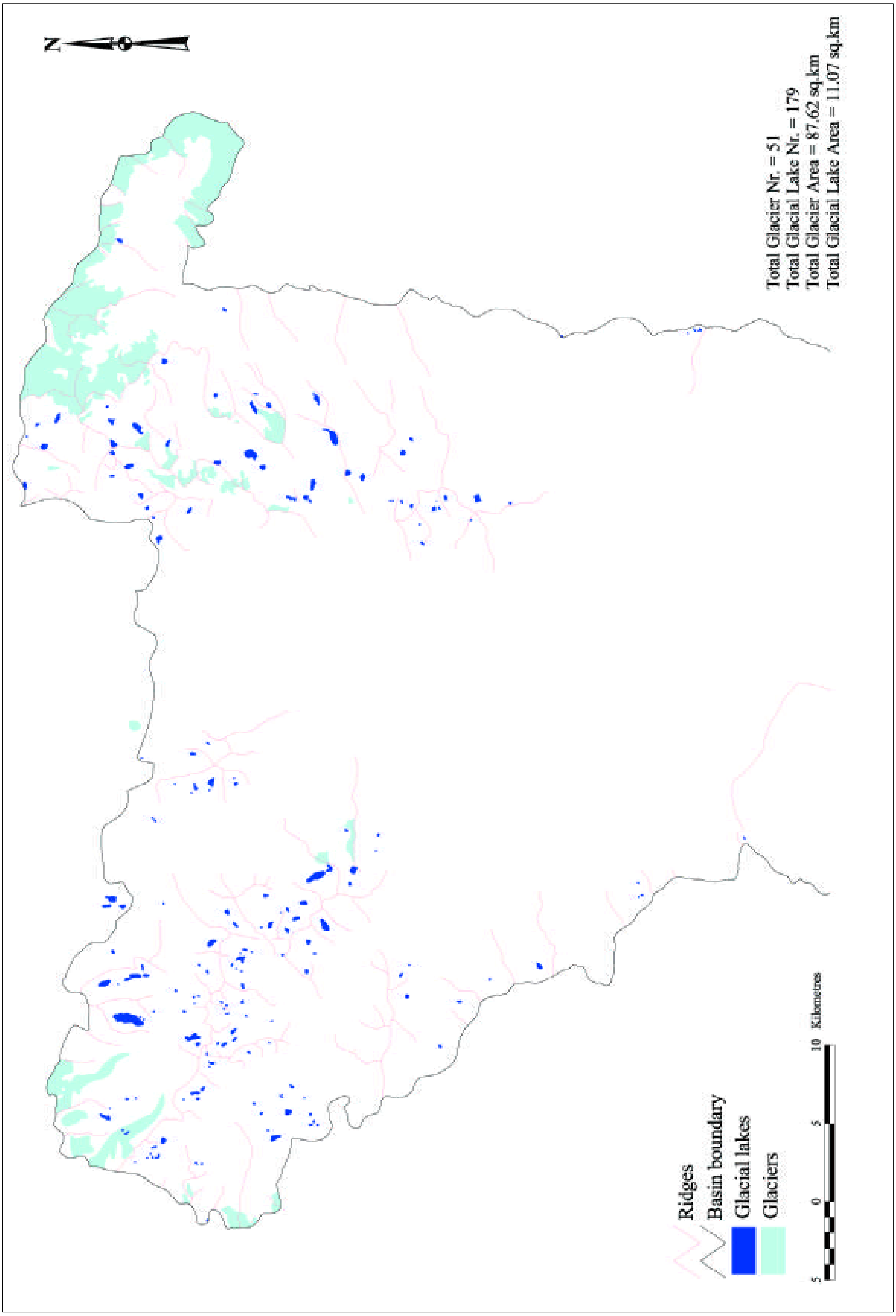


Figure 7.8: Glaciers and glacial lakes of the Kuri Chu Sub-basin

Table 7.15: Summary of glaciers in the Kuri Chu Sub-basin on the basis of aspect								
Aspect	N	NE	NW	E	W	S	SE	SW
Number of glacier	3	10	4	2	4	5	14	9
Area (km^2)	0.97	13.02	14.82	0.84	2.44	3.12	41.08	11.33
Area (%)	1.11	14.86	16.91	0.96	2.78	3.56	46.88	12.96
Maximum area (km^2)	0.39	2.75	13.89	0.72	1.70	1.52	12.84	2.42
Mean area (km^2)	0.32	1.30	3.71	0.42	0.61	0.62	2.93	1.26
Minimum area (km^2)	0.20	0.20	0.10	0.10	0.00	0.10	0.10	0.10
Maximum length (m)	1000	2450	2150	750	1250	1550	6600	1800
Minimum length (m)	550	350	200	650	300	300	400	250
Highest elevation (m)	4610	4280	4680			5400	5765	
Mean elevation (m)		6320	6980			7900	7855	
Tongue elevation (m)		4080	4600			5000	4180	
Ice reserve (km^3)	0.026	0.655	1.497	0.029	0.110	0.132	3.427	0.610

Mountain glaciers are the dominant type in the Kuri Chu Sub-basin. They occupy an area of 72.14 sq.km and contain around 84% of the ice reserve of this sub-basin (Table 7.16).

Table 7.16: Distribution of glaciers by type in the Kuri Chu Sub-basin								
Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	of largest glacier	of smallest glacier	km^3	%
Mountain	38	74.51	72.14	82.33	13.89	0.16	5.423	83.73
Ice apron	4	7.84	0.72	0.82	0.40	0.04	0.017	0.26
Cirque	1	1.96	0.10	0.11	0.10	0.10	0.002	0.03
Niche	4	7.84	0.48	0.55	0.13	0.11	0.008	0.12
Valley	4	7.84	14.18	16.18	6.00	0.72	1.027	15.86
Total	51		87.62				6.477	

The Dangme Chu Sub-basin

In this sub-basin only 25 glaciers have been identified, covering an area of 38.32 sq.km (Figure 7.9). None of the glaciers in this sub-basin has been physically checked to date. Most of the glaciers are mountain glaciers and east oriented glaciers seem to be the dominant type in this region (Table 7.17). The largest glacier, Dangm_gr 19, has a maximum area of 5.60 sq.km and a length of 4.43 km and is located at latitude 27° 54’ 28.68" and longitude 91° 28’ 50.39". A total of 2.258 km^3 of ice reserve has been estimated (Table 7.18). All the glaciers have been studied from satellite images due to the unavailability of topographic maps and hence the elevations of the glaciers in this sub-basin are unknown.

Table 7.17: Summary of glaciers in Dangme Chu Sub-basin on the basis of aspect				
Aspect	NE	E	SE	SW
Number of glacier	1	11	5	8
Area (km^2)	0.98	17.01	5.99	14.56
Area (%)	2.54	44.14	15.54	37.78
Maximum area (km^2)	0.98	3.99	4.04	5.60
Mean area (km^2)	0.98	1.55	1.20	1.82
Minimum area (km^2)	1.00	0.40	0.10	0.20
Maximum length (m)	1506	2200	2382	4433
Minimum length (m)	1506	760	580	473
Ice reserve (km^3)	0.040	0.940	0.360	0.920

Table 7.18: Distribution of glaciers by type in Dangme Chu Sub-basin								
Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	of largest glacier	of smallest glacier	km^3	%
Mountain	23	92.00	38.32	99.43	5.60	0.20	2.254	99.82
Ice apron	1	4.00	0.11	0.29	0.11	0.11	0.002	0.09
Niche	1	4.00	0.11	0.29	0.11	0.11	0.002	0.09
Total	25		38.54				2.258	

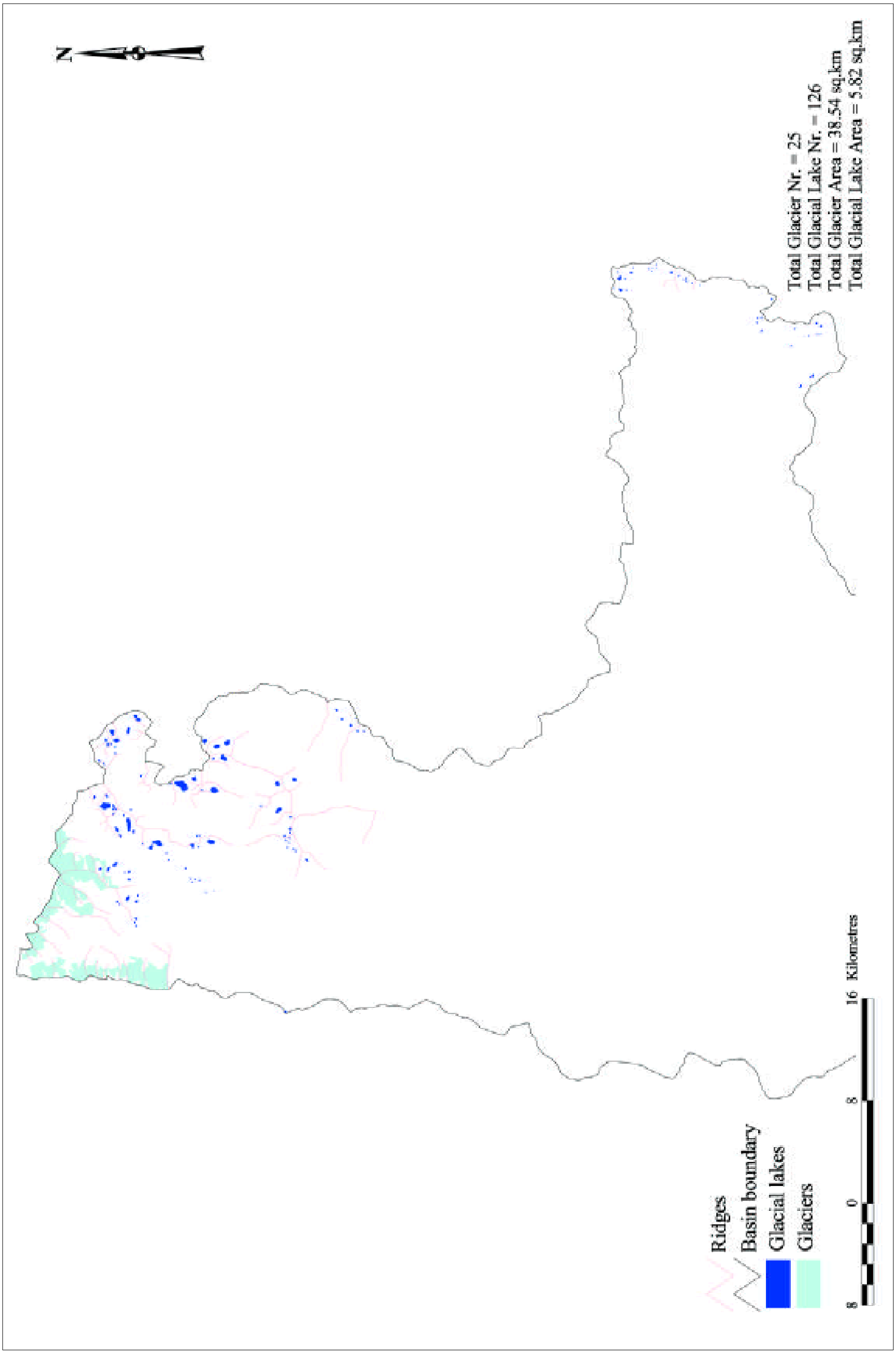


Figure 7.9: Glaciers and glacial lakes of the Dangde Chu Sub-basin

The Northern Basin

Contrary to the other rivers of Bhutan, the rivers of the Northern Basin flow from south to north. These rivers flow from Bhutan to Tibet (China). The Northern Basin is bounded by the Teri Gong –Jejekangphu Gong –Table Mountain–Kangri Mountain Range from the south.

The aspect of glaciers is distributed in all directions. The glaciers with northeast aspects are highest in number (19). The second highest number (13) of glaciers is in the northwest aspect (Figure 7.10). There are only five glaciers with north aspect. The number of glaciers in the east, west, and south aspects are three, two, and two respectively (Table 7.19). The area occupied by the northeast and northwest aspect glaciers is more than 80%. Due to unavailability of topographic maps of the Northern Basin area, the elevations of the glaciers are unknown.

The majority of the glaciers are ice apron and valley types (Table 7.20). This is the only basin in the Bhutan Himalayas which consists of a large number of valley glaciers. The valley glaciers including the mountain type make up 48% in terms of number. The area occupied by these glaciers is more than 85% (Table 7.20).

Table 7.19: Summary of glaciers in the Northern basin on the basis of aspect

Aspect	SE	E	NW	NE	N	SW	W	S
Number of glacier	8	3	13	19	5	7	2	2
Area (km^2)	14.7	2.40	158.9	159.45	35.45	1.80	14.49	0.48
Percentage area (%)	3.81	0.62	40.98	41.12	9.14	0.46	3.74	0.12
Maximum area (km^2)	9.09	1.00	99.77	48.14	27.6	0.59	11.92	0.24
Mean area (km^2)	1.85	.80	12.22	8.39	7.09	0.26	7.25	0.24
Minimum area (km^2)	0.12	.45	0.30	0.09	0.32	0.17	2.57	0.24
Maximum length (m)	4990	910	12710	10990	8585	935	6570	460
Minimum length (m)	200	305	380	425	540	285	1790	440
Ice reserve (km^3)	1.10	0.10	25.40	19.54	4.17	0.05	1.35	0.01

Table 7.20: Glacier types in the Northern Basin

Glacier type	Number		Area				Ice reserve	
	Number	%	km^2	%	of largest glacier	of smallest glacier	km^3	%
Mountain	10	17	70.57	18.20	20.82	1.61	6.866	13.28
Ice cap	2	3	2.25	0.58	1.30	0.95	0.099	0.19
Ice apron	23	39	14.00	3.61	2.57	0.12	0.578	1.12
Niche	3	5	0.47	0.12	0.21	0.09	0.009	0.02
Cirque	3	5	0.54	0.14	0.20	0.15	0.011	0.02
Valley	18	31	299.91	77.35	99.77	1.00	44.157	85.38
Total	59		387.74				51.720	

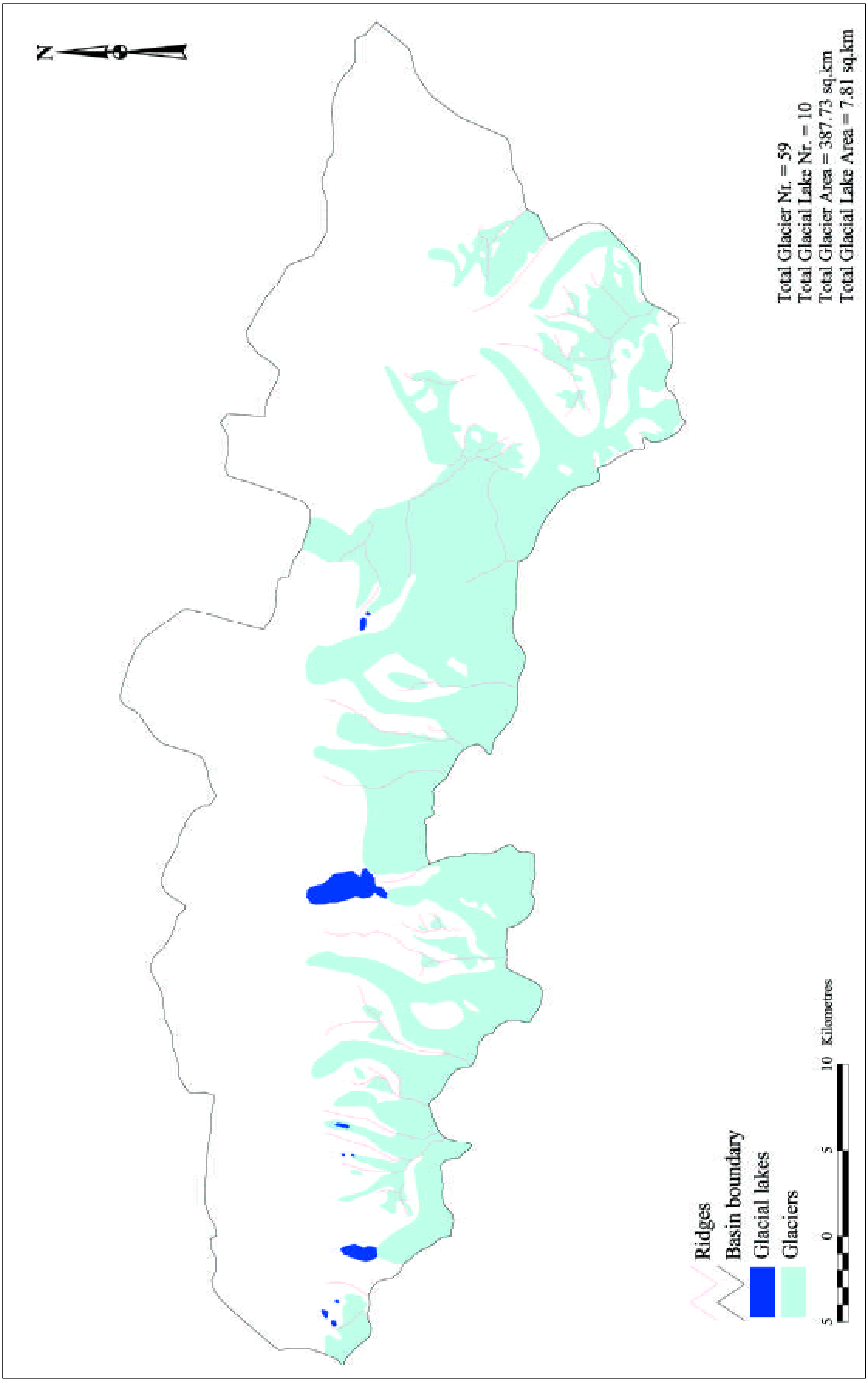


Figure 7.10: Glaciers and glacial lakes of the Northern Basin

Chapter 8
The Inventory of Glacial Lakes

8.1 Brief Description of Glacial Lake Inventory

The inventory of glacial lakes has been systematically carried out using topographic maps. As not all the topographic maps for the country are available and most of the topographic maps of the glaciated region are photocopies of poor quality, for identification, classification, and evaluation of the dangerous stage of glacial lakes, different types of satellite images have been used vigorously. The spatial inventory is based entirely on the topographic maps on a scale of 1:50,000 published in the 1950s–1970s by the Survey of India. The information gap resulting from the unavailability of topographic maps is filled by the printed Land Observation Satellite (LANDSAT) Thematic Mapper (TM) images on a scale equivalent to the topographic maps and all the projection parameters of the topographic maps are incorporated in the images to make the prints compatible with the topographic maps. The spatial distribution and aerial extension of the glacial lakes were obtained with the help of geographic information systems (GIS).

8.2 Glacial Lakes—Their Numbering, Type, and Characteristics

A glacial lake is defined as a water mass existing in a sufficient amount and extending with a free surface in, under, beside and/or in front of a glacier and originated by glacier activities such as the retreating processes of a glacier.

For the purpose of the inventory, the numbering of the lakes started from the outlet of the major stream and proceeded clockwise round the basin.

It is obvious to note that the lakes associated with perennial snow and ice originate from glaciers. But the isolated lakes found in the mountains and valleys far from the glaciers may not have a glacial origin. Due to the rapid rate of ice and snow melt, possibly caused by global warming, accumulation of water in these lakes has been increasing rapidly. The isolated lakes above 3,500 masl are considered to be the remnants of the glacial lakes left due to the retreat of the glaciers.

The lakes are classified into erosion lakes, valley trough lakes, cirque lakes, blocked lakes, lateral and end moraine-dammed lakes, and supraglacial lakes.

Erosion lakes

Glacial erosion lakes are the water bodies formed in a depression after the glacier has retreated leaving the lakes isolated from the glaciers (Figure 8.1). They may be cirque type and trough valley type lakes and are generally stable lakes.

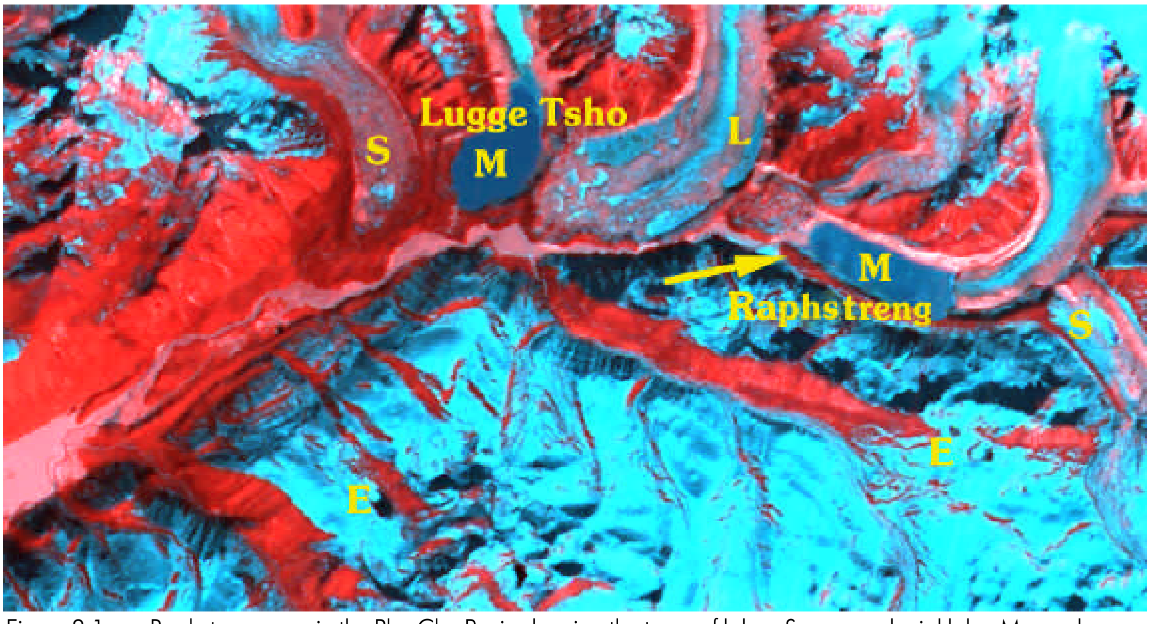


Figure 8.1: Raphstreng area in the Pho Chu Basin showing the types of lakes. S—supraglacial lake, M—end moraine-dammed lake, L—lateral moraine-dammed lake, E—erosion lake

Supraglacial lakes

The supraglacial lakes are small and change their position in the glacier. The Lanzhou Institute of Glaciology and Geocryology (LIGG)/the Water and Energy Commission Secretariat (WECS)/the Nepal Electricity Authority (NEA) study (LIGG/WECS/NEA 1988) did not consider such lakes in their classifications. However, the history of past glacial lake outburst flood (GLOF) events of moraine-dammed lakes indicates that they are initially derived from supraglacial lakes. As the target of the project is to identify and monitor the potentially dangerous glacial lakes with the help of time series' satellite images, aerial photographs, and topographic maps, it will be helpful to know the activity of supraglacial lakes. If supraglacial lakes are situated at the tongue of a valley glacier, larger in size, or grouping rapidly to expand their size, then they are potentially dangerous and may burst out in the near future.

These lakes develop within the ice mass away from the moraine with dimensions of from 50 to 100m. These lakes may develop in any position of the glacier but the extension of the lake is less than half the diameter of the valley glacier. Shifting, merging, and draining of the lakes characterise the supraglacial lakes. The merging of lakes results in expansion of the lake area and storage of a huge volume of water with a high potential energy. The tendency of a glacial lake towards merging and expanding indicates the danger level of the GLOF. Most of the potentially dangerous lakes are advanced forms of supraglacial lake.

Moraine-dammed lakes

A typical example of a moraine-dammed lake is Raphstering Tsho formed on the tongue of the Raphstering Glacier in the Pho Chu Sub-basin of the Lunana region (Figure 8.1). In the retreating process of a glacier, glacier ice tends to melt in the lowest part of the glacier surrounded by lateral and end moraines. As a result, many supraglacial ponds are formed on the glacier tongue. These ponds sometimes enlarge to become a large lake by interconnecting with each other which is accompanied no deepen further. A moraine-dammed lake is thus born. The lake is filled with melt water and rainwater from the drainage area behind the lake and starts flowing from the outlet of the lake even in the winter season when the flow is minimum.

There are two kinds of moraine-dammed lakes, end moraine-dammed lakes and lateral moraine-dammed lakes, depending on the position and morphology of the damming conditions (Figure 8.1). The moraine material may be ice-cored or ice-free. Before the ice body of the glacier completely melts away, glacier ice exists in the moraine and beneath the lake bottom. The ice bodies cored in the moraine and beneath the lake are sometimes called **dead ice** or **fossil ice**. As glacier ice continues to melt, the lake becomes deeper and wider. Finally when ice contained in the moraines and beneath the lake completely melts away, the container of lake water consists of only the bedrock and the moraines.

Ice-dammed lakes

An ice-dammed lake is produced on the side(s) of a glacier, when an advancing glacier happens to intercept a tributary/tributaries pouring into a main glacier valley. Since the glaciers in the Bhutan Himalayas produce relatively rich debris, thick lateral moraines are deposited on both sides of the glacier tongue. As such an ice core-dammed lake is usually small in size and does not come into contact with glacier ice. This type of lake is less susceptible to GLOF than a moraine-dammed lake.

A glacial lake is formed and maintained only up to a certain stage of glacier fluctuation. If one follows the lifespan of an individual glacier, it is found that the moraine-dammed glacial lakes build up and disappear with a lapse of time. The moraine-dammed lakes disappear once they are fully destroyed or when debris fills the lakes completely or the mother glacier advances again to lower altitudes beyond the moraine dam position. Such glacial lakes are essentially ephemeral and are not stable from the point of view of the life of glaciers.

8.3 Glacial Lakes of Bhutan

As in the inventory of glaciers, the inventory of glacial lakes was carried out by dividing the country into six basins with further division into thirteen sub-basins. The sub-basins are Amo Chu, Ha Chu, Pa Chu, Thim Chu, Mo Chu, Pho Chu, Dang Chu, Mangde Chu, Chamkhar Chu, Kuri Chu, Dangme Chu, Nyere Ama Chu, and Northern Basin.

Altogether 2,674 lakes have been identified above 3,500 masl, which cover an area of 106.8 sq.km (Table 8.1 and Figure 8.2). The details of the lake inventory database are given in Annex II. In 1998 Ageta and co-workers inventoried 30 glacial lakes in the northern and northwestern parts of the country for GLOF risk assessments and future monitoring (Ageta and Iwata 1999).

Table 8.1: Distribution of lakes in the basins and Sub-basins of the Bhutan Himalaya

S. No.	Sub-basin	Basin	Lake number	Area (km^2)
1	Amo Chu	Amo Chu	71	1.83
2	Ha Chu	Wang Chu	53	1.83
3	Pa Chu		94	1.82
4	Thim Chu		74	2.82
5	Mo Chu	Puna Tsang Chu	380	9.78
6	Pho Chu		549	23.49
7	Dang Chu		51	1.81
8	Mangde Chu	Manas Chu	521	17.59
9	Chamkhar Chu		557	21.03
10	Kuri Chu		179	11.07
11	Dangme Chu		126	5.82
12	Nyere Ama Chu	Nyere Ama Chu	9	0.076
13	Northern Basin	Northern Basin	10	7.81
	Total		2674	106.8

The Amo Chu basin

In the Amo Chu Basin a total of 71 lakes has been identified. As no glaciers exist in the basin within Bhutan, these lakes are not associated with any glaciers (Figure 8.3). The lakes in this region have been classified into three types: erosion, valley, and cirque lakes (Table 8.2). There are 46 erosion lakes, 21 valley lakes, and four cirque lakes. The cumulative surface area of the lakes in the basin is 1.83 sq.km.

Table 8.2: Types of lake in the Amo Chu Basin

Type	Number		Area (m^2)		Area of largest lake (m^2)
	Number	%	Area	%	
Erosion	46	64.79	542,982.00	29.67	61,614.69
Valley	21	29.58	881,665.37	48.18	243,538.30
Cirque	4	5.63	405,346.14	22.15	141,970.64

The Wang Chu basin

In the Wang Chu Basin there are 221 lakes. Most of the lakes are small in size and only a few are associated with glaciers. At present these lakes do not pose any danger from GLOF.

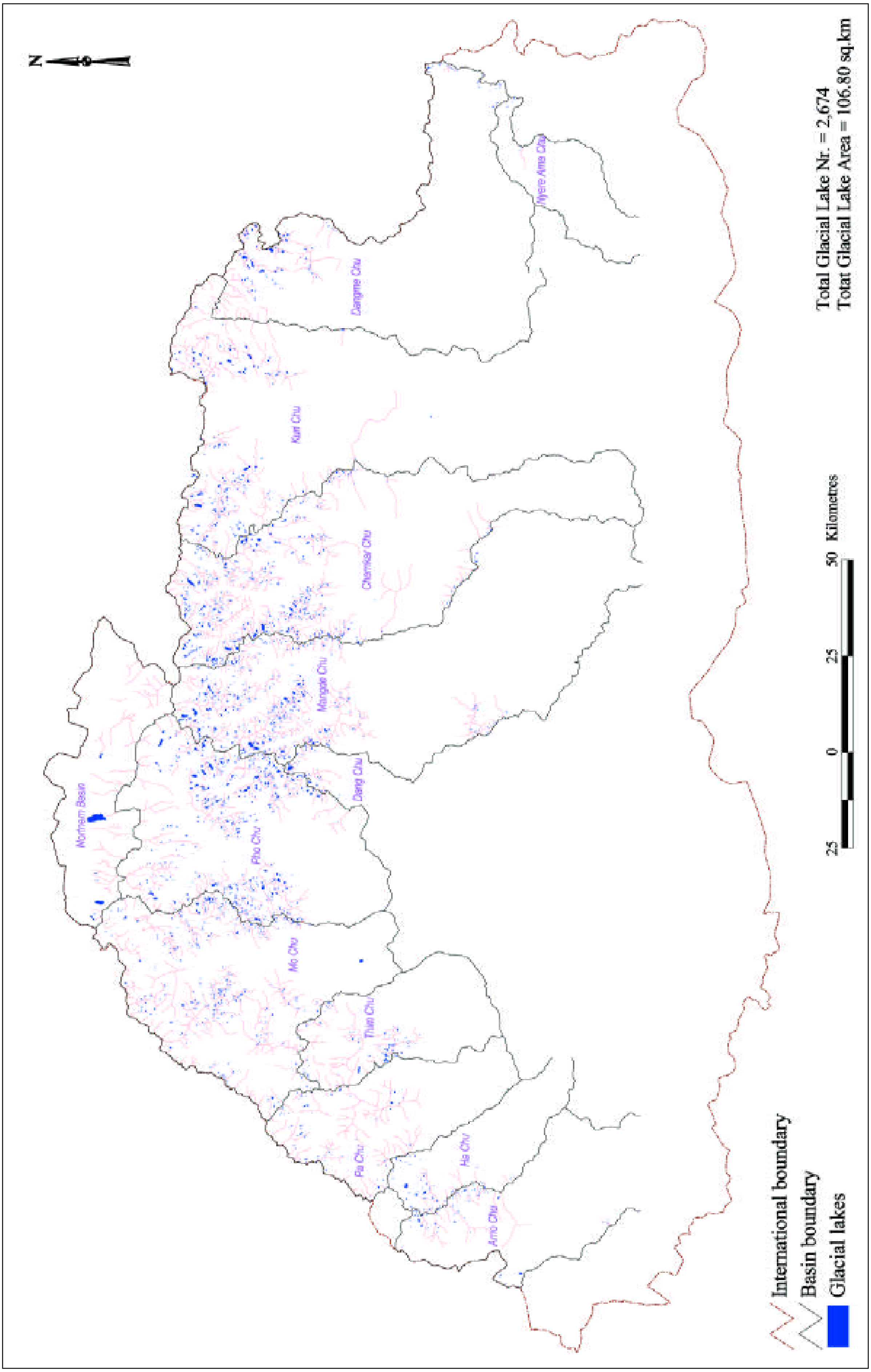


Figure 8.2: Glacial lakes of Bhutan

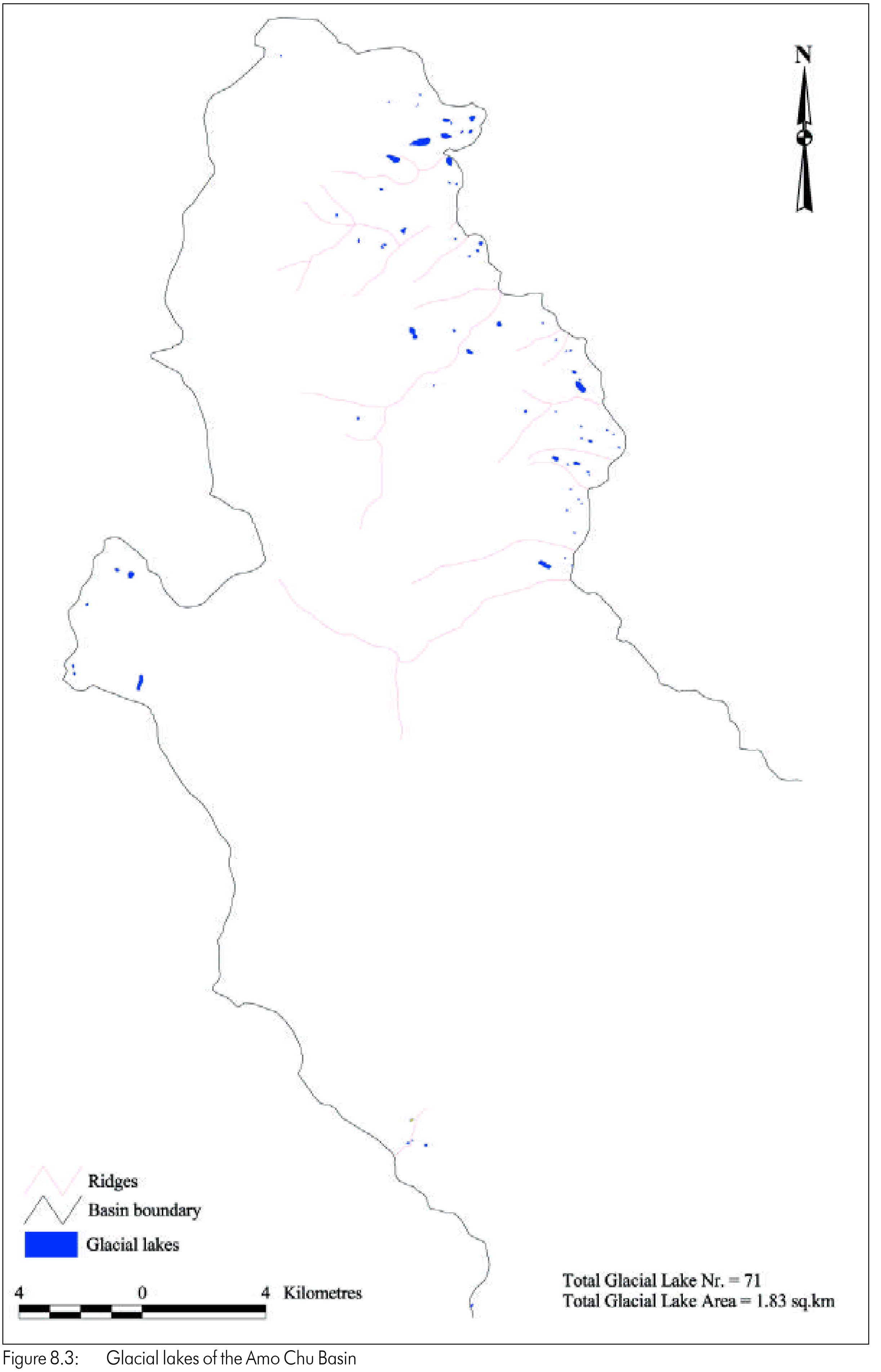


Figure 8.3: Glacial lakes of the Amo Chu Basin

The Wang Chu River Basin consists of three sub-basins—they are the Ha Chu, the Pa Chu, and the Thim Chu Sub-basins from west to east.

The Ha Chu Sub-basin

A total of 53 lakes has been identified in the Ha Chu Sub-basin (Table 8.3 and Figure 8.4) and none of them are associated with glaciers. Lake Ha_gl 37 is the largest lake with an area of 0.47 sq.km and has an average length of 520m. It is classified as a cirque lake and lies at an elevation of 4,430 masl.

Table 8.3: Types of lake in the Ha Chu Sub-basin

Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	37	69.81	958,356.91	52.32	234,770.75
Valley	10	18.87	188,061.51	10.27	49,476.66
Cirque	6	11.32	68,530.62	37.41	467,172.06

The Pa Chu Sub-basin

In the Pa Chu Sub-basin a total of 94 lakes has been identified. The majority of these are erosion lakes (Table 8.4 and Figure 7.2) and 16 of them are associated with glaciers. Among the lakes associated with glaciers, five have been identified as major lakes (Table 8.5). Lakes Pa_gl 41 and 42 are directly in contact with Glacier Pa_gr 8, and Lake Pa_gl 44 with Glacier Pa_gr10. These glacial lakes, although small at present, have the potential to expand into large lakes in the future. The Lake Pa_gl 41 is a moraine-dammed lake 110m in length, whereas Lakes Pa_gl 44 and Pa_gl 10 are supraglacial lakes with lengths of 40 and 90m respectively (1960s topomap, Survey of India). Lhabu Tsho Lake (Pa_gl 35) is located about 570 masl southeast of Glacier Pa_gr 6. It is a cirque lake, 325m x 124m in area lying at an altitude of 4,750 masl. The largest lake in the region is Darkey Pang Tsho Lake (Pa_gl 80) which has dimensions of 525m x 435m and lies at an altitude of 4,240 masl. It is a cirque lake with no visible outlet.

Table 8.4: Types of lake in the Pa Chu Sub-basin

Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	54	57.45	648,004.38	35.58	60,611.94
Valley	25	26.60	583,946.67	32.06	172,070.30
Cirque	7	7.45	487,271.08	26.76	228,503.08
Supraglacial	3	3.19	16,617.52	0.91	20,493.73
Blocked	4	4.26	64,808.09	3.56	7452.26
Moraine-dammed	1	1.06	20,493.73	1.13	34,353.47

Table 8.5: Major glacial lakes associated with glaciers in the Pa Chu Sub-Basin

Lake	Elevation (masl)	Type	Area (m²)	Associated glacier	Remarks
Pa_gl 41	4320	moraine-dammed	20 494	Pa_gr 8	in contact with large glacial lake
Pa_gl 42	4520	supraglacial	7452	Pa_gr 8	in contact with large glacial lake
Pa_gl 44	4470	supraglacial	5278	Pa_gr 10	in contact with large glacial lake
Lhabu Tsho (Pa_gl 35)	4750	cirque	40 384	Pa_gr 6	lies 570m southeast of the glacier
Darkey Pang Tsho (Pa_gl 80)	4240	cirque	228 503		largest lake in the basin

The Thim Chu Sub-basin

In the Thim Chu Sub-basin 74 lakes have been identified, out of which erosion and valley lakes are more or less in equal number and there are five cirque lakes (Table 8.6 and Figure 7.3). Among them only one lake (Thim_gl 58) is associated with a glacier (Thim_gr 8). The lake is located 205m southwest of the associated glacier at an elevation of 4,640 masl. The largest lake in this sub-basin is the Santo Tsho Lake (Thim_gl 29) which has a surface area of 483 126 m², a mean length of 1,250m and lies at an altitude of 4,320 masl (Table 8.7).

Table 8.6: Types of lake in the Thim Chu Sub-basin

Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	35	47.30	1 007 094.14	35.75	258 780.13
Valley	34	45.95	1 581 797.00	56.14	483 126.11
Cirque	5	6.76	61 228 458.12	8.11	62 036.37

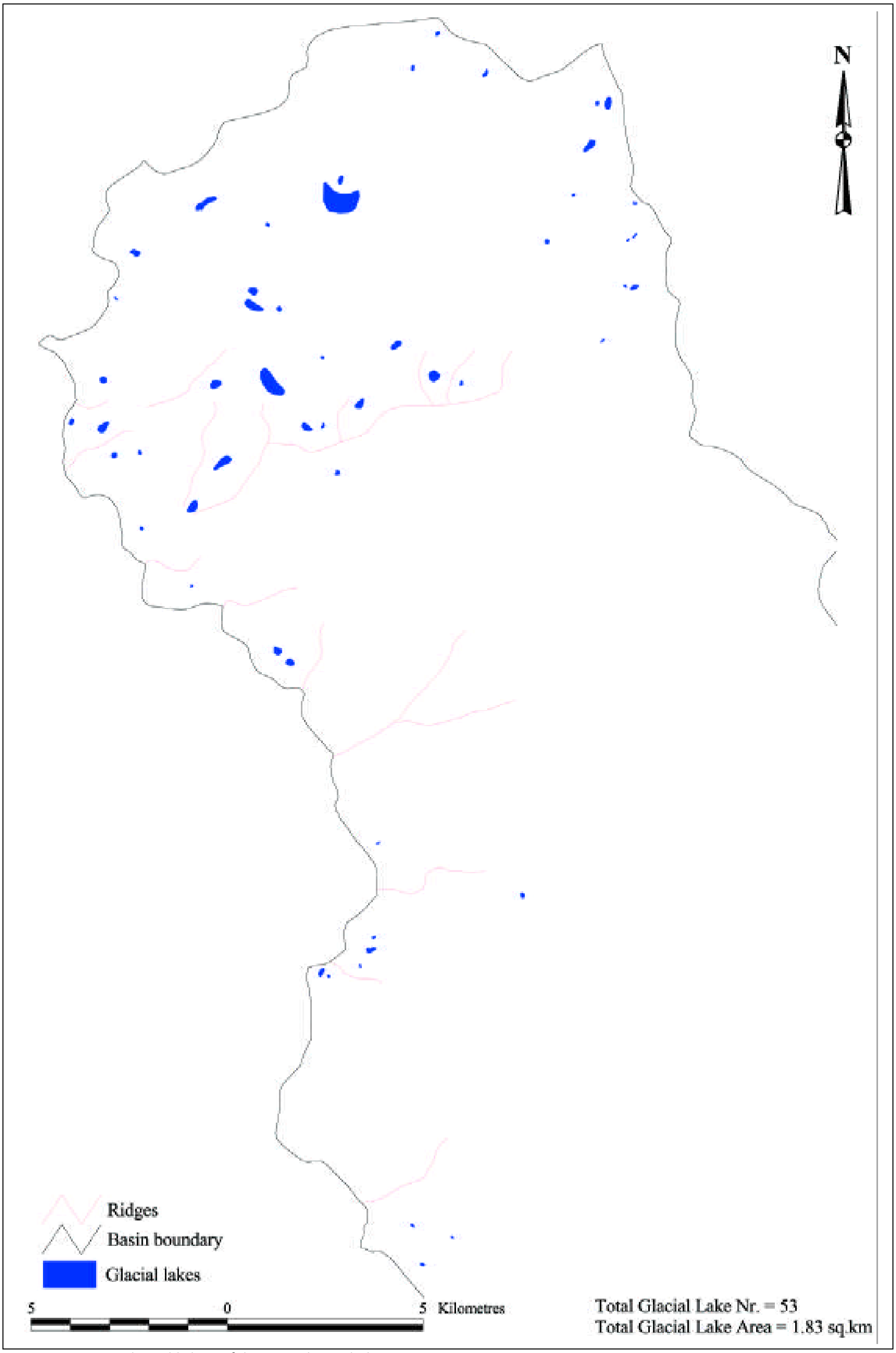


Figure 8.4: Glacial lakes of the Ha Chu Sub-basin

Table 8.7: Major glacial lakes associated with glaciers in the Thim Chu Sub-basin					
Lake name/ number	Elevation (masl)	Type	Area (m^2)	Associated glacier	Remarks
Thim_gl 58	4,640	erosion	3,825	Thim_gr 8	smallest lake
Santo Tsho (Thim_29)	4,320	valley	483,126		largest lake in the sub-basin

The Puna Tshang Chu (Sankosh) basin

The Puna Tshang Chu (Sankosh) Basin consists of the Mo Chu and Pho Chu Sub-basins which contain glaciers and the Dang Chu Sub-basin which does not.

There are 980 lakes with a cumulative area of 35.2m^2 in the Puna Tshang Chu Basin. Of the sub-basins, the Pho Chu is the largest with the highest number of lakes. Some of the lakes are large in size and are associated with glaciers.

The Mo Chu Sub-basin

In the Mo Chu sub-basin a total of 380 lakes has been identified. Most of them are erosion and valley lakes (Table 8.8 and Figure 7.4).

Table 8.8: Types of lake in the Mo Chu Sub-basin					
Type	Number		Area (m^2)		Area of largest lake (m^2)
	Number	%	Area	%	
Erosion	209	55.00	3,857,822.19	39.45	291,766.76
Valley	130	34.21	4,041,660.47	41.33	495,757.66
Cirque	23	6.05	1,622,627.58	16.594	210,015.07
Supraglacial	8	2.10	33,815.03	0.344	5,949.88
Blocked	6	1.57	93,327.28	0.955	38,008.97
Moraine-dammed	3	0.79	96,109.73	0.983	52,090.11
Lateral moraine-dammed	1	0.47	34,287.76	0.35	34,287.76

Seventy-seven lakes are associated with glaciers. The erosion lakes are highest in number followed by the valley lakes. Generally the erosion, valley, and cirque lakes are not susceptible to outburst, but the supraglacial, blocked, moraine-dammed, and lateral moraine-dammed are susceptible to outburst causing flooding downstream. Ten lakes of these types have been identified in the Mo Chu Sub-basin. The largest lake, Hoka Tsho (Mo_gl 1) is an erosion lake located at an elevation of 2,240 masl.

Lakes that are not associated with any glacier even if they are large in size do not pose any danger of GLOF. It is those lakes that are associated with large glaciers that pose a threat of flooding as they have the potential to grow in size as the glaciers recedes. The Lakes Mo_gl 200, 201, 202, 234, and 235 are associated with large glaciers (Table 8.9).

Table 8.9: Major glacial lakes associated with glaciers in the Mo Chu Sub-basin					
Lake name/ number	Elevation (masl)	Type	Area (km^2)	Associated glacier	Remarks
Kab Tsho (Mo_gl 200)	4280	moraine-dammed	52 090	Mo_gr 47	small lakes associated with large glaciers—they have the potential to grow into large lakes
Mo_gl 201	4080	moraine-dammed	30 864	Mo_gr 51	
Mo_gl 202	4380	lateral moraine-dammed	34 288	Mo_gr 52	
Setang Burgi Tsho (Mo_gl 234)	4480	valley	232 775	Mo_gr 84	the lake lies 50m northwest of the glacier
Mo_gl 235	4960	valley	150131	Mo_gr 87	in contact with glacier and needs to be monitored

The Pho Chu Sub-basin

In the Pho Chu Sub-basin 549 lakes have been identified, 53.92% of the lakes are erosion lakes and 33.33% are valley lakes. Supraglacial, blocked, moraine-dammed, and lateral moraine-dammed lakes together constitute 6.56% of the total lake area (Table 8.10 and Figure 7.5).

Several potentially dangerous lakes exist in the Pho Chu Sub-basin. It is in this sub-basin that most of the monitoring and mitigation work of glacial lakes has been undertaken. Some of the well-known glacial lakes in the sub-basin are Tarina Tsho, Raphstreng Tsho, Lugge Tsho, and Thorthormi Tsho Glacial Lakes. The glacial lakes that are associated with the glaciers and posing danger are given in Table 8.11 and described below.

Table 8.10: Types of lake in the Pho Chu Sub-basin					
Type	Number		Area (m^2)		Area of largest lake (m^2)
	Number	%	Area	%	
Erosion	296	53.92	7,908,139	33.66	723,672.60
Valley	183	33.33	10,200,084	43.41	468,690.32
Cirque	34	6.19	3,156,923	13.44	455,024.10
Supraglacial	14	2.55	47,795	2.03	145,948.56
Blocked	8	1.46	202,455	0.86	64,946.45
Moraine-dammed	9	1.64	1,396,854	5.95	769,799.72
Lateral moraine-dammed	5	0.91	152,520	0.65	70,675.33

Table 8.11: Major glacial lakes associated with glaciers in the Pho Chu Sub-basin					
Lake name/ number	Elevation (masl)	Type	Area (m^2)	Associated glacier	Remarks
Pho_gl 84	5,040	valley	214,078	Pho_gr 8	The lake is directly in contact with the glacier.
Pho_gl 148	4,880	valley	454,510	Pho_gr 21	The lake is 1.3 km long and is in contact with the mountain glacier.
Pho_gl 163	4,280	valley	369,572	Pho_gr 41	The lake is quite large and is situated 603m southeast of the glacier.
Tarina Tsho (Pho_gl164)	4,320	Moraine-dammed	280,550	Tarina Pho_gr 44 /49	The lake is over 1 km long; it has breached in the past.
Pho_gl 172	4,310	supraglacial	33,522	Pho_gr 49	Large valley glacier with other supraglacial lakes forming in it.
Pho_gl 206	4,260	supraglacial	44,194	Bechung Pho_gr 79	Severak supraglacial lakes are forming; needs to be monitored.
Pho_gl 207	4,320	supraglacial	15,463	Bechung Pho_gr 79	
Rapshtreng Tsho (Pho_gl209)	4,360	moraine-dammed	145,949	Rapshtreng (Pho_gr80)	Mitigation measures carried out.
Lugge Tsho (Pho_gl210)	4,600	moraine-dammed	769,800	Lugge (Pho_gr82)	Still attached to glacier; terminal moraine has ice core; breached in 1994.

Tarina Tsho (Pho_gl 164) consists of two lakes, one above the other. The outlets of both the lakes are clear and drain into the Pho Chu western branch. The lower lake is rectangular in shape and is about 500m long and 300m wide. This lake has breached in the past, which is evidenced by breached end moraine and a large debris fan in the downstream area. Although at present the lake has a well defined outlet and is detached from the glacier tongue, the size of the lake and the presence of glacier ice on the steep, rocky cliff directly above the lake causes some concern.

The second lake lies directly above the lower lake and is in the shape of a boomerang. It has dimensions of approximately 2 x 0.3 km and is in contact with the glacier tongue resting on a rocky cliff. The outer slope of the end moraine through which the lake is drained is vegetated and has a gentle slope, therefore no immediate danger from this lake is anticipated.

Glacial Lakes Pho_gl 187, 188, and 189 are supraglacial lakes in the large Wachey Glacier (Pho_gr 68). Although these lakes are small at present, they have the potential to grow into large lakes as this glacier recedes.

Raphstreng Tsho glacial lake

Raphstreng Tsho (Pho_gl 209) lies at an elevation of 4,360 masl. On the 1960s map this lake has an area of 0.15 sq.km. In 1986 the lake was 1.65 km long, 0.96 km wide, and 80m deep (GSI; GSB 1986). Nine years later in 1995 (WAPCOS 1997) the maximum length measured 1.94 km, the width 1.13 km and the depth 107m. Figure 8.5 shows the expansion of Raphstreng Tsho glacial lake from 1956 to 1996 (Ageta et al. 1999).

Prior to the 1994 flood from Lugge Tsho, the left lateral moraine was 295m to 410m wide (Indo-Bhutan Expedition 1995). Toe erosion of the moraine initiated by the flood has reduced the width to 178m. This weakening of the lake barrier and the large size of the lake caused grave concern to the Bhutanese

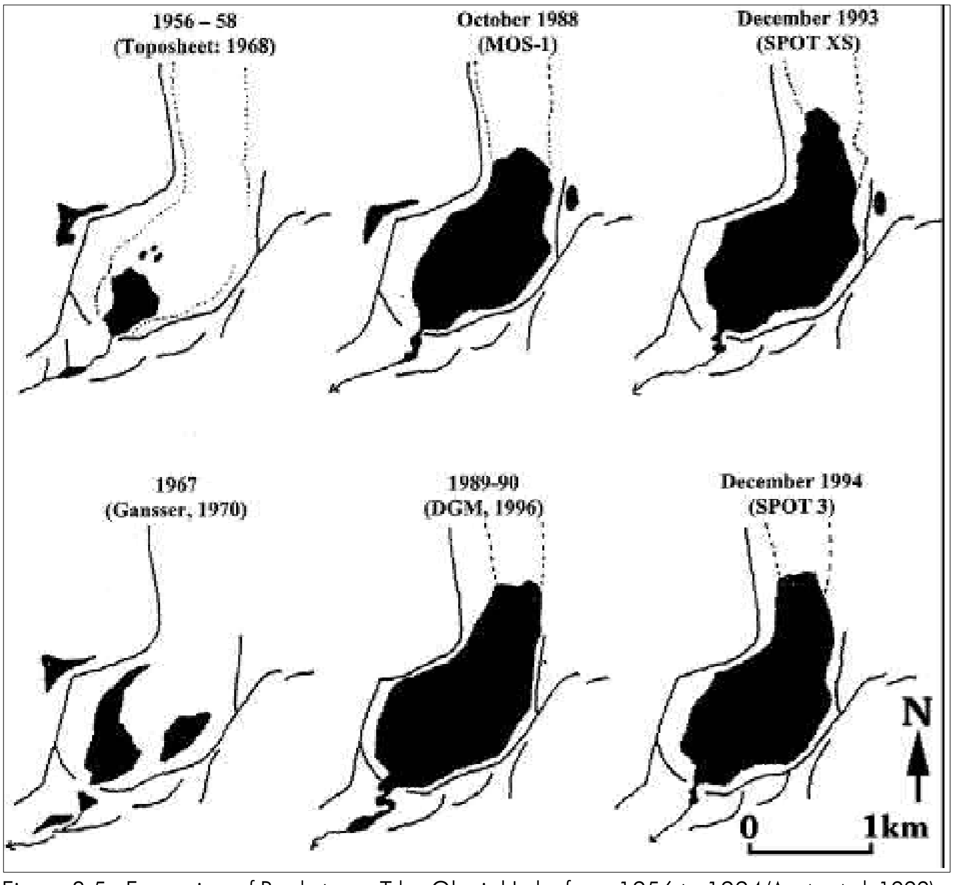


Figure 8.5: Expansion of Raphstreng Tsho Glacial Lake from 1956 to 1994 (Ageta et al. 1999)

Government. Immediate investigation on the stability of the lake was carried out in 1995. Lowering of the lake by 4m (WAPCOS 1997) commenced in 1996 and was completed in 1998.

Thorthormi Tsho glacial lake

On the 1960s map no lakes were seen in Thorthormi Glacier. At present several of supraglacial lakes have been observed within this large glacier. The largest of the lakes is called Thorthormi Tsho. Thorthormi Tsho Glacial Lake is not visible on the toposheet of 1958; some supraglacial lakes are visible on the map as reported by Gansser (Figure 8.6). The Thorthormi terminal moraine acts as a dam between Thorthormi Tsho and Raphstreng Tsho Lakes and has a width of 30m at its crest. Thorthormi supraglacial Lake is 65m higher than Raphstreng Tsho Lake and lies directly above it. This lake is separated from the Pho Chu by a thin left lateral moraine, which is continuously eroding. Considering the present scenario in which the lake is at a higher elevation than Raphstreng Tsho Lake, and that the terminal and left lateral moraine are narrow and unstable, this lake and glacier need to be continuously monitored.

Lugge Tsho glacial lake

This lake is a rectangular-shaped, pro-glacial, moraine-dammed lake. On 7 October 1994 this lake breached at the junction of its left lateral moraine and terminal moraine causing damage to lower valleys downstream and to the Punakha Dzong. The lake is still increasing in size due to the retreat of the glacier tongue as shown in Figure 8.7. The lake was not visible in the topographic map of 1958 and appeared in 1967 in the form of supraglacial lakes (Gansser 1970). The outlet channel is at the same level as the lake surface and has a gentle slope. The terminal moraine has and ice core which is evidenced by the bumpy topography of the terminal moraine. Due to the continuous sliding of the left lateral moraine at the outlet and the presence of ice core in the terminal moraine, the breached outlet may get blocked and cause another GLOF.

Supraglacial Lakes Pho_gl 206 and 207 associated with Bechung Glacier, although small in size at present, will grow in size in the future. Regular monitoring of their expansion is required. A small supraglacial lake in the Tshoju Glacier was observed with no surface outlet, but from the middle of the terminal moraine a substantial amount of outflow was seen.

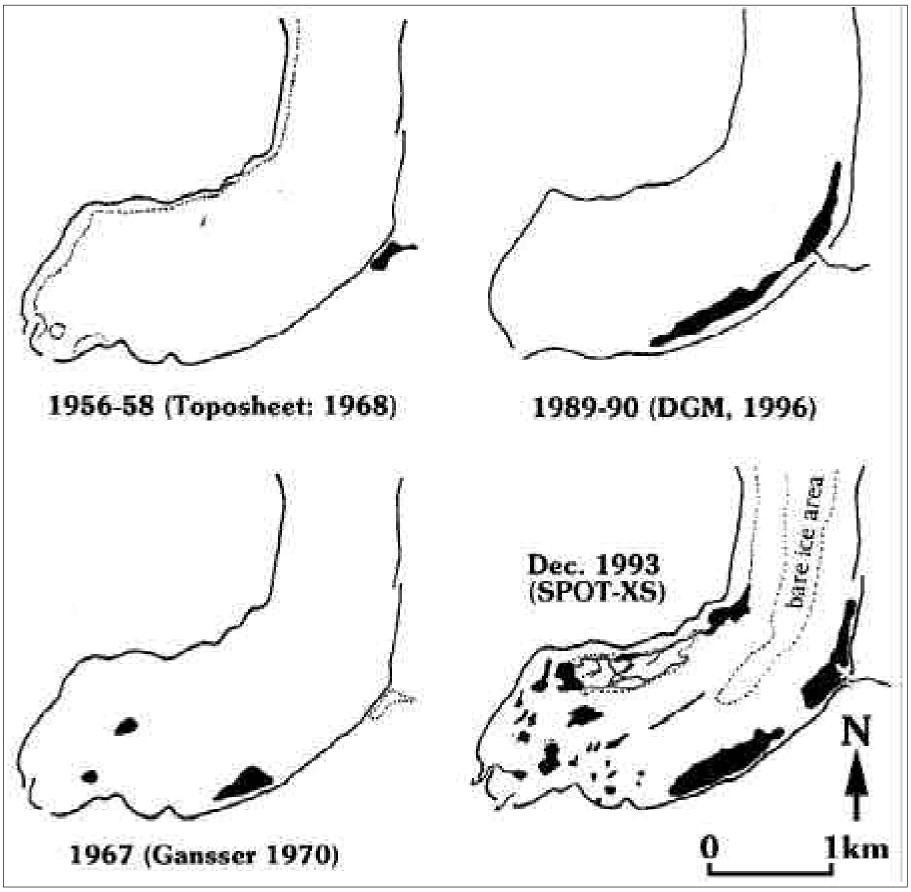


Figure 8.6: Expansion of Thorthormi Tsho Glacial Lake from 1956 to 1990(Ageta et al. 1999)

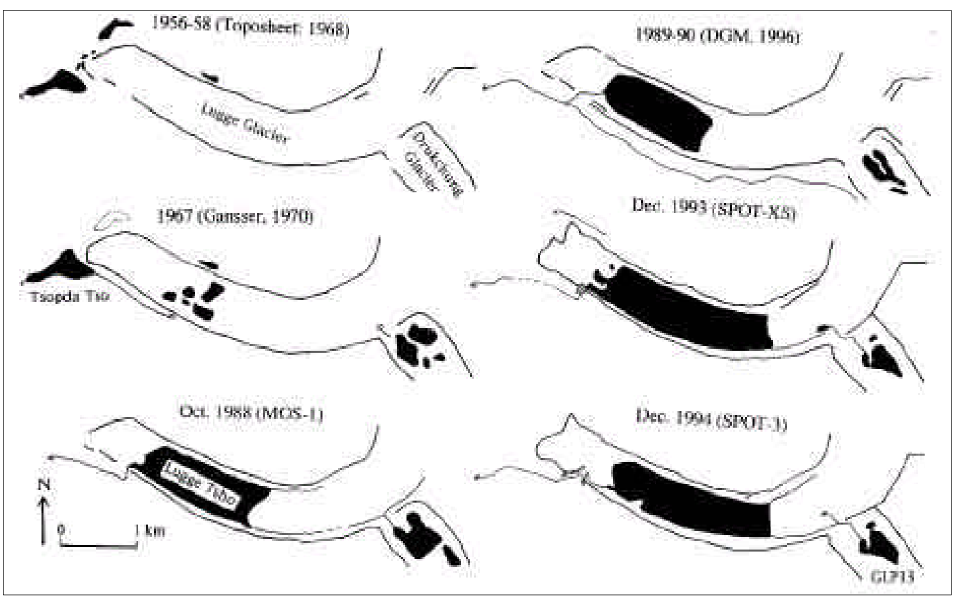


Figure 8.7: Expansion of Lugge Tsho, Tsopda Tsho, and Drukchung Tsho Glacial Lakes from 1956 to 1994 (Ageta et al. 1999)

The Dang Chu Sub-basin

The lakes in the Dang Chu Sub-basin have been classified into three types, erosion, valley, and cirque. There are 34 erosion lakes, 14 valley lakes, and three cirque lakes. The area covered by the valley lakes is 66.98% of all the lakes in the region (Table 8.12). The largest lake is Dang_gl 31. It is 1.56 km long and located at an elevation of 4,730 masl with a surface area of 7.9 sq.km. None of the lakes of this sub-basin is associated with glaciers (Figure 8.8).

Table 8.12: Types of lake in Dang Chu Sub-basin					
Type	Number		Area (m^2)		Area of largest lake (m^2)
	Number	%	Area	%	
Erosion	34	66.67	431,284.48	23.77	65,654.74
Valley	14	27.45	1,215,368.76	66.98	789,373.64
Cirque	3	5.88	167,835.20	9.25	100,492.03

Table 8.13: Types of lakes in the Mangde Chu Sub-basin					
Type	Number		Area (m^2)		Area of largest lake (m^2)
	Number	%	Area	%	
Erosion	202	38.58	2,511,787.46	14.34	288,133.99
Valley	250	47.98	10,304,174.80	58.83	868,294.42
Cirque	35	6.27	1,993,290.86	11.38	217,085.14
Supraglacial	25	4.80	362,275.27	2.07	146,451.70
Blocked	5	0.96	746,305.17	4.26	466,125.34
Moraine-dammed	4	0.77	1,598,214.37	9.12	710,226.90

The Manas Chu basin

The Manas River is formed by joining two rivers of similar catchment area within Bhutan. They are the Mangde Chu and the Dangme Chu. Each of these two sub-basins has a tributary of substantial size. These are the Chamkhar Chu and the Kuri Chu respectively.

The Mangde Chu Sub-basin

A total of 521 lakes has been identified in this sub-basin (Figure 7.6). Valley lakes and erosion lakes are dominant, numbering 250 and 202 respectively. The valley lakes have an area of 10.3 sq.km, that is, 58.83% of the total area occupied by the lakes of the sub-basin (Table 8.13). The largest lake is Mangd_gl 106. It has a surface area of 0.87 sq.km and lies at an elevation of 5,040 masl. It is directly in contact with Glacier Mangd_gr 10 (Table 8.14).

Table 8.14: Major glacial lakes associated with glaciers in Mangde Chu					
Name/number	Elevation (masl)	Type	Area (m^2)	Associated glacier	Remarks
Mangd_gl 99	4960	moraine dammed	192607	Mangd_gr 8	in contact with glacier
Mangd_gl 104	5000	valley	521081	Mangd_gr 9	1.2 km long
Mangd_gl 106	5040	valley	868294	Mangd_gr10	1.5 km long; in contact with glacier
Mangd_gl 270	5280	valley	239778	Mangd_gr 51	850m long; 200m east of glacier
Mangd_gl 307	5240	valley	767429	Mangd_gr 65	1.8 km long; in contact with glacier
Mangd_gl 308	4193	moraine dammed	710227	Mangd_gr 70	1.2 km long; 30m from glacier
Mangd_gl 310	5200	valley	200746	Mangd_gr 76	0.5 km long; in contact with glacier
Mangd_gl 366	5160	valley	150806	Mangd_gr 101/102	0.8 km long; in contact with glacier
Mangd_gl 398	5182	erosion	288134	Mangd_gr 117	0.8 km long; 20m away from glacier

No field visits have been carried out in this region. Out of the 521 lakes in the the Mangde Chu Sub-basin, 200 lakes are associated with glaciers. Although there have been no reports of any GLOFs in the region it is necessary to study this sub-basin in detail as there are many lakes (large and small) attached to glaciers.

Table 8.15: Types of lake in the Chamkhar Chu Sub-basin					
Type	Number		Area (m^2)		Area of largest lake (m^2)
	Number	%	Area	%	
Erosion	161	28.90	3,416,929.39	16.34	624,669.81
Valley	306	54.95	12,723,820.30	60.85	437,816.58
Cirque	28	5.03	2,471,170.51	11.82	802,938.10
Supraglacial	55	9.87	2,138,650.25	10.23	1,035,131.51
Blocked	1	0.18	32,401.00	0.15	32,401.23
Moraine-dammed	5	0.90	128,774.10	0.62	47,247.94

The Chamkhar Chu Sub-basin

In the Chamkhar Chu Sub-basin a total of 557 lakes was identified (Figure 7.7). The majority of the lakes fall into the class of valley lakes (306 lakes). The valley lakes occupy 60.85% of the total lake area in the sub-basin (Table 8.15). The largest lake is Cham_gl 383 (supraglacial lake). It has a surface area of 1.03 sq.km and is 2.6 km long (Table 8.16). No field visit has been carried out in the glaciated region of this sub-basin.

The valley Glacier Cham_gr 71 was named Chubda Glacier (Karma 1999). Within this glacier, several supraglacial lakes were observed during the expedition in August 1999. Five major glacial lakes associated with glaciers (Table 8.16) were identified in this sub-basin.

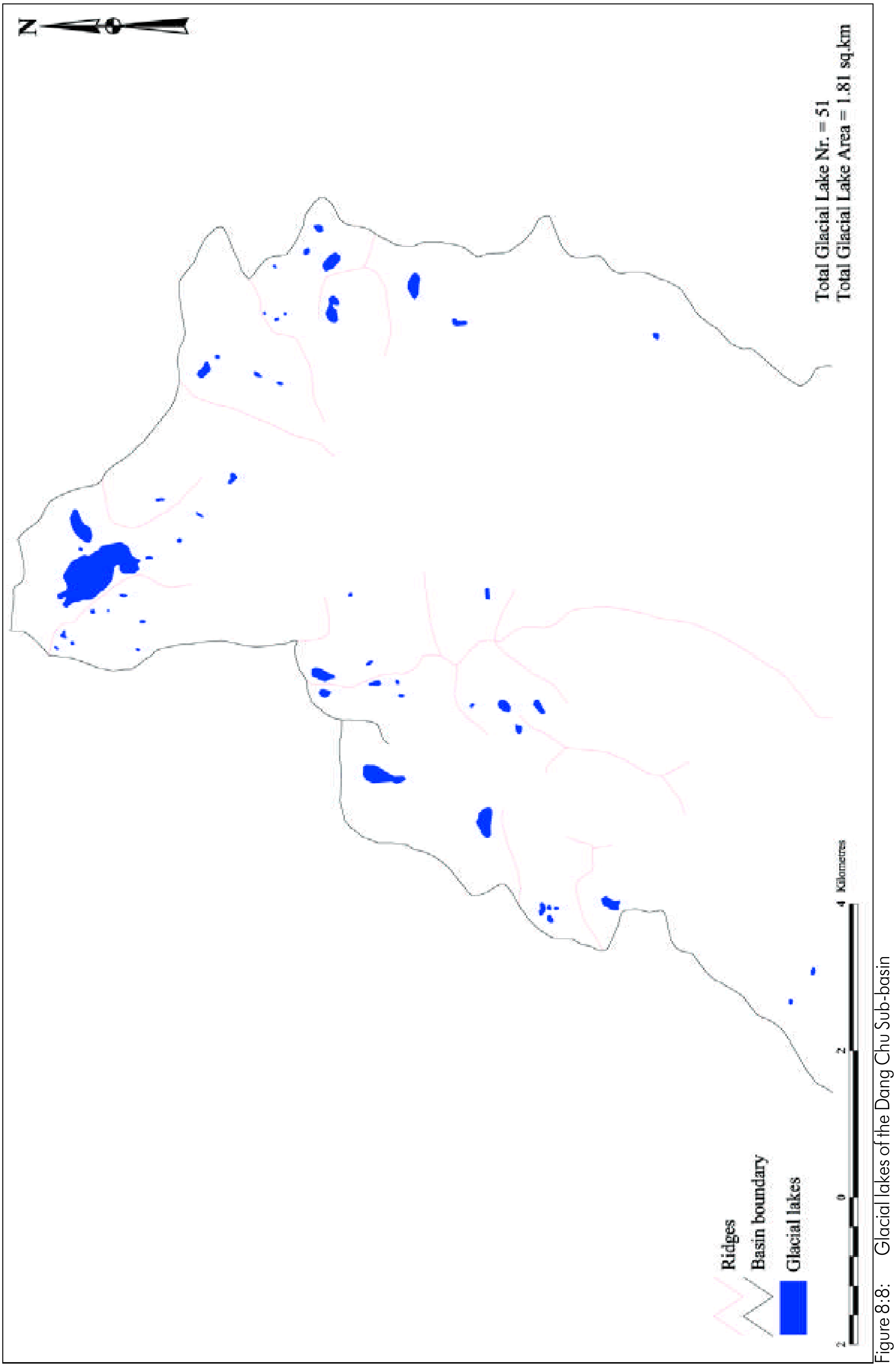


Figure 8:8: Glacial lakes of the Dang Chu Sub-basin

Table 8.16: Major glacial lakes associated with glaciers in the Chamkhar Chu Sub-basin					
Name/ number	Elevation (masl)	Type	Area (m²)	Associated glacier	Remark
Cham_gl 163	4,766	cirque	802,938	Cham_gr 2	1.5 km long; 425m away from glacier; a number of supraglacial lakes are forming
Cham_gl 198	5,046	erosion	624,670	Cham_gr 9	1.5m long; directly in contact with glacier
Cham_gl 232	5,200	supraglacial	205,146	Cham_gr 15	0.6 km long; needs to be urgently studied as this has the potential to grow even larger
Cham_gl 242-284	4,680-5,160	supraglacial		Cham_gr 25	Numerous small supraglacial lakes in the glacier; needs to be monitored as these may join and become one large lake.
Cham_gl 383	4,840	supraglacial	1,035,132	Cham_gr 71	Very large lake, 2.6 km long within the glacier; needs to be studied in detail.

Kuri Chu

In this sub-basin 179 lakes have been identified (Figure 7.8). Erosion lakes occupy 50.88% of the total lake area in the sub-basin and valley lakes 32.26% (Table 8.17). The largest lake in the sub-basin is a cirque lake (Kuri_gl 102) having an area of 0.918 sq.km lying at an elevation of 4,774 masl. The lake is 1.95 km long. In the headwaters of the Kuri Chu there are 11 lakes associated with glaciers. Details of a few of the larger lakes associated with glaciers are given in Table 8.18.

Table 8.17: Types of lake in the Kuri Chu Sub-basin					
Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	84	46.93	5,635,093.37	50.88	421,298.90
Valley	73	40.78	3,573,598.03	32.26	258,827.12
Cirque	20	11.17	1,818,881.01	16.42	918,538.74
Supraglacial	2	1.12	48,575.96	0.44	30,379.50

Table 8.18: Major glacial lakes associated with glaciers in the Kuri Chu Sub-basin					
Lake name/ number	Type	Area (m²)	Latitude/ longitude	Associated glacier	Remarks
Kuri_gl 129	erosion	132,967	28° 02' 35.47" 91° 17' 49.66"	Kuri_gr 16	0.72 km long; 485m away from glacier
Kuri_gl 142	erosion	361,758	27° 55' 53.22" 91° 16' 20.88"	Kuri_gr 23	0.75 km long; 875m away from glacier
Kuri_gl 172	valley	161,706	27° 55' 47.56" 91° 18' 08.77"	Kuri_gr 33	0.85 km long; in contact with glacier

The Dangme Chu Sub-basin

Table 8.19: Types of lake in the Dangme Chu sub-basin					
Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	77	61.11	2,815,766.11	48.38	642,108.68
Valley	38	30.16	1,806,838.53	31.05	373,285.22
Cirque	11	8.73	1,196,905.60	20.57	232,524.25

A total of 126 lakes has been identified in this sub-basin, most of them are small compared to the lakes in other basins (Figure 7.9). There are 77 erosion lakes, 38 valley lakes, and 11 cirque lakes (Table 8.19). The largest lake in the region is Dangm_gl 59 which has a surface area of 0.64 sq.km and a length of 1.3 km. It lies at an altitude of 4,560 masl. In this sub-basin there are no prominent lakes associated with the glaciers. Only the minor lakes in this sub-basin are associated with the glaciers. They are Dangm_gl 10, 14, and 15.

The Nyere Ama Chu basin

In this basin there are only nine lakes (Figure 8.9) of two types. There are five erosion lakes and four valley lakes (Table 8.20). All these lakes are small in size, the largest is only 185m long.

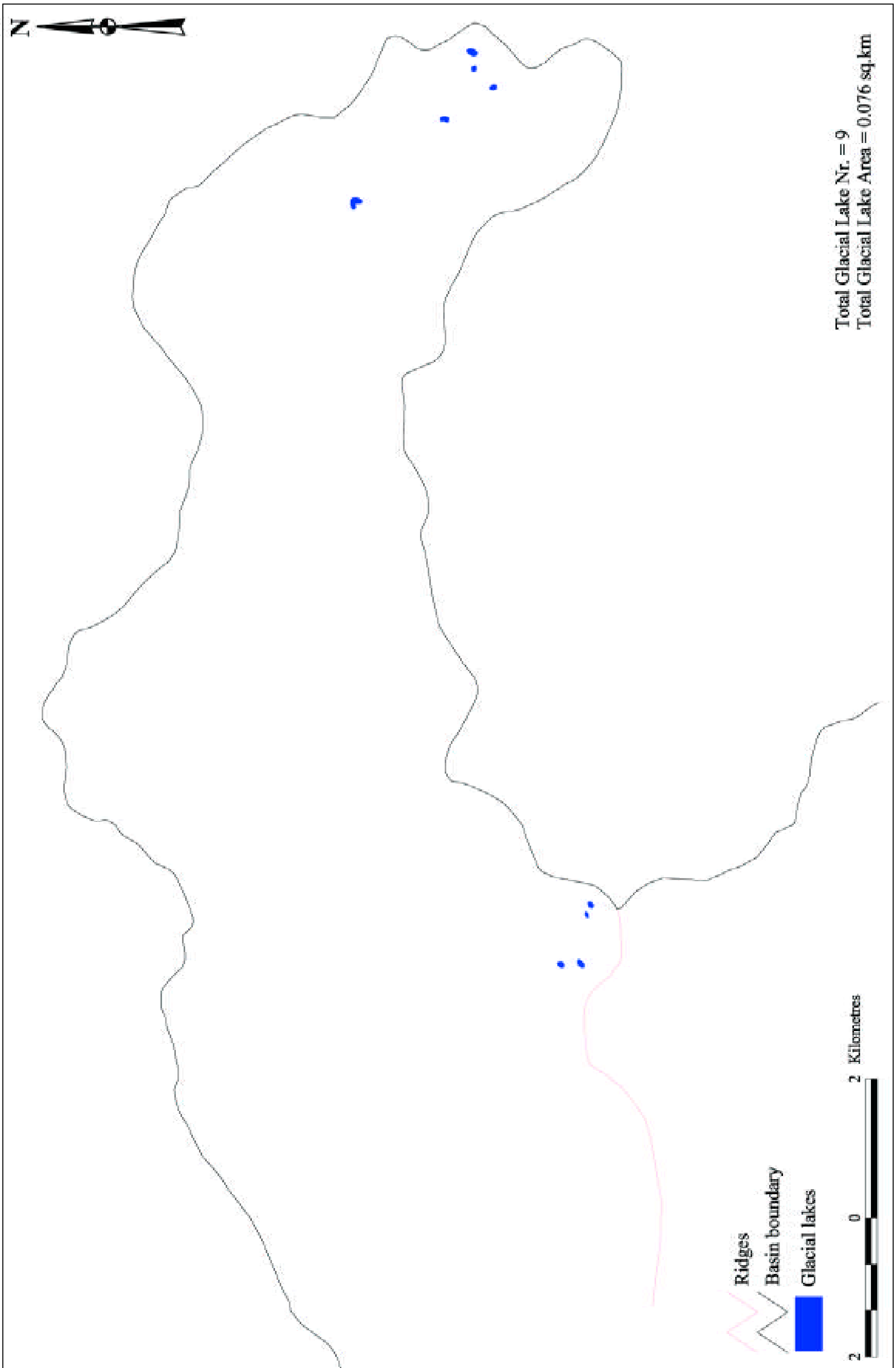


Figure 8.9: Glacial lakes of the Nyere Ama Chu basin

Table 8.20: Types of lake in the Nyere Ama Chu Basin					
Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	5	55.56	50,903.68	66.78	17,841.96
Valley	4	44.44	25,321.13	33.22	8,559.00

The Northern basin

The Northern Basin comprises the rivers originating from the watershed of Bhutan. All these rivers flow north towards Tibet (Figure 7.10). There are 10 glacial lakes in this basin covering a total area of 7.81 sq.km (Table 8.21). Most of the glacial lakes are erosion lakes. There are two moraine-dammed and two supraglacial lakes. Only one valley lake exists in this basin. Details of the lakes associated with the glaciers are given in Table 8.22.

Table 8.21: Types of lake in the Northern Basin					
Type	Number		Area (m²)		Area of largest lake (m²)
	Number	%	Area	%	
Erosion	5	50	508,199	6.50	219,072
Moraine-dammed	2	20	7,125,098	91.19	5,640,910
Supraglacial	2	20	164,567	2.11	151,160
Valley	1	10	15,634	0.20	15,634

Table 8.22: Major glacial lakes associated with glaciers in the Northern Basin				
Name/ Number	Type	Area (m²)	Associated glacier	Remark
Out_gl 1	erosion	219,072	Out_gr 26	470m away from the glacier
Out_gl 2	erosion	49,712	Out_gr 26	85m away from the glacier
Out_gl 3	moraine-dammed	5 640,910	Out_gr 34	largest glacial lake in contact with the glacier
Out_gl 4	supraglacial	151,160	Out_gr 50	in contact with the glacier
Out_gl 5	valley	15,634	Out_gr 51	280m away from the glacier
Out_gl 6	supraglacial	13,407	Out_gr 51	in contact with the glacier
Out_gl 7	moraine-dammed	1,484,188	Out_gr 57	in contact with the glacier
Out_gl 8	erosion	33,111	Out_gr 58	315m away from the glacier
Out_gl 9	erosion	129,144	Out_gr 58	815m away from the glacier
Out_gl 10	erosion	77,160	Out_gr 58	150m away from the glacier

Chapter 9
Glacial Lake Outburst Floods and Damage in the Country

9.1 Introduction

Periodic or occasional release of large amounts of stored water in a catastrophic outburst flood is widely referred to as a **jokulhlaup** (Iceland), **a debacle** (French), an **aluvión** (South America), or a **Glacial Lake Outburst Flood** (GLOF) (Himalayas). A jokulhlaup is an outburst which may be associated with volcanic activity, a debacle is an outburst but from a proglacial lake, an **aluvión** is a catastrophic flood of liquid mud, irrespective of its cause, generally transporting large boulders, and a GLOF is a catastrophic discharge of water under pressure from a glacier. GLOF events are severe geomorphological hazards and their floodwaters can wreak havoc on all human structures located on their path. Much of the damage created during GLOF events is associated with the large amounts of debris that accompany the floodwaters. Damage to settlements and farmland can take place at very great distances from the outburst source, for example in Pakistan, damage occurred 1,300 km from the outburst source (Water and Energy Commission Secretariat (WECS) 1987b).

9.2 Causes of Lake Creation

Global warming

There is concern that human activities may change the climate of the globe. Past and continuing emissions of carbon dioxide (CO_2) and other gases will cause the temperature of the Earth's surface to increase—this is popularly termed 'global warming' or the 'greenhouse effect'. The 'greenhouse effect' gives an extra temperature rise.

Glacier retreat

An important factor in the formation of glacial lakes is the rising global temperature, which causes glaciers to retreat in many mountain regions.

During the so-called 'Little Ice Age' (AD 1550–1850), many glaciers were longer than today. Moraines formed in front of the glaciers at that time nowadays block the lakes. Glaciation and interglaciation are

natural processes that have occurred several times during the last 10 000 years and before.
As a general rule, it can be said that glaciers in the Himalayas have retreated about 1 km since the Little Ice Age, a situation that provides a large space for retaining melt water, leading to the formation of moraine-dammed lakes (LIGG/WECS/NEA 1988).

Röthlisberger and Geyh (1985) conclude in their study on 'glacier variations in Himalaya and Karakorum' that a rapid retreat of nearly all glaciers with small oscillation was found in the period from 1860/1900–1980.

Causes of glacial lake water level rise

The rise in water level in glacial lakes dammed by moraines creates a situation that endangers the lake to reach breaching point. The causes of water level rise in glacial lakes are given below.

- Rapid change in climatic conditions that increase solar radiation causing rapid melting of glacier ice and snow with or without the retreat of the glacier.
- Intensive precipitation events
- Decrease in sufficient seepage across the moraine to balance the inflow because of sedimentation of silt from the glacier runoff, enhanced by the dust flow into the lake.
- Blocking of ice conduits by sedimentation or by enhanced plastic ice flow in the case of a glacial advance.
- Thick layer of glacial ice (dead ice) weighed down by sediment below the lake bottom which stops subsurface infiltration or seepage from the lake bottom.
- Shrinking of the glacier tongue higher up, causing melt water that previously left the glacier somewhere outside the moraine, where it may have continued underground through talus, not to follow the path of the glacier.
- Blocking of an outlet by an advancing tributary glacier.
- Landslide at the inner part of the moraine wall, or from slopes above the lake level.
- Melting of ice from an ice-core moraine wall.
- Melting of ice due to subterranean thermal activities (volcanogenic, tectonic).
- Inter-basin sub-surface flow of water from one lake to another due to height difference and availability of flow path.

9.3 BURSTING MECHANISMS

Different triggering mechanisms of GLOF events depend on the nature of the damming materials, the position of the lake, the volume of the water, the nature and position of the associated mother glacier, physical and topographical conditions, and other physical conditions of the surroundings.

Mechanism of ice core-dammed lake failure

Ice-core dammed (glacier-dammed) lakes drain mainly in two ways.

- through or underneath the ice
- over the ice

Initiation of opening within or under the ice dam (glacier) occurs in six ways.

- Flotation of the ice dam (a lake can only be drained sub-glacially if it can lift the damming ice barrier sufficiently for the water to find its way underneath).
- Pressure deformation (plastic yielding of the ice dam due to a hydrostatic pressure difference between the lake water and the adjacent less dense ice of the dam; outward progression of cracks or crevasses under shear stress due to a combination of glacier flow and high hydrostatic pressure).
- Melting of a tunnel through or under the ice
- Drainage associated with tectonic activity
- Water overflowing the ice dam generally along the lower margin
- Sub-glacial melting by volcanic heat

The bursting mechanism for ice core-dammed lakes can be highly complex and involve most or some of the above-stated hypothesis. Marcus (1960) considered ice core-dammed bursting as a set of interdependent processes rather than one hypothesis.

A landslide adjacent to the lake and subsequent partial abrasion on the ice can cause the draining of ice core-moraine-dammed lakes by overtopping as the water flows over, the glacier retreats, and the lake fills rapidly.

Mechanism of moraine-dammed lake failure

Moraine-dammed lakes are generally drained by rapid incision of the sediment barrier by outpouring waters. Once incision begins, the hustling water flowing through the outlet can accelerate erosion and enlargement of the outlet, setting off a catastrophic positive feedback process resulting in the rapid release of huge amounts of sediment-laden water. Peak discharge from breached moraine-damaged lakes just downstream from the moraine can be estimated from an empirical relationship developed by Costa (1985) (Figure 9.1) The onset of rapid incision of the barrier can be triggered by waves generated by glacier calving or ice avalanching, or by an increase in water level associated with glacial advance.

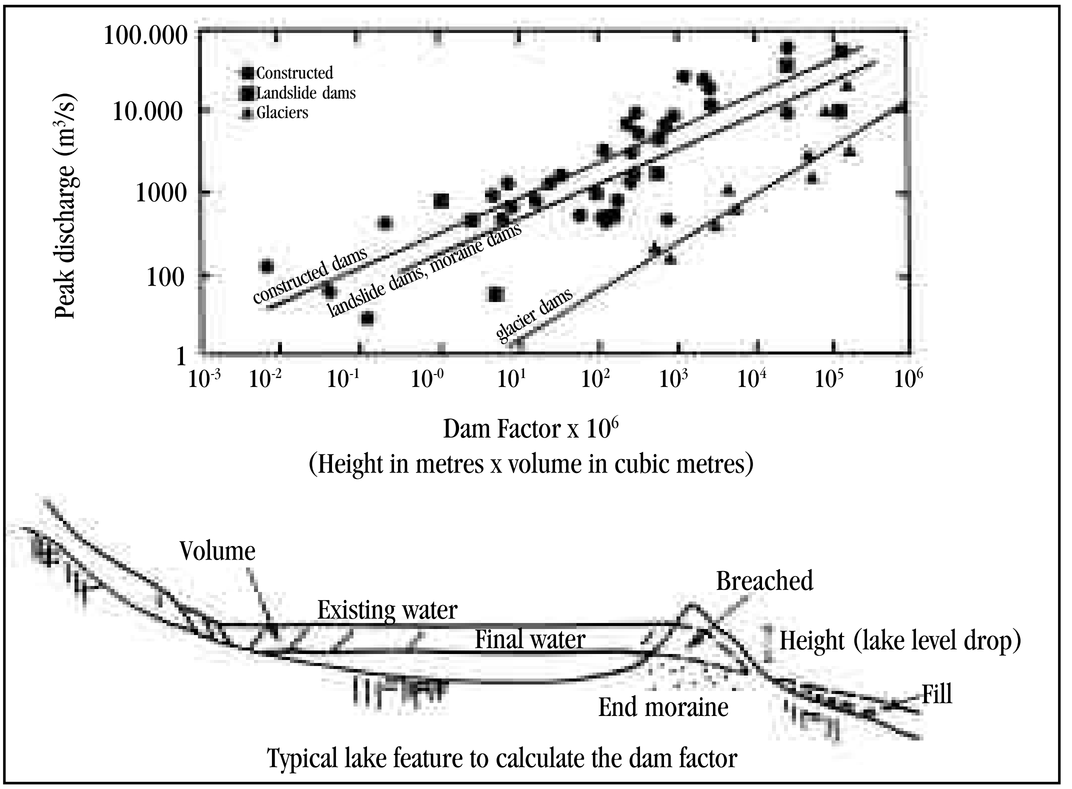


Figure 9.1: Peak discharge* from breached moraine-dammed lakes can be estimated from an empirical relationship developed by Costa (1985)

Dam failure can occur for the following reasons:

- melting ice core within the moraine dam,
- rock and/or ice avalanche into a dammed lake,
- settlement and/or piping within the moraine dam,
- sub-glacial drainage, and
- engineering works.

Melting ice-core

The impervious ice core within a moraine dam melts, lowering the effective height of the dam, thus allowing lake water to drain over the residual ice core. The discharge increases as the ice core melts, and as greater amounts of water filter through the moraine, carrying fine materials. The resulting regressive erosion of the moraine dam ultimately leads to its failure.

Overtopping by displacement waves

Lake water is displaced by the sudden influx of rock and/or ice avalanche debris. The resultant waves overtop the freeboard of the dam causing regressive and eventual failure.

Settlement and/or piping

Earthquake shocks can cause settlement of the moraine. This reduces the dam freeboard to a point that the lake water drains over the moraine and causes regressive erosion and eventual failure.

Sub-glacial drainage

A receding glacier with a terminus grounded within a proglacial lake can have its volume reduced without its ice front receding up-valley. When the volume of melt water within the lake increases to a point that the formerly grounded glacier floats, an instantaneous sub-glacial drainage occurs. Such drainage can destroy any moraine dam, allowing the lake to discharge until the glacier loses its buoyancy and grounds again.

Engineering works

Artificial measures taken to lower the water levels or to change dam structures may trigger catastrophic discharge events. For example, in Peru in 1953, during the artificial lowering of the water level, an earth slide caused 12m high displacement waves, which poured into a trench, excavated as part of the engineering works and almost led to the total failure of the moraine dam.

9.4 Surge Propagation

As GLOFs pose severe threats to humans, man-made structures, agricultural fields, and natural vegetation it is important to make accurate estimates of the likely magnitude of future floods. Several methods have been devised to predict peak discharges, which are the most erosive and destructive phases of floods. The surge propagation hydrograph depends upon the type of GLOF event, i.e. from moraine-dammed lake or from ice-dammed lake (Figure 9.2). The duration of a surge wave from an ice-dammed lake may last for days to even weeks, while from a moraine-dammed lake the duration is shorter, minutes to hours. The peak discharge from the moraine-dammed lake is usually higher than from ice-dammed lakes.

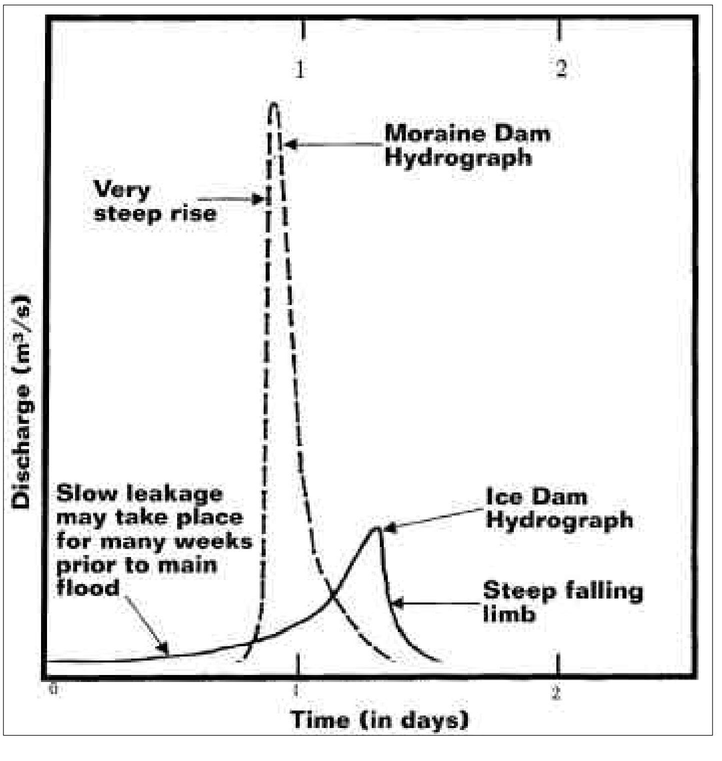


Figure 9.2: Difference in release hydrograph between moraine- and ice-dammed lakes

The following methods have been proposed for estimation of peak discharges.

1) Clague and Mathews formula

Clague and Mathews (1973) were the first to show the relationship between the volume of water released from ice-dammed lakes and peak flood discharges.

$$Q_{max} = 75(V_0 * 10^{-6})^{0.67}$$

where
Q_{max} = peak flood discharge ($m^3 s^{-1}$)

V_0 = total volume of water drained out from lake (m^3)

The above relationship was later modified by Costa (1988) as the peak discharge yielded from the equation was higher than that measured for Flood Lake in British Columbia that occurred in August 1979:

$$Q_{max} = 113(V_0 * 10^{-6})^{0.64}$$

Later Desloges et al. (1989) proposed:

$$Q_{max} = 179(V_0 * 10^{-6})^{0.64}$$

This method of discharge prediction is not based on any physical mechanism, but seems to give reasonable results.

2) Mean versus maximum discharge method

If the volume of water released by a flood and the flood duration are known, the mean and peak discharges can be calculated. Generally the flood duration will not be known in advance. Hence, this method cannot be used to determine the magnitude of future floods. Observations of several outburst floods in North America, Iceland, and Scandinavia have shown that peak discharges are between two to six times higher than the mean discharge for the whole event.

3) Slope area method

This method is based on measured physical parameters such as dimensions and slope of channel during peak flood conditions from direct observations or geomorphological evidence.

$$Q_{max} = vA$$

The peak velocity is calculated by the Gauckler–Manning formula (Williams 1988)

$$v = r^{0.67} S^{0.50}/n$$

where
v = peak velocity
S = bed slope for a 100m channel reach
n = Manning's roughness coefficient
r = hydraulic radius of the channel

$$r = A/p$$

where
A = cross-sectional area of the channel
p = perimeter of the channel under water

For sediment floored channels, bed roughness is mainly a function of bed material, particle size, and bed form or shape and can be estimated from:

$n = 0.038D^{0.167}$

where
D = average intermediate axis of the largest particles on the channel floor.

Desloges et al. (1989) compared the results from all the three methods for a jokulhlaup from the ice-dammed Ape Lake, British Columbia. All the methods gave comparable results.

- The Clague and Mathews method gave a calculated peak discharge of 1680 ± 380 $m^3 s^{-1}$.
- The mean versus maximum discharge method gave 1080–3240 $m^3 s^{-1}$.
- The slope area method gave 1,534 and 1,155 $m^3 s^{-1}$ at a distance of 1 and 12 km from the outlet respectively.

These general relationships are useful for determining the order of magnitude of initial release that may propagate down the system. However, to predict the magnitude of future floods, the first method should be applied, because volume of lake water can be estimated in advance.

Attenuation of a peak discharge of 15,000–20,000m s^{-1} has been reported for the Poiqu River in Tibet (Sun Koshi in Nepal) within a distance of 50 km (XuDaoming 1985).

9.5 Sediment Processes During a Glacial Lake Outburst Flood

During a GLOF, the flow velocity and discharge are exceptionally high and it becomes practically impossible to carry out any measurement. Field observations after a GLOF event have shown a much higher sediment concentration of rivers than before the GLOF event (Electrowatt Engineering Service Ltd 1982; WECS 1995a). WECS (1995a) calculated the volume of sediment as $22.5*10^4$ m^3 after the Chubung GLOF of Nepal in 1991. A high concentration of 350,000 mg^{-1} during a GLOF in the Indus River at Darband in 1962 is reported by Hewitt (1985).

Figure 9.3 gives a hypothetical GLOF illustration showing discharge and variation in sediment concentration (WECS 1987a). The total sediment load is generally accepted as the wash load, which moves through a river system and finally deposits in deltas. In Bhutan, no measurements have been undertaken on total sediment during GLOF events, however, rough estimates of total load during torrents can be made assuming a high sediment concentrations (WECS 1987b). During a GLOF event, stones the size of small houses can be easily moved (WECS 1987b). The relationship between flow velocity and particle diameter can also be used to calculate the size of boulders that can be moved during such events.

9.6 Socioeconomic Effects of Glacial Lake Outburst Floods

The impacts of GLOF events downstream are extensive in terms of damage to roads, bridges, trekking trails, villages, agricultural land, natural vegetation, as well as the loss of human lives and infrastructure. The sociological impacts can be direct when human lives are lost, or indirect when the agricultural lands are converted to debris filled lands and the village has to be shifted. The records of past GLOF events in the Himalayas show that once every three to ten years, a GLOF has occurred with varying degrees of socioeconomic impact. Therefore, the most appropriate mitigating methods must be applied after conducting a proper hazard assessment study based on possible economic loss evaluation.

Glacial lakes were formed by the retreat of glaciers. Most of these lakes are dammed by moraines. These moraine dams if unstable could fail and give rise to GLOF events, having a devastating effect downstream. During recent decades there has been a rapid retreat of glaciers all over the world. It has been observed that the glaciers in Bhutan are retreating at a rate of about 30–40m $year^{-1}$ (Section 7.3), new lakes are being formed, and the size of existing lakes attached to glaciers is increasing.

There have been several cases of GLOFs in Bhutan, but only one has been recorded in detail. Records for the other cases are based on verbal information gathered from elderly people many years after the flood took place.

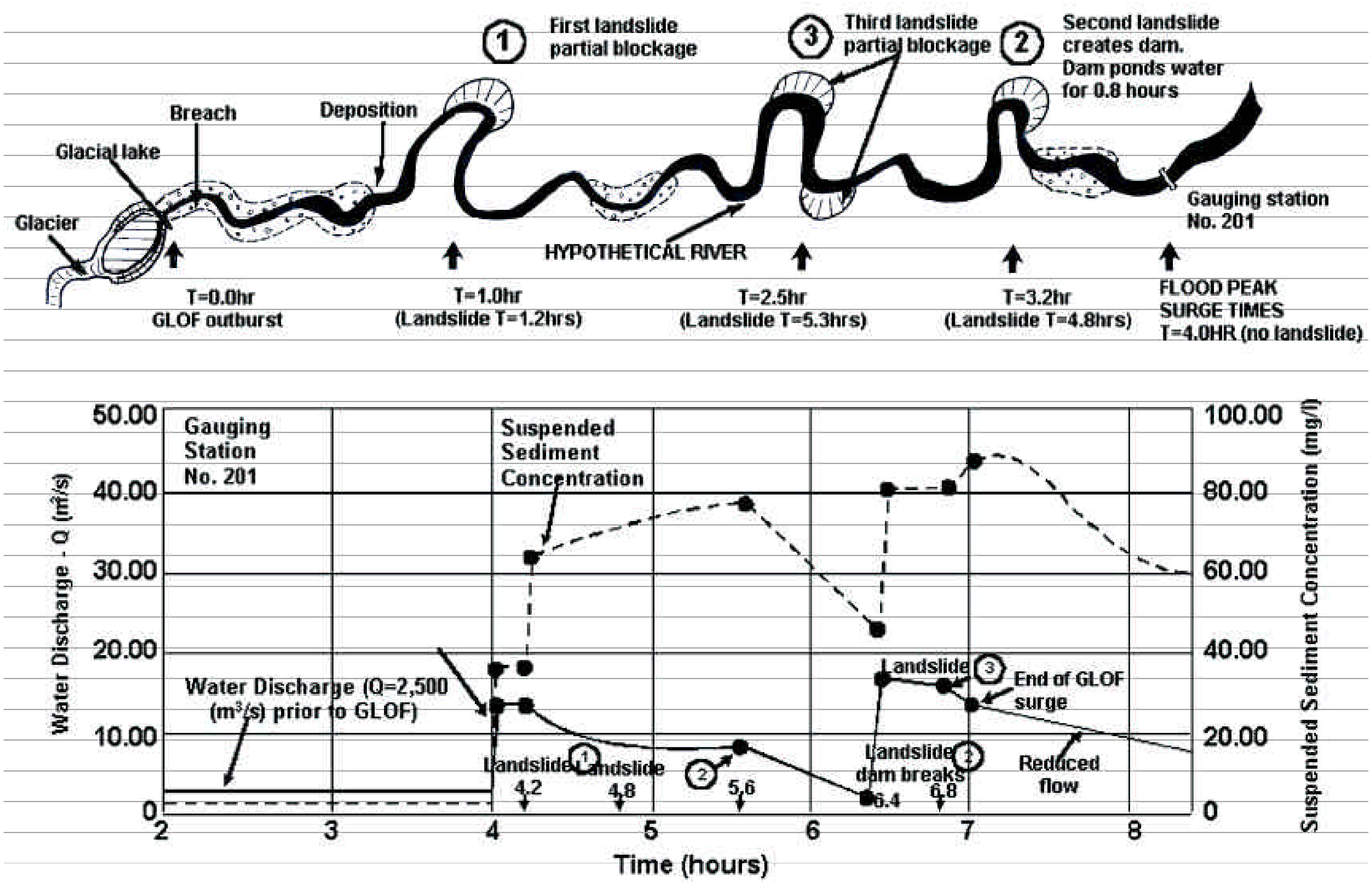


Figure 9.3: Hypothetical GLOF illustration showing discharge and variation in sediment concentration (WECS 1987a)

9.7 Brief Review of Glacial Lake Outburst Flood Events and Damage Caused

The 1957 GLOF

The 1957 GLOF affected the Punakha–Wangdue Valley, which destroyed part of Punakha Dzong. Gansser (1970) attributed this flood to the outburst from Tarina Tsho, western Lunana.

1960 GLOF

This flood also destroyed part of Punakha Dzong due to the bursting of some lakes in eastern Lunana. It is said to have lasted for five days and there are no written records on this flood.

1994 GLOF

The most recent flood occurred on 7 October 1994 due to a partial burst from Lugge Tsho located in eastern Lunana, which caused loss of life and property along the Punakha–Wangdue Valley and damaged part of Dzongchung of Punakha Dzong (Watanabe and Rothacher 1996).

From the survey conducted on 20–23 October 1994, a total of 91 households was affected by the flood in the Lunana region (Geological Survey of Bhutan 1994). Twelve houses were damaged, 5 water mills were totally washed away, and 816 acres of dry land were damaged (and some was washed away and others were partially covered by silt and sand). There was major damage to pasture land which affected the people in the region because they are dependent on their yaks for their livelihood. A total of 965 acres of pasture land was washed away or covered by sand and silt. Livestock (16 yaks) were carried away by the flood. Food grains lost totalled about 6 tonnes, which can be considered as a huge amount for the people living in these regions. Some of the field photographs taken after the GLOF events are shown in Plates 9.1– 9.17.

Plate 9.1: Lugge Tsho Glacial Lake two weeks after the GLOF of 7 October 1994
(Yeshi Dorji)

Plate 9.2: Lugge Tsho Glacial Lake in contact with the tongue of Lugge Glacier. The photograph was taken two weeks after the GLOF of 7 October 1994. The tonal difference indicates the fresh surfaces on the slope after the first (7 October) and the second (17 October) events.
(Yeshi Dorji)

Plate 9.3: The occurrence of dead ice within the moraine of Lugge Tsho
(D.R. Gurung 1999)

Plate 9.4: The end moraine of Lugge Glacier slumps and fine sand indicating that it is under-lain by dead ice.
(D.R. Gurung 1999)

Plate 9.5: The U-shaped valley looking downstream and Tenchey, Dota, and Tshoju Villages The sand deposited by the flood of 1994 is still seen in between Dota and Tshoju where only a little grass has grown.
(Yeshi Dorji)

Plate 9.6: Thanza Village and erosion downstream caused by the flood of 1994.
(Tshering Tashi, NEC)

Plate 9.7: Tshoju Village is just behind, the photograph was taken facing southeast. It shows the lacustrine deposit and sand deposited by the flood of 1994.
(Yeshi Dorji)

Plate 9.8: The debris brought down by the flood and deposited in the riverbed below Lhedi Village which destroyed the pasture land of Lunaps; a few trees were seen in the riverbed.
(Yeshi Dorji 1994)

Plate 9.9: Damage caused by the flood of 1994 to one of the oldest and most sacred temples in Punankha.
(Helvetas)

Plate 9.10: Erosion caused by the flood on the right bank of the Mochu above Punakha Dzong.
(Helvetas 1994)

Plate 9.11: A log being brought down by the flood of 1994 and the scene below Wangdue Phodrang Bridge.
(Helvetas 1994)

Plate 9.12: Punakha Dzong three days after the disaster of 1994. Also shown is the confluence of the Phochu and the Mochu below the Dzong and scars of the back flow water after it had joined the Mochu and dammed the flow above the Dzong.
(Phuntso Norbu 1994)

Plate 9.13: Thorthormi Glacier, Lugge Glacier, Lugge Hanging Glacier just above the right lateral moraine of Lugge and Druckchung Glaciers, Lugge Tsho, and Thorthormi Tsho. Also showing is the trench formed by water flowing from Lugge Hanging Glacier into Thorthormi Lake. The breach point of Lugge is also seen on the left lateral moraine of Lugge.
(Phuntso Norbu October 1994)

Plate 9.14: Supraglacial lakes being formed in Thorthormi Lake and erosion caused by the 1994 flood on the left lateral moraine.
(Phuntso Norbu 1994)

Plate 9.15: Raphstreng Lake with a frozen surface. Also shows first subsidiary lake. This was taken from a chopper before the mitigation measures for Raphstreng were undertaken.
(Yeshi Dorji March 1995)

Plate 9.16: Raphstreng Lake, right lateral moraine, glacial snout, the new excavated outlet, and erosion caused by the flood of 1994 along the main river bed.
(Phuntsho Norbu 1999)

Plate 9.17: Gangri Tsho and deep V-shaped cut at the outlet indicating that the lake had breached earlier.
(Karma 1998)

Chapter 10
The Glacial Lakes Studied in Bhutan

10.1 Previous Studies

The first study on the glaciers and glacial lakes in Bhutan was carried out by Augusto Gansser, a Swiss geologist, during his expedition to the Bhutan Himalayas in the 1960s and 1970s. During his expedition to Lunana in 1967 he identified a number of dangerous lakes which could flood in the lower valleys. He was of the opinion that the 1957 Punakha flood was due to an outburst from Taraina Tsho in western Lunana. He also identified a number of growing lakes and made sketch maps of the Lunana lakes. Gansser made small-scale maps of present day glaciers and glacial lakes of north and northwest Bhutan using LANDSAT images (Gansser 1983).

A preliminary aerial reconnaissance survey was carried out over the Lunana area (Raphstreng Tsho area) in September 1974 and August 1981 by a team of experts from the Geological Survey of India (GSI) to assess the probability of a flash flood by the bursting of the lake and the impact downstream along the Pho Chu Valley. The Royal Government of Bhutan (RGOB) initiated the survey when local people reported that the lake water level had risen to the extent of overflowing. The team was of the opinion that there was no immediate danger of outburst but recommended that a detailed ground survey be carried out.

In 1984 a joint expedition of the Geological Survey of Bhutan (GSB) and the GSI was carried out to study Lunana Lake (Raphstreng Tsho). Monitoring of inflow and outflow of the water discharge was carried out and a detailed map on a cale of 1:2,000 showing depth contours of the lake at 20-metre intervals was prepared. The team could stay for a duration of only 8 days. However the expedition resulted in a more detailed understanding of the relationship between the glacial lake and the glacier (GSI and GSB 1986). The team submitted a recommendation note for further detailed work on a continuing basis for a couple of years.

Lunana lake expedition (July to September 1986)

Following the recommendation of the 1984 expedition, in July 1986 a joint expedition team from GSB and GSI carried out detailed studies of Lunana Lake (now called Raphstreng Tsho). The team members were A.R. Sharma (Senior Geologist), GSI team leader; D.K.Ghosh (Junior Geologist), GSI; Phuntso

Norbu (Assistant Geologist), GSB; K.S. Ghalley and S. Kafley (Mineral Prospectors), GSB (GSI and GSB 1986).

The main objective of the expedition was to study, in detail, all aspects that had a direct bearing on a possible Lunana Lake outburst. The expedition team started trekking from Nika Chu Bridge on the 11 July 1986 and reached Lunana on 7 August 1986. The team could carry out detailed studies for a period of 36 days only, against the original planned schedule of 60 days, due to logistic constraints.

The detailed study carried out in the area comprised:

- hydrometry of the lake outlet stream,
- suspended sediment transport studies of the lake and outlet stream,
- ice flow studies of the glacier feeding the lake,
- geomorphological studies of the Thanza Valley, and
- recording of meteorological parameters of the area during the period of study.

From these studies the team came to a conclusion that there was no danger of a lake outburst in the near future but recommended periodical checks every two to three years due to the presence of ice cores in the moraine dams (GSI and GSB 1986).

Joint expedition team (1995)

After the flood on 7 October 1994, due to a breach of the Lugge Tsho resulting in loss of life and property, in 1995 the RGOB sent an Indo-Bhutanese team of experts (GSI and RGOB) to Lunana to carry out preliminary studies to identify the cause and effect of the flash flood in the Pho Chu. The team consisted of an engineering geologist, a structural geologist, a glaciologist, a surveyor from GOI, and other officials from RGOB. They recommended short-term and long-term mitigation measures (Dorji 1996a,b).

The short-term measures suggested were:

- that flow of the Pho Chu from Lugge and Tshopda Tsho area, be ensured by unloading the crown of the landslide located about 70 km downstream of Tshopda Tsho outlet and constructing gabion-toe walls on either bank of the Pho Chu,
- lower the outlet of Thorthormi by 10m in stages to reduce the hydrostatic pressure,
- restore the original section of the morainic barrier of Raphstreng Tsho washed away by the 1994 flood,
- lower the level of Raphstreng by 20m to reduce the volume by 38% and hydrostatic pressure from 68,152 kN to 51,799 kN, and
- draining should be carried out in stages as sudden draw down can lead to slope failure.

It was suggested that the short-term mitigation measures mentioned above would not withstand catastrophic events like earthquakes, so it would be necessary to implement the long-term measure of constructing check dams, dykes, and other structures to reduce the energy of the flood, thus reducing damage downstream. It was also suggested that fast-growing shrubs, grass, and trees having soil holding capacity be planted to stabilise the slopes. It was recommended that seismic and meteorological stations be set up and that regular monitoring of the lakes be carried out.

Expedition to Roduphu glacial lake (1996)

This expedition was undertaken based on the report that there is a lake which could burst and cause flooding downstream. The expedition was funded by the National Environment Commission and coordinated by the Ministry of Home Affairs. Team members were from the Division of Geology and Mines and the Division of Roads of the Survey of Bhutan and National Environment Commission (National Environmental Commission 1996).

The expedition team discovered three small lakes in the headwaters of the Roduphu Chu, a major tributary of the Mo Chu. A desk study of the 1989 SPOT image showed that Roduphu Tsho III, situated at about 4,750 masl, was 300m long and 175m wide with no visible surface outlet. In July–August 1996 the expedition discovered evidence that the lake had been drained recently by 1.55m. The team also reported that during retreat of the Roduphu Glacier a number of small lakes were being formed (Roduphu Tsho I) which could become sizeable lakes in a decade or so. These lakes have outlets that flow over and under the morainic deposit. Although these lakes do not pose immediate danger, periodic physical monitoring was recommended.

All the detailed investigations carried out in Bhutan were in the eastern Lunana region (Raphstreng Tsho area). A number of expeditions went to study this lake due to its earlier history (not recorded in writing) and the recent GLOF of 1994. The other glacial lakes studied (preliminary studies) are the glacial lakes in the headwaters of the Chamkhar Chu and the Paro Chu.

Japan–Bhutan joint research programme (1998)

Nagoya University, Tokyo Metropolitan University, and the GSB undertook a joint research programme in 1998. The objective was to prepare an updated inventory of major glacial lakes located at the headwaters of Bhutan and to produce an assessment of the dangers of GLOF, including ranking of the vulnerability of glacial lakes by a combined study on the variation of glacial lakes and the surrounding glacial area (Ageta and Iwata 1999).

The following studies/observations were carried out.

- Eighteen glacial lakes named by the Division of Geology and Mines and 12 other glacial lakes were observed.
- Water temperature (vertical profile) and lake depth of GLP9 (Raphstreng Tsho) were surveyed.
- Three automatic weather stations were established in Lunana region to measure air temperature, precipitation, and maximum snow depth.
- Jichu Dramo Glacier in the southern part was surveyed for mapping by terrestrial photogrammetry.
- Geomorphological observations of glaciated zones and areas surrounding glacial lakes were made, and dating samples were collected from moraines and sediments for reconstruction of palaeo-environmental changes.
- The relationship between glacier variation and glacial lake change was checked for recent years from a glaciological point of view.
- Water samples for stable isotope measurements and data of ground temperature distribution were collected for an analysis to be made of the hydro-climatological environment in high mountainous areas where glacial lakes are distributed.

Based on the above studies, observations, and data collection, an updated glacial lake inventory and risk assessment of moraine dam failure of the glacial lakes in Bhutan were presented in the report on 'Assessment of Glacier Lake Outburst Flood in Bhutan' (Ageta and Iwata 1999).

10.2 Glacial Lakes Studied

The lakes of Bhutan that have been studied are described below. The extent of studies carried out on these lakes was not the same. Among the lakes studied, Raphstreng Tsho drew the attention of most of the investigators.

Raphstreng Tsho (eastern Lunana)

After identification of a number of dangerous lakes by Gansser's expedition in 1967 to Lunana area, Lunana Lake (now called Raphstreng Tsho) drew the attention of RGOB and other researchers. As explained in previous sections, in 1974 and 1981 aerial reconnaissance surveys were carried out over Lunana area (Raphstreng Tsho) by the Geological Survey of India. In 1984 a joint expedition was made by the GSB and the GSI to carry out a ground survey. A detailed map on a scale of 1:2,000 showing depth contours of Lunana Lake at contour intervals of 20m was also prepared during this expedition.

For more detailed studies, in 1986, a joint expedition team of the GSB and the GSI was sent to Lunana Lake again. The following major studies were carried out by the expedition team.

Hydrometry of the lake outlet stream

To measure the water discharge from the lake outlet a bridge approximately at right angles to the stream was used. Water discharge was calculated using the area velocity method. A current meter was used as the velocity measuring instrument. The area was calculated from the cross section prepared by measuring the depth of the stream at every 1m along the width of the stream. Velocity measurements were taken every 1m along the width of the stream by lowering the current meter from the bridge and submerging the propeller at least 30 cm below the surface of the water.

Using the water discharge values obtained by the above method and the corresponding gauge level records (recorded every hour between 0800 and 1700 h), a rating curve was drawn to estimate the water discharge values. From the 10 hourly discharge values, the average rate of discharge in $m^3 s^{-1}$ was calculated for each day. The total water volume for a period of 31 days from 12 August 1986 was 21.27 x $10^6 m^3$. Average discharge per day was 0.68 x $10^6 m^3$.

Suspended sediment transport studies of the lake and outlet stream

To study the suspended sediment transport of inflow and outflow of the lake, water samples were taken from the lake reservoir and outlet of the lake. These samples were filtered through ashless filter paper no. 42 and weighed. Then they were ignited using the ashing procedure and the residue weighed to calculate the silt content in tonnes. A total of 46 samples was collected. It was found that for the period of 26 days between 13 August and 7 September 1986 (i) the average rate of sediment discharge was 125.82 t day^{-1}, (ii) the average rate of sediment input was 154.08 t day^{-1}, and (iii) the average rate of siltation was 28.26 t day^{-1}.

Ice flow studies of the glacier feeding the lake

This study was carried out to see whether there is any glacier surge tendency, or the ice flow is restricted only to glacier surface movement. Two stakes were fixed across the width of the glacier about 350m upstream of the glacier snout. The observations were taken for a period of 16 days from 20 August. By this method it was observed that the average horizontal movement varied from 8.5 cm day^{-1} to 17.5 cm day^{-1}. Although the data are insufficient to come to a definite conclusion, up to an average horizontal movement of 17.5 cm day^{-1} definitely does not indicate any surging tendency of the glacier.

In Lunana, four glaciers were recognised with well-defined boundaries and separate from each other (numbered as Glaciers I, II, III, and IV). The elevation of the snout of these glaciers ranges from 4,150 masl to 4,200 masl. Glaciers III and IV, now known as Thorthormi Glacier and Lugge Glacier respectively, are at a higher level than Lunana Glacier (Glacier II) which is now called Raphstreng Tsho Glacier. The snout of Glacier III is wider than the snout of other glaciers in Lunana and no lakes were observed in 1986. It was assumed that in future, as the glacier melts, it would deposit more frontal moraine thereby increasing the width between Lunana Lake and Glacier III. The only unstable portion in Lunana Lake was the left flank of the snout, from where morainic debris was sliding into the lake during summer months. Two dead ice patches were observed, on the eastern and western margins of the lake at the existing water level and more was expected within the morainic deposit in the same areas.

Geomorphological studies of Thanza Valley

Geomorphological studies were also carried out in Thanza Valley, but not in detail. It was believed that the whole of Thanza Valley was a glaciated valley with its outlet at Tshojo Village. This is evidenced by the number of end and lateral moraine deposits left by the fast retreating glaciers in the valley. This geomorphology later was changed by fluvioglacial process giving rise to sharp and wide gullies. The flood plain (1.5 km long and 0.75 km wide) between Tenchey and Tsojo represents an old glacial lake. The widest part of the valley lies beyond Tsojo between Lhedi and Rholo, after which the Pho Chu enters deep gorges.

To record the meteorological parameters of the area during the period of study, a small meteorological station was set up to measure daily precipitation, maximum and minimum temperature, variation in daily temperature, and relative humidity (Table 10.1). The instrument used was a maximum–minimum, dry and wet bulb thermometer of IMD specification.

Table 10.1: Variation in daily temperature, precipitation, and relative humidity (observation time 08:00 h, observation period 8 August to 13 September 1986)		
Meteorological parameters	**August**	**September**
Maximum daily temperature		
Highest maximum	23° C on 8 August	17° C on 3 September
Lowest maximum	10° C on 11 August	9.5° C on 12 September
Minimum daily temperature		
Highest minimum	7° C for 6 days	17° C on 02 September
Lowest minimum	3° C on 19 August	4° C on 11 September
Daily precipitation		
Total rainfall	75.5 mm for 24 days	60.8 mm for 12 days
Maximum rainfall	20.6 mm on 19 August	10.2 mm on 10 September
Rain free days	4 days	Nil
Humidity		
Highest	98% on 11 August	97% on 12 September
Lowest	80% for 8 days	80% for 4 days
Average	85.5%	86%

The studies carried out by the 1986 expedition revealed the safety of the morainic barrier surrounding the lake with no signs of possible breaching in the near future. However, it was recommended that periodical checks every two or three years would be required in view of the presence of ice core in these moraines which on melting is likely to effect geomorphological changes by way of subsidence.

In 1996 RGOB sent an Indo-Bhutan team of experts in to carry out immediate short-term mitigation measures for Raphstreng Tsho. More detailed studies were taken up simultaneously. During this period, in addition to the collection of hydrometeorological data, a topographical map of Raphstreng Tsho outlet area was prepared on a scale of 1:2,000 with contour intervals of 2.5m. From this contour map cross sections and longitudinal sections at required locations were prepared.

Other investigations

Three samples were taken from different locations and subjected to the following tests: mechanical analysis, Atterberg limits, specific gravity, and chemical analysis. The Atterberg limits test indicated that all three samples showed non-plastic characteristics. Based on grain size analysis and the Atterberg limits test, two of the soil samples fell into the GP-GM group and one fell into the GP group of the Indian Standard of Soil Classification System. Specific gravity of the soil samples (passing 4.75 mm sieve) varied from 2.69 to 2.70. Using the data collected in the field, stability analysis was carried out and it was found that, if the reservoir level of the lake is at 4,347.6 masl in elevation, it is critical. If the level is at 4,344.7 masl in elevation then the slope is just stable, so it was recommended that the lake level be lowered to 4,344.7 masl in elevation (WAPCOS 1997).

In 1998 the Japan–Bhutan research team carried out field observation along the 'Snowman Trek' route, in the north and northwestern part of Bhutan (Ageta and Iwata 1999). The focus of the field observation was to observe water temperature distribution of Raphstreng Tsho, to ascertain the thermal condition of the lake, and to find out if there is seepage from Thorthormi Glacier into Raphstreng Tsho.

Measurements were carried out on 6 October 1998 using a water temperature profiler, ABT-1 (ALEC Electronics Company Ltd) on a rubber boat. The instrument can measure water temperature at an interval of 1-metre depths with an accuracy of 0.1°C. Measurement sites were located using a theodolite. The vertical profile of water temperature was measured at 18 sites (11 sites located in the middle of the lake and seven on the left edge of the lake along the morainic ridge separating Thorthormi Glacier). The bathymetric map of the 1986 expedition team was used. Observations showed that the surface temperature of the lake was in the range of 10-15°C and decreased with depth to 4°C at around 20m depth at all the sites. The water temperature profile of the seven sites on the left side of the lake along the ridge separating Thorthormi Glacier did not indicate any sign of seepage from Thorthormi Glacier into Raphstreng Tsho. The result of the study indicated two possibilities: (i) the water temperature of the seepage is almost the same as that of the lake water of Raphstreng, or (ii) due to the small amount of seepage water, the seepage water mixed with the lake water and the seepage water did not make a distinctive layer in Raphstreng Tsho.

The other observations made by the joint research team were climatic. Three automatic weather stations were established in Lunana region (Thanza, upper part of Jichu Dramo Glacier, near the terminus of Jichu Dramo Glacier) to measure air temperature, precipitation, and maximum snow depth. The results of these observations have not yet been published.

The research team produced a check list for risk assessment of moranic dam failure and/or lake burst and a data sheet for a glacial lake inventory in the Bhutan Himalayas. From these data sheets, risk assessment of moraine dam failure and/or lake burst and a glacial lake inventory of 30 lakes observed were produced in the report 'Assessment of Glacier Lake Outburst flood in Bhutan (Ageta and Iwata 1999).

In 1999 the Austro–Bhutan expedition team carried out integrated geophysical, hydrological, and geological investigations in the Lunana area with special emphasis on Raphstreng Tsho and Thorthormi Tsho (Häusler et al. 2000).

The materials/equipment used were:

- Digital Indian Remote Sensing Satellite Series 1D (IRS-1D) image data, panchromatic with ground resolution of 5.8m, of 3 January 1999,
- topographic maps of the area of the scale 1:50,000 (Survey of India),
- WTW-LF318 instrument to measure conductivity (equipment manufactured by Wissenschaftlich Technische Wersatten (WTW) company,
- WTW-pH320 to measure pH,
- WTW-pH330 with a SenTixORP redox to measure redox potential,
- stepped frequency ultra wideband sub-surface imaging radar (SUSI), frequency range 1 MHz –8 GHz, was used for subsurface radar investigation,
- seismograph (24 channel ABEM terraloc Mark III) for seismic refraction and reflection investigation,
- resistivity meter with multi-core cable system, and
- theodolite.

From the digital IRS-1D image and topographic map of the area, using ERDAS/IMAGINE software, satellite image maps on scales of 1:25,000 and 1:5,000 were produced for use as base maps to monitor glacier decay and for field survey. A 3-D digital elevation model was prepared to help in the interpretation of geology and geomorphology.

The Raphstreng terminal moraine is made up of three terminal moraine ridges of different ages. The youngest is in contact with the lake, while the outermost ridge is the oldest. The left lateral moraine of Raphstreng is affected by mass movement, especially along the Raphstreng–Thorthormi moraine segment. As this process continues, the possibility of a dam break is high from Thorthormi Lake, which in the future will develop into a large lake.

During the hydrological investigation water samples were collected for analysis of stable and unstable isotopes, tritium, and unstable isotope for dating of water. In addition water temperature, electrical conductivity, pH, and redox potential were measured. Tracer experiments were also conducted using natrium nitrate and urainine to find the source of seepage.

For the sub-surface radar investigation, the band width selected was 100 MHz leading to a depth resolution of about 1.5m depending on the actual soil conditions. The centre frequency selected was 150 MHz in conjunction with 512 frequency lines. The antennas selected were a modified dipole, 60cm apart and horizontally oriented at 90° with respect to profile line (Häusler et al. 2000).

For the seismic investigation a geophone spacing of 20m was selected. For refraction investigation the shot point distance was 120m, whereas for the reflection survey for the RT9901 spread it was 5m and for the TT9902 it was 10m. Recording time for all records (refraction and reflection) was 500 ms, giving a sampling interval of 0.5 ms. The charge was placed at an average depth of 0.7m. For processing of refraction data, software developed by Joanneum Research using the 'generalised reciprocal method' by

D. Plamer was used. The software used for processing reflection data was FOCUS/DISCO (Paradigm Geophysical) on a UNIX based workstation.

For electrical resistivity investigation, a one channel multi-core cable system with 56 stainless steel electrodes was used for acquisition of field data. For processing the data, RES2DIVN software was used. The purpose of this investigation was to delineate ice cores and groundwater flows in the moraines.

From the analysis of the data collected, risk potential was estimated and presented in the report of the Raphstreng Tsho Outburst Flood Mitigatory Project (Häuslar et al. 2000)

Roduphu glacial lake

In July 1996 an expedition was undertaken to Roduphu Sinchhe Glacial Lake based on the report that there was the possibility of a lake burst in that region which could cause a flood hazard downstream (National Environmental Commission 1996).

The team physically verified the lake (Roduphu Tsho III). It is situated at an elevation of 4,750 masl. In the SPOT image of 1989 the lake measured 300m long and 175m wide. During field verification it was found to be a shallow greenish-blue lake about 120m long and 80m wide. It has been observed that the left lateral moraine on which the lake is situated has been affected by progressive landslides and due to this the lake has been recently drained by 1.55m as evidenced by the fresh water mark along the periphery of the lake. The outlet formed is 10m wide and still has active landslides on both sides of the slope. It is envisaged that this lake will decrease in size and become a tiny lake or even a stream only as its basin is continuously eroded by landslides.

It was also observed that within the retreating Roduphu Glacier several small lakes were being formed (Roduphu Tsho I) which could form into sizeable lake in a decade or so. These lakes have an outlet that flows over and under the morainic deposit. Although these lakes do not pose immediate danger, periodic physical monitoring was recommended in the brief report on the Expedition to Roduphu and Sinchhe Glacial Lakes (July–August 1996).

Tshokar Tsho glacial lake

Tshokar Tsho, one of the main lakes feeding the Chamkhar Chu, falls under the Choekor Gewog in Bumthang Dzongkhag. Two expedition teams (one to Tshokar and the other to Upe Tsho) were fielded in April–May 1999 based on the information that Tshokar Tsho and Upe Tsho could burst (Karma and Tamang 1999).

Tshokar Tsho is located at an altitude of 4235 masl and measures about 1.2 km x 0.5 km. This lake serves as a reservoir for the lakes which lie above it (eight lakes were observed which ultimately drain into Tshokar Tsho). A small slide occurred 650m upstream from the inlet to Tshokar Tsho in the summer of 1998, measuring 300m in length with a maximum base width of 200m. This may have been caused by increased discharge from the upper lakes combined with the breaching of Gangri Tsho I, which lies above it. The whole channel length was eroded and bedrock exposed. The inlet of the lake was filled up with sand, logs, gravels, and big boulders (Karma and Tamang 1999). The outlet is 60m wide and the outflow is smooth. The whole area is well vegetated with cypress trees, silver fir, and thick bushes. No seepage was observed along the entire slope of the outlet. Water discharge measurements at the outlet and the inlet were recorded for a period of 15 days.

During the expedition, apart from the Tshokar Tsho, eight other lakes were reported where Gangri Tsho I (Table 10.2) with a hanging glacier (Gangri Glacier) about 300m above the lake had breached as evidenced by the V-shaped channel in the terminal moraine (in 1998, according to yak herders).

Upe Tsho glacial lake (1999)

The investigation of Upe Tsho was taken up, for the reasons mentioned in the previous section, in April–May 1999. The area around Upe Tsho was geologically mapped. The area studied lies within the latitudes 27° 46'30" and 27°49'15" N and longitude 90°37'15" and 90°38'45" E in topographic map sheet No. 79 I/9.

Table 10.2: Summary of the lakes			
Name of Lake	Altitude (masl)	Dimension (km)	Remarks
Gangri Tsho I	4,820	0.20 x 0.15	Has a hanging glacier; breached in 1998
Gangri Tsho II	4,900	0.65 x 0.15	Detached glacier; thin moraine layer at the outlet over rock exposure; monitoring required
Gangri Tsho III	4,680	0.90 x 0.50	Surrounded by rock all around (stable)
Tsangdumroe Tsho	4,360	0.25 x 0.15	No danger at present
Zangdopelri Tsho I	4,440	0.46 x 0.35	-do-
Zangdopelri Tsho II	4,380	0.27 x 0.19	-do-
Gangbi Tsho	5,050	0.33 x 0.20	-do-
Tshonak Tsho	4,400	0.75 x 0.33	-do-
Tshokar Tsho	4,235	1.20 x 0.58	Largest lake; all the above lakes drain into it

The general lithology of the area consists of gneiss and schists of the Thimphu Formation with intrusions of pegmatites and lucogranites. The general trend of the formation is north–east dipping northwesterly. There are 11 major glacial lakes reported in the Upe region (Table 10.3) and the region is divided into Lower Upe and Upper Upe.

Table 10.3: Summary of the lakes in the Upe region							
Lake name	Altitude (masl)	Dimension (km)	Depth Appr. (m)	Inflow ($l\ s^{-1}$)	Outflow ($l\ s^{-1}$)	Outlet slope (°)	Remarks
Lower Upe Tsho	4,480	1.5 x 0.45	12.0	6.3	41.8	43	Largest lake; wide joints along outlet slope which could cause slope failure
Upper Upe Tsho	4,560	0.75 x 0.25	9.0	3.7	3.0	12	No direct outlet; water comes on surface after 40m downstream
UUT 1	4,780	0.25 x 0.25	6.0	none	2.2	34	Clear outlet; stable
UUT 2	4,760	0.18 x 0.08	5.5	none	1.5	42	Steep cliff at outlet; stable
LUT 1	4,920	0.25 x 0.08	6.5	none	2.5	34	Stable
LUT 2	4,680	0.18 x 0.05	4.8	none	3.3	34	Flows directly into Lower Upe Tsho; stable
Tsho Chum Tsho	4,560	1.25 x 0.20	6.0	7.0	8.3		Clear, wide outlet; stable
1. TST 1	4,600	0.28 x 0.20	5.0	2.4	2.6	11	Wide outlet opening into U-shaped valley
2. TST 2	4,640	0.15 x 0.13	4.5	none	2.4	7	Stable
1. DS1	4,640	0.38 x 0.12	7.0	4.0	4.6	34	Stable
2. DS 2	4,760	0.25 x 0.08	5.0	none	4.0	28	Stable

Lower Upe Tsho, the largest lake in the Upe region lies at an altitude of 4,480 masl and measures 1.5 km x 0.4 km at the headwaters of the Chamkhar Chu. From field observations, Lower Upe Tsho is a moraine-dammed lake with no attached glaciers (Kuenza and Gyenden 1999).

Lower Upe Tsho is charged by many small streams, a lake code-named LUT2, and Upper Upe Tsho. The outflow of Lower Upe Tsho was recorded as 41.8 $l\ s^{-1}$. Lower Upe Tsho has a well defined outlet but the probable danger is that there are large joints at the outlet, with joint spacing of 2m, which could, in the future, due to freezing and thawing, lead to failure of the dam.

Upper Upe Tsho lies at an altitude of 4,560 masl. It is in the form of a crater lake surrounded on all sides by steep, barren mountains. The lake is fed by two other lakes located northeast and northwest, code-named UUT 1 and UUT2, and has an outflow of 3 $l\ s^{-1}$. Upper Upe Tsho has the capacity to accumulate large amounts of water and if it bursts it can trigger the flooding of Lower Upe Tsho (Karma and Gyenden 1999).

Chubda Tsho glacial lake

An expedition was made to Churapokto Tsho GLC5 (now called Chubda Tsho as the lake lies in the place called Chubda) in the headwaters of the Chamkhar Chu to carry out a field check as it was shown to be a large lake attached to a glacier in the inventory 'Glaciers and Glacial Lakes in Bhutan' (Geological Survey of Bhutan 1999).

The expedition team prepared a topographical map of the Chubda Tsho area at the scale of 1:5,000 using the tape and tripod compass method and took daily water discharge measurements for 14 days at the outlet (Kuenza 1999).

Chubda Tsho is a supraglacial lake within the Chubda Glacier. It lies at an altitude of 4762 masl and is about 3.4 km long and 0.3 km wide. The water is muddy with fresh ice cliffs in the middle of the lake. Some of the smaller supraglacial lakes have clear water, unlike the main lake. Several number seepage points were noticed with a major seepage point observed on the right side of the outlet at the base of the slope of the end moraine. The discharge from this seepage was as large as that from the outlet stream. This glacial lake poses a major hazard to the lower valleys of Bumthang and therefore needs to be monitored constantly. Mitigation measures may be taken after carrying out a detailed study of the lake and the glacier associated with it.

Other lakes

The other lakes reported are described below.

Thana Tsho I located at an altitude of 4,670 masl is a clear bluish water coloured lake, having dimensions of about 500 x 300m. The lake does not have an open outlet but flow comes out as seepage beneath the boulders. The lake is fed by the melt water from the snow and ice existing on Markhang La about 150m above the lake.

Thana Tsho II lies in the northeast of Thana Tsho I at an altitude of about 5,000 masl and measures 500m x 100m. The associated glacier, Thana Glacier named after Thana Gang (mountain), is 400m away from the lake located at an altitude of 5,080 masl (hanging glacier). The width of the glacier snout is about 400m with an average thickness of 20m. The visible length of the snowfield is about 1 km. The lake is fed by two small streams flowing from either side of the glacier. The water from the stream smells of sulphur and even the boulders are coated with yellowish stains (Kuenza 1999).

Ngangami Tsho lies at an altitude of 4,730 masl. It was once a large lake. Breaching of the lake in the past is evidenced by the V-shaped cutting in the end moraine. The exact year of the burst is unknown, but according to local people it occurred in the 1950s. Inside the terminal moraine large sand bars with horizontal laminations were observed. The melt water from the glacier, which is 1.5 km away from the lake, flows into the lake. The outflow from the lake comes out as seepage through the end moraine.

Churabuk Tsho lies at an altitude of 4,900 masl with clear water. It is 500m long and about 200m wide. The lake is fed by Chubda Glacier located 600–700m away from the lake.

Pamey Tsho also has clear water and lies at an altitude of 4,780 masl, south of Monla Karchung La. It is in the form of a cirque lake measuring about 400m x 250m. It has a clear outlet, but most of the outflow comes out as seepage through the end moraine.

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 are useful for detailed geomorphic studies and for evaluation of the active glaciers and potentially dangerous lakes.

In general, in terms of 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 generally 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 Lugge Tsho Glacial Lake which is associated with many supraglacial lakes in the topographic map of 1968 (Figure 8.5). The successive merging of supraglacial lakes in the Lugge Tsho Glacial Lake has formed a bigger lake as shown in satellite images from different years (Figure 8.5).

Some new lakes of considerable size are also formed at glacier tongues such as the lakes at Raphstreng Glacier.

These activities of supraglacial lakes are indications 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 and aerial photographs.

The valley lakes with an area bigger than 0.1 km^2 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 km^2 associated (in contact or distance less than 0.5 km) with steep hanging glaciers are considered to be potentially dangerous.

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. 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 in Nepal 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 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.

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 the Pho Chu Sub-basin)
- sudden advance of a glacier towards the lower tributary or mother glacier having a well-developed lake at its tongue

11.2 Potentially Dangerous Glacial Lakes

Altogether there are 2,674 glacial lakes in Bhutan, among them 562 lakes are associated with glaciers. The lakes are classified according to the distance from the glaciers: at a distance between 500–2,000m, 50–500m, or less than 50m. As the lakes get closer to the glacier and are affected by the different parameters mentioned above, the lakes will be potentially dangerous. Among the glacier associated glacial lakes, 174 lakes are at a distance of less than 50m. The lakes are also classified into different types for the identification of potentially dangerous lakes (Table 11.1). There are different types of lakes associated with glaciers: end moraine-dammed lakes, lateral moraine-dammed lakes, supraglacial lakes, blocked lakes, valley trough lakes, cirque lakes, and erosion lakes. Among these lakes, moraine-dammed lakes and blocked lakes are susceptible to breach out easily due to different phenomena. Supraglacial lakes, when they start merging with one another to form a larger lake and finally change into a moraine-dammed lake, become dangerous.

The study of topographic maps, satellite images, and field information showed that most of the identified potentially dangerous lakes started to form more than 40 years ago.

From the present study, 24 glacial lakes have been identified as potentially dangerous lakes based on the analysis of data using different criteria and the study of topographic maps and satellite images (Figure 11.1 and Table 11.2). Among the identified potentially dangerous lakes, three lakes are in the Chamkhar

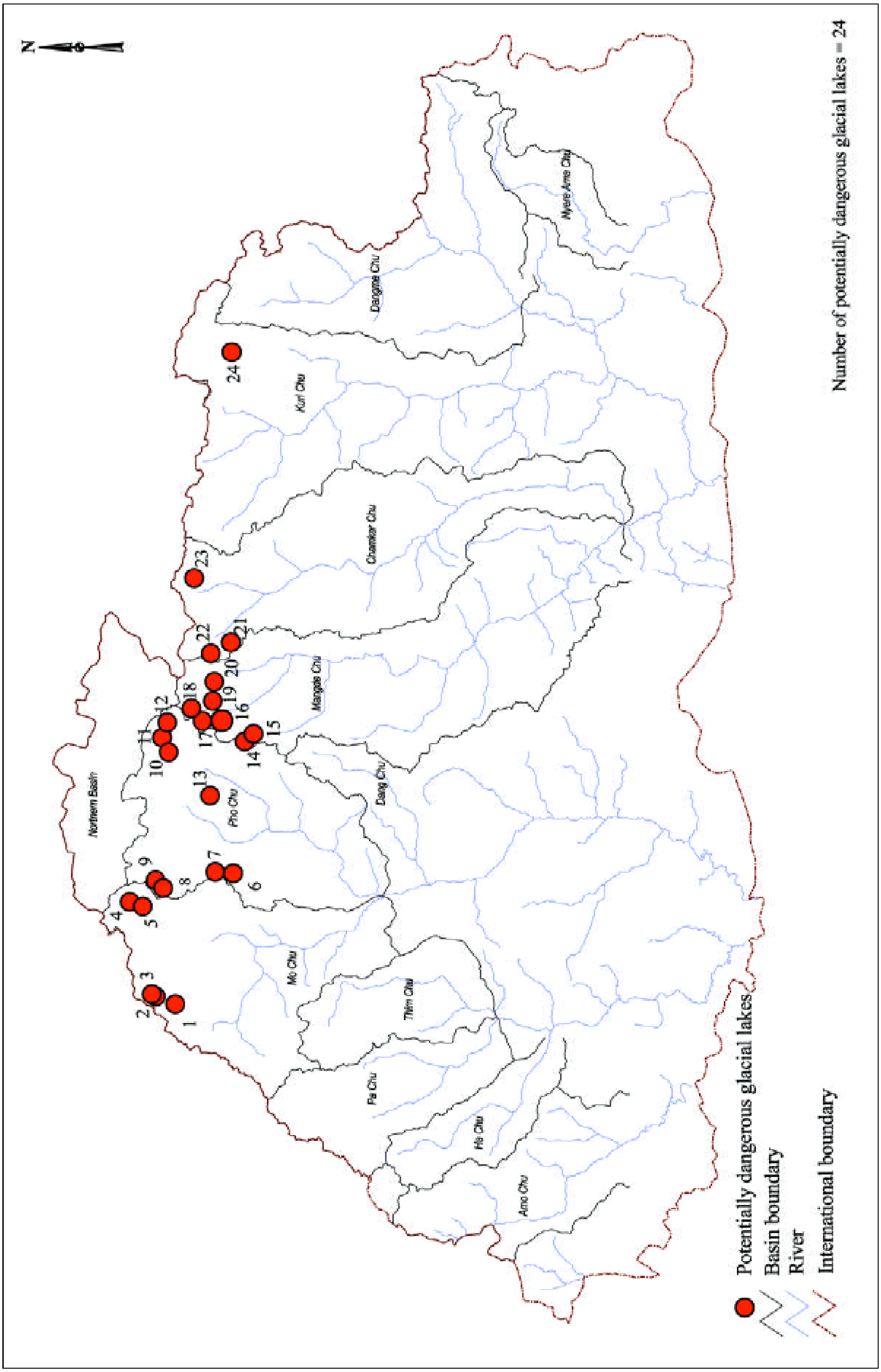


Figure 11.1: Potentially dangerous glacial lakes of Bhutan

Table 11.2: Potentially dangerous glacial lakes in Bhutan							
S. No.	Lake Number	Name Tsho	Latitude	Longitude	Altitude (masl)	Length (m)	Area (m^2)
Mo Chu Sub-basin							
1	Mo_gl 200	Kab	28° 04' 00.00	89° 35' 05.50	4280	285	52 090.11
2	Mo_gl 201		28° 06' 15.60	89° 36' 55.60	4080	325	30 863.71
3	Mo_gl 202		28° 07' 44.40	89° 36' 31.60	4380	325	34 287.76
4	Mo_gl 234	Setang Burgi	28° 10' 06.00	89° 51' 21.10	4480	795	232 774.52
5	Mo_gl 235		28° 08' 35.40	89° 50' 43.00	4960	565	150 131.36
Pho Chu Sub-basin							
6	Pho_gl 84		27° 56' 48.53	89° 55' 14.03	5040	660	214 078.18
7	Pho_gl 148		27° 58' 09.42	89° 56' 16.69	4880	1285	454 510.02
8	Pho_gl 163		28° 06' 06.43	89° 54' 11.83	4280	1200	369 572.13
9	Pho_gl 164	Tarina	28° 06' 37.22	89° 54' 37.81	4320	1095	280 550.42
10	Pho_gl 209	Raphstreng	28° 06' 43.56	90° 14' 03.65	4360	550	145 948.56
11	Pho_gl 210	Lugge	28° 05' 00.34	90° 18' 28.58	4600	1980	769 799.72
12	Pho_gl 211		28° 05' 40.45	90° 19' 11.95	4710	650	141 975.78
13	Pho_gl 313		27° 59' 58.72	90° 07' 18.86	5030	205	222 134.80
Mangde Chu Sub-basin							
14	Mang_gl 99		27° 54' 22.13	90° 16' 45.88	4960	605	192 607.29
15	Mang_gl 106		27° 53' 19.45	90° 17' 33.94	5040	1480	868 294.42
16	Mang_gl 270		27° 58' 09.32	90° 20' 06.98	5280	850	239 778.31
17	Mang_gl 285		28° 00' 20.90	90° 19' 50.77	5390	795	341 412.93
18	Mang_gl 307		28° 02' 21.01	90° 21' 58.87	5240	1800	767 429.06
19	Mang_gl 310		27° 58' 49.87	90° 23' 05.53	5200	575	200 746.06
20	Mang_gl 385		27° 58' 58.53	90° 26' 21.90	5086	535	466 125.34
Chamkar Chu Sub-basin							
21	Cham_gl 198		27° 56' 22.27	90° 32' 15.91	5046	1495	624 669.81
22	Cham_gl 232		27° 59' 11.33	90° 30' 31.42	5200	565	205 146.23
23	Cham_gl 383		28° 01' 25.91	90° 42' 31.77	4840	2645	103 5131.5
Kuri Chu Sub-basin							
24	Kuri_gl 172		27° 55' 47.56	91°18' 08.77		850	161 706.43

Chu Basin, one is in the Kuri Chu Basin, seven are in the Mangde Chu Basin, five are in the Mo Chu Basin, and eight are in the Pho Chu Basin. The Amo Chu, Ha Chu, Dang Chu, and Nyere Ama Chu Basins do not contain potentially dangerous lakes.

The potentially dangerous lakes of the Chamkhar Chu Basin are Cham_gl 198, Cham_gl 232, and Cham_gl 283. The first two lakes are located above 5,000 masl and the last one is below 5,000 masl. The lake areas occupied by Cham_gl 198 and Cham_gl 383 are 0.6 and 1.03 sq.km respectively.

There is only one potentially dangerous lake in the Kuri Chu Sub-basin, on the basis of morphology and position of the lake. The area occupied by the lake is about 0.162 sq.km, but the depth is unknown, as it was not studied. If the average depth of the lake is around 10m, the volume of water will exceed by 1.6 million m^3. Lakes of this type have had GLOF events in the past with the hazard immediately downstream of the breached lake.

Seven glacial lakes are identified as potentially dangerous lakes in the Mangde Chu Sub-basin: Mangd_gl 99, Mangd_gl 106, Mangd_gl 270, Mangd_gl 285, Mangd_gl 307, Mangd_gl 310, and Mangd_gl 385. Mangd_gl 106 and Mangd_gl 307 have an area greater than 0.7 sq.km.

There are five potentially dangerous glacial lakes in the Mo Chu Sub-basin: Mo_gl 200, Mo_gl 201, Mo_gl 202, Mo_gl 234, and Mo_gl 235. The lakes are identified as potentially dangerous on the basis of morphology and position of the lake with respect to the associated glacier. The lake areas of the identified potential dangerous lakes do not exceed 0.25 sq.km.

The potentially dangerous lakes identified in the Pho Chu Sub-basin are Pho_gl 84, Pho_gl 148, Pho_gl 163, Pho_gl 164, Pho_gl 209, Pho_gl 210, Pho_gl 211, and Pho_gl 213. Among them Pho_gl 210 (Lugge Tsho) has had GLOF events in the past, and there are several GLOF events reported from Lunana region but the relevant lakes are unidentified.

Raphshtering Tsho in the Pho_Chu Sub-basin is very well known among layman and researchers. Mitigation measures have been applied on a phase-wise basis to prevent GLOF hazards along the downstream valley.

Chapter 12
Glacial Lake Outburst Flood Mitigation Measures, Monitoring and Early Warning Systems

There are several possible methods for mitigating the impact of Glacial Lake Outburst Flood (GLOF) surges, for monitoring, and for early warning systems. The most important mitigation measure for reducing GLOF risk is to reduce the volume of water in the lake in order to reduce the peak surge discharge.

Downstream in the GLOF prone area, measures should be taken to protect infrastructure against the destructive forces of the GLOF surge. There should be monitoring systems prior to, during, and after construction of infrastructures and settlements in the downstream area.

Careful evaluation by detailed studies of the lake, mother glaciers, damming materials, and the surrounding conditions are essential in choosing an appropriate method and in starting any mitigation measure. Any measure taken must be such that it should not create or increase the risk of a GLOF during and after the mitigation measures are in place. Physical monitoring systems of the dam, lake, mother glacier, and surroundings are necessary at different stages during and after the mitigation process.

12.1 Reducing The Volume of Lake Water

Possible peak surge discharge from a GLOF could be reduced by reducing the volume of water in the lake. In general any one or combination of the following methods may be applied for reducing the volume of water in the lake:

- controlled breaching,
- construction of an outlet control structure,
- pumping or siphoning out the water from the lake, and
- making a tunnel through the moraine barrier or under an ice dam.

Controlled breaching

Controlled breaching is carried out by blasting, excavation, or even by dropping bombs from an aircraft. One of the successful examples has been that reported for Bogatyr Lake in Alatau, Kazakhastan

(Nurkadilov et al. 1986). An outflow channel was excavated using explosives and 7 million cubic metres of water was successfully released in a period of two days. These methods, however, can give strong, uncontrolled regressive erosion of the moraine wall causing a fast lowering of the lake level. Lliboutry et al. (1977a, b, c) described a case from Peru of the sudden discharge of 6–10 million cubic metres of water after two years of careful cutting of a trench in the moraine wall.

Construction of an outlet control structure

For more permanent and precise control of lake outflows, rigid structures made out of stone, concrete, or steel can be used. However, the construction and repairs of the required mitigation works at high elevations, in difficult terrain conditions and in glacial lake areas far from road points and not easily accessed, will cause logistic difficulties. Therefore, preference should be given to construction materials available locally such as boulders and stones. The boulders on the moraine walls can be held in place by wire mesh ('gabion') and/or held down by appropriate anchors.

Open cuts in a moraine dam can be excavated during the dry season when a lake's water level is lower than during the wet season. Such a method is risky as any displacement wave arising from an ice avalanche can rip through the cut and breach the moraine. This method should be attempted where there is no risk of avalanches into the lake.

Pumping or siphoning out the water from the lake

Examples given by Lliboutry et al. (1977a, b, c) from Peru and the pumping programme for the control of Spirit Lake after the eruption of Mount St Helens in Washington State in the USA are very costly because of the large amount of electricity needed for the powerful pumps. The pumping facility consisted of 20 pumps with a total capacity of 5 $m^3 s^{-1}$ and the cost of the pumping plant, operation, and maintenance for about 30 months was approximately US $11 million (Sager and Chambers 1986).

In the Hindu-Kush Himalayan region, there is no hydroelectric power distribution at high altitudes nor a simple means of transporting fuel to high elevations. Many of the lakes are higher than the maximum flying altitude for helicopters.

The use of a turbine, propelled by the water force at the outside of the moraine dam, will lower the energy costs. The problem of coupling the turbine and the pumps has to be solved.

Siphons with manageable component size are attractive in that they are readily transportable, relatively easy to install, and can be very effective for smaller size lakes.

Making a tunnel through the moraine dam

Tunnelling through moraines or debris barriers, although risky and difficult because of the type of material blocking the lake, has been carried out in several countries. In Peru, Lliboutry et al. (1977a, b, c) reported problems related to tunnelling through a moraine dam which had been severely affected by an earthquake.

Tunnelling can only be carried out through competent rock beneath or beside a moraine dam. The costs of such a method are very high. Unfortunately, not all moraine dams are suitable for tunnelling.

The construction of tunnels would pose difficulties in the Himalayas due to the high cost of transporting construction materials and equipment to high elevations.

12.2 Preventative Measures Around the Lake Area

Any existing and potential source of a larger snow and ice avalanche, slide, or rockfall around the lake area which has a direct impact on the lake and dam has to be studied in detail. Preventative measures against the instabilities of the moraine dam and the surrounding area, such as removing masses of loose rocks to ensure there will be no avalanches into the lake, will reduce to some extent the danger of GLOF.

12.3 Protecting Infrastructure Against the Destructive Forces of the Surge

The sudden hydrostatic and dynamic forces generated by a rapid moving shock wave can be difficult to accommodate by conventionally designed river structures such as diversion weirs, intakes, bridges, settlements on the river banks, and so on. It will be necessary to build bridges with appropriate flow capacities and spans at elevations higher than those expected under GLOF events. The Nepal–China highway, after reconstruction, has arched bridges well above the 1981 GLOF levels. Also, the road has been moved to higher levels and has gabion protection at the base of the embankments. Settlements should not be built at or near low river terraces but at heights well above the riverbed in an area with GLOF potential. Slopes with potential or old landslides and scree slopes on the banks of the river near settlements should be stabilised. It is essential that appropriate warning devices for GLOF events be developed in such areas.

12.4 Monitoring and Early Warning Systems

A programme of monitoring GLOFs throughout the country should be implemented using a multi-stage approach, multi-temporal data sets, and multi-disciplinary professionals. Focus should first be on the known potentially dangerous lakes and the river systems on which infrastructure is developed. Monitoring, mitigation, and early warning system programmes could involve several phases as follow.

- Detailed inventory and development of a spatial and attribute digital database of the glaciers and glacial lakes using reliable medium- to large-scale (1:63,360 to 1:10,000) topographic maps
- Updating of the inventory of glaciers and glacial lakes and identification of potentially dangerous lakes using remote-sensing data such as the LANDSAT TM, IRS1C/D, LISS3, SPOT XS, SPOT PAN (stereo), and IRS1C/D PAN (stereo) images
- Semi-detailed to detailed study of the glacial lakes, identification of potentially dangerous lakes and the possible mechanism of a GLOF using aerial photos
- Annual examination of medium- to high-resolution satellite images, e.g. LANDSAT TM, IRS1D, SPOT, and so on. to assess changes in the different parameters of potentially dangerous lakes and the surrounding terrain
- Brief over-flight reconnaissance with small format cameras to view the lakes of concern more closely and to assess their potential for bursting in the near future
- Field reconnaissance to establish clearly the potential for bursting and to evaluate the need for preventative action
- Detailed studies of the potentially dangerous lakes by multi-disciplinary professionals
- Implementation of appropriate mitigation measure(s) in the highly potentially dangerous lakes.
- Regular monitoring of the site during and after the appropriate mitigation measure(s) have been carried out
- Development of a telecommunication and radio broadcasting system integrated with on-site installed hydrometeorological, geophysical, and other necessary instruments at lakes of concern and downstream as early warning mechanisms for minimising the impact of a GLOF
- Interaction/cooperation among all of the related government departments/institutions/agencies / broadcasting media, and others for detailed studies, mitigation activities, and preparedness for possible disasters arising from GLOF events

The methodology for the inventory of glaciers and glacial lakes, the use of geographic information systems (GIS), and the remote sensing techniques and identification of potentially dangerous lakes are explained in Chapters 4–6 and 11.

12.5 Mitigation Measures, Monitoring, and Early Warning Systems Applied in the Country

Mitigation measures to prevent the bursting of the lake were implemented in 1996 on Raphstreng Tsho only. Initially a number of methods was suggested:

- siphoning,
- pumping, and
- excavation of a channel.

All these methods were suggested basically to reduce the level of water in the lake by 20m initially, but it was later worked out that 4m was sufficient. Considering the site conditions, it was found that the excavation of a channel was the best suited method for mitigating GLOF hazards from Raphstreng Tsho.

A detailed topographic survey of Raphstreng Tsho and its two subsidiary lakes was carried out, on a scale of 1:2,000 with 2.5m contour intervals. L-sections and cross-sections of the existing natural channel through which the water from Raphstreng Tsho was going to Pho Chu were prepared. These sections were used to estimate the quantity of excavation required to lower the lake. The water level of the main lake is at 4,348.79 masl. It joins subsidiary lake I at a level of 4,348.50 masl after travelling 5m along the channel. The outlet of subsidiary lake I is at an elevation of 4,348.15 masl and is 70m away from Raphstreng outlet. The water from the subsidiary lake I outlet flows through a narrow channel 8–15m wide for 60m, joins subsidiary lake II at an elevation of 4,343.9 masl, and flows out through its outlet at 4343.4 masl. The outlet of subsidiary lake II is 180m away from the main lake along its flow path. From this section the water follows the natural channel and joins the Pho Chu.

The sequence of excavation activities is given below.

- The outlet of subsidiary lake II was excavated first to lower the level of this lake.
- In the next step, the channel between the two subsidiary lakes was excavated. Once this had reached the desired depth, the outlet of subsidiary lake I was cut to allow the water to flow out.
- Then the channel between subsidiary lake I and the main lake was excavated. When this was completed, the outlet of the main lake was excavated to let the water flow out, thus reducing the level of the lake by 4m.

Flood mitigation measures (Phase I—1996)

The scope of the work for the 1996 expedition was to carry out the immediate mitigation measures for the biggest lake (Raphstreng Tsho) as recommended by the joint expedition team of 1995. The project was funded by the Government of India, and Water and Power Consultancy Services (India) Ltd (WAPCOS) was appointed to provide consultants. The Indo-Bhutan expedition team comprised experts from the Department of Geology and Mines (DGM), the Department of Roads (DOR), the Survey of Bhutan and the Royal Bhutan Army (RBA), the Geological Survey of India (GSI), and WAPCOS.

The team was to carry out a site survey and investigation to firm up the various parameters to be used for the preparation of design and cost estimates of civil work planned for preventing a possible outburst of the glacial lakes in Lunana. The survey and investigation carried out comprised hydro-meteorological and topographical surveys and geotechnical, geological, and foundation investigations.

Due to the urgency to lower the lake level of Raphstreng Tsho, the civil work for this purpose was carried out simultaneously. The initial proposal, to siphon together with excavating the spillway to reduce the lake level by 20m, was found unfeasible, so an alternative solution had to be found. Based on the reconnaissance study it was decided that the existing channel through which the lake water was flowing into the Pho Chu would be used for lowering the lake water level. The excavation work was done using manual tools like crowbars, shovels, spades, pick axes, and so on. The team reached Lunana on 7 July 1996 and actual excavation of the channel started on 12 July. The total number of person days used at this site until 19 October 1996 was 67 848 (WAPCOS 1997). During this period the water level in the main lake (Raphstreng Tsho) was lowered by 0.95m, in the lower subsidiary lake I by 0.94m, and in the subsidiary lake II by 1.5m (Figure 12.1). The report of WAPCOS 1997 recommended that lowering of the lake by 20m was not absolutely necessary and that lowering it by 4m should be sufficient. To implement this recommendation of lowering the lake water level by 4m, work was carried out in 1997 and 1998.

Raphstreng Tsho outburst flood mitigation project (Lunana) Phase II—1999

After a fact finding mission (Phase I), actual fieldwork (Phase II) under Austro-Bhutanese cooperation was planned as the Raphstreng Tsho Outburst Flood Mitigation Project. The main aim of the project was to assess the geo-risks of the Raphstreng/Thorthormi Tsho area (Häuslar et. al. 2000). An integrated multi-disciplinary approach was adopted using remote sensing, geological, hydro-geological, and geophysical methods. IRS-1D PAN digital data for 3 January 1999 with a ground resolution of 5.8m was acquired.

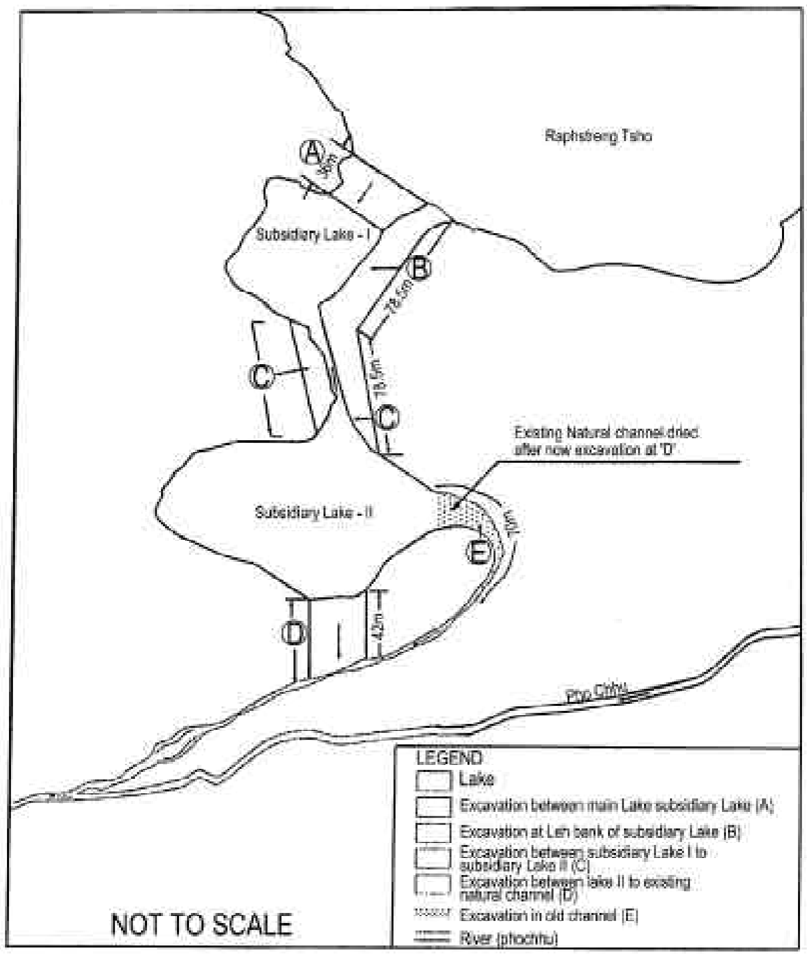


Figure 12.1: Schematic sketch of excavation work carried out for the mitigation of Raphstreng Tsho in 1996

ERDAS/IMAGINE software was used to generate the required satellite image maps: on a scale of 1:2500 for monitoring the decay of glaciers, at a scale of 1:5,000 for a base map for field work, and a 3-D digital elevation model (DEM) for geomorphological and geological interpretation.

From the hydrological studies conducted a hypothesis was postulated that (i) seepage water is not pure glacial melt, (ii) local ice must be expected along the flow path, (iii) in a multi-source groundwater system lake water is not the major contributor, and (iv) in multi-genetic moraines a very stable piping system exists. It is concluded that if this hypothesis is proved, the seepages will not weaken the morainic dam (Häuslar et al. 2000).

Sub-surface radar, geoelectric resistivity, and seismic investigation were used to interpret the sub-surface nature of the moraine dam. The findings from these investigations were that the end moraine of Raphstreng Tsho is not an ice core dam. It is concluded that the present day risk for an outburst from Raphstreng is low, but the risk of an outburst of Thorthormi Glacial Lake in the future is considered high and it could occur in 15–20 years considering the present trend of climate change (Häuslar et al. 2000). Häuslar and Leber (1998) proposed that special risk engineering at Lugge Tsho outlet and a more sound GLOF risk assessment east of Thanza be carried out.

Chapter 13
Conclusions

Databases of the glaciers and glacial lakes of Bhutan, based on medium- to large-scale topographic maps, have not been developed prior to the present study. For the glacier inventory the study used the methodology developed by the Temporary Technical Secretary for the World Glacier Inventory (Muller et al. 1977), and for the glacial lake inventory, the methodology developed by the Lanzhou Institute of Glaciology and Geocryology (LIGG) (LIGG/Water and Energy Commission Secretariat [WECS]/Nepal Electricity Authority [NEA] 1988) was used with modification.

Creating inventories of and monitoring glaciers and glacial lakes can be done quickly and correctly using a combination of satellite images and aerial photographs simultaneously with topographic maps. The multi-stage approach of using remotely sensed data and field data increases the ability and accuracy of the work. The integration of visual and digital image analysis with a geographic information system (GIS) can provide very useful tools for the study of glaciers, glacial lakes, and Glacial Lake Outburst Floods (GLOFs).

Analysts' experiences and adequate field knowledge of the physical characteristics of glaciers, glacial lakes, and their associated features are necessary for the interpretation of topographic maps, satellite images, and aerial photographs. Evaluation of spectral responses by different surface cover types in different bands of satellite images is necessary. Different techniques of digital image enhancement and spectral classification of ground features are useful for the study of glaciers and lakes. With different spectral band combinations in false colour composite (FCC) and individual spectral bands, glaciers and glacial lakes were studied using the knowledge of image interpretation keys.

The Digital Elevation Model (DEM) is useful in deciding the rules for discrimination of features and land-cover types in GIS techniques and for better perspective viewing and presentations. DEM suitable for the present study of the whole country is not yet available.

The topographic maps published by the Survey of India in the 1950s–1970s on a scale of 1:50,000, based on aerial photographs and field verification are the only map series that cover the whole of Bhutan on medium scale. Based on this map series, spatial and attribute databases of glaciers and glacial lakes were developed.

The inventory of glaciers and glacial lakes of Bhutan as a whole is divided into the following six basins.

- Amo Chu (Torsa) Basin
- Wang Chu Basin
- Puna Tshang Chu (Sankosh River) Basin
- Manas River Basin
- Nyere Ama Chu Basin
- Northern basin, rivers flowing from Bhutan towards Tibet, China

The Amo Chu, Nyere Ama Chu, and Northern Basins have no sub-basins of significant size. For the inventory of glaciers and glacial lakes the Wang Chu Basin is divided into the Thim Chu, Pa Chu, and Ha Chu Sub-basins; the Puna Tshang Chu Basin is divided into the Mo Chu, Pho Chu, and Dang Chu Sub-basins; and the Manas Chu Basin is divided into the Mangde Chu, Chamkhar Chu, Kuri Chu, and Dangme Chu Sub-basins. Thus, 13 basins and sub-basins were covered by the study.

The Amo Chu and Nyere Ama Chu Basins and the Ha Chu and Dang Chu Sub-basins do not have glaciers within their watersheds. In Bhutan there are 677 glaciers altogether with an area of 1,316.71 sq.km. The estimated ice reserve is 127.25 km^3. The Wang Chu Basin consists of 36 glaciers with an area of 48.92 sq.km and an estimated ice reserve of 3.55 km^3; the Puna Tsang Chu Basin consists of 272 glaciers with an area of 503.11 sq.km and an estimated ice reserve of 43.21 km^3; and the Manas Chu Basin consists of 310 glaciers with an area of 376.95 sq.km and an estimated ice reserve of 28.77 km^3

Prior to the present study, there was no inventory of lakes of the whole country. In this study any lakes in contact with or near a glacier, or occupying a basin produced by glacial erosion or deposition, were termed 'glacial lakes'. However, some of the lakes inventoried were isolated and far behind the ice mass, and their water may or may not actually be derived from glacial meltwater. Altogether 2,674 lakes were identified as glacial lakes in Bhutan.

Among the glacial lakes studied, Raphstreng Tsho in eastern Lunana received the greatest attention due to the 1994 GLOF events.

The characteristic features used to identify potentially dangerous lakes in general are:

- moraine-dammed glacial lakes in contact or very near to large glaciers,
- merging of supraglacial lakes at the glacier tongue such as Raphstreng Tsho and Lugge Tsho Lakes of the Pho Chu Basin,
- some new lakes of considerable size formed at glacier tongues,
- lakes rapidly growing in size, and
- rejuvenation of lakes after a past glacial lake outburst event.

Twenty-four glacial lakes have been identified as potentially dangerous lakes from the study of topographic maps, literature, and satellite images available. The potentially dangerous lakes identified are located within four sub-basins: the Chamkhar Chu, Mangde Chu, Mo Chu, and Pho Chu Sub-basins. Among the potentially dangerous lakes, three lakes belong to the Chamkhar Chu Sub-basin, one lake to the Kuri Chu Sub-basin, seven lakes to the Mangde Chu Sub-basin, five lakes to the Mo Chu Sub-basin, and eight lakes to the Pho Chu Sub-basin.

Among the dangerous lakes, Lugge Tsho and some unidentified lakes have been found to have had outburst events.

It is recommended that the potentially dangerous lakes identified be further investigated and field surveys carried out.

The 1995 Indo-Bhutan joint expedition to Lunana carried out hydrometeorological and topographical surveys and geotechnical, geological, and foundation investigations. The team recommended short- and long-term mitigation measures.

Based on the reconnaissance study, the water levels of subsidiary lakes I and II of Raphstreng Tsho were reduced by 0.94m and 1.5m respectively in October 1996. In 1996, Water and Power Consultancy

Services (India) Ltd (WAPCOS) recommended lowering the lake water level 4m (WAPCOS 1997). To implement the above recommendation work was carried out in 1997 and 1998.

It is concluded that the present day risk for an outburst from Raphstreng is low, but the risk of an outburst of Thorthormi Glacial Lake in the future is considered high and it could occur in 15–20 years considering the present trend of climate change (Häuslar et al. 2000). Häuslar and Leber (1998) proposed that special risk engineering at Lugge Tsho outlet and a more sound GLOF risk assessment east of Thanza be carried out.

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SUMMARY OF GLACIERS AND GLACIAL LAKES OF BHUTAN

S.N.	Sub-basins	Glaciers			Glacial Lakes	
		Number	Area (km^2)	Ice Reserves (km^3)	Number	Area (km^2)
1	Amo Chu*	0	0	0	71	1.83
2	Ha Chu*	0	0	0	53	1.83
3	Pa Chu	21	40.51	3.22	94	1.82
4	Thim Chu	15	8.41	0.33	74	2.82
5	Mo Chu	118	169.55	11.34	380	9.78
6	Pho Chu	154	333.56	31.87	549	23.49
7	Dang (Tang) Chu*	0	0	0	51	1.81
8	Mangde Chu	140	146.69	11.92	521	17.59
9	Chamkhar Chu	94	104.10	8.11	557	21.03
10	Kuri Chu	51	87.62	6.48	179	11.07
11	Dangme Chu	25	38.54	2.26	126	5.82
12	Nyere Ama Chu*	0	0	0	9	0.076
13	Northern Basin	59	387.73	51.72	10	7.81
Total		**677**	**1,316.71**	**127.25**	**2,674**	**106.776**

* Sub-basins having no glaciers

Annex 1
Database of Glacier Inventory

Glacier Inventory of Pa Chu Basin

Total Number :21 Total Area : 40.51 (km²) Ice Reserve : 3.22 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Pa_gr 1		78E/5	27°47'11"	89°13'59"	518929	965	5920	5620	5320	S	S	63021	0.0169
Pa_gr 2		78E/5	27°46'48"	89°14'45"	411701	1832	5920	5790	5660	SE	SE	67021	0.0121
Pa_gr 3		78E/5	27°47'25"	89°14'43"	3295229	2510	5880	5290	4700	SE	SE	63021	0.2139
Pa_gr 4		78E/5	27°48'8"	89°15'31"	6794209	4292	7226	6013	4800	S	S	60021	0.5650
Pa_gr 5		78E/5	27°46'49"	89°17'2"	466868	1398	5280	5020	4760	SW	SW	67021	0.0146
Pa_gr 6		78E/5	27°47'28"	89°17'32"	1992736	2354	5680	5340	5000	S	S	60021	0.1076
Pa_gr 7		78E/5	27°47'37"	89°18'2"	358218	5497	5600	5380	5160	NE	NE	67021	0.0100
Pa_gr 8		78E/5	27°49'17"	89°17'52"	11310071	6055	7326	5823	4320	SE	SE	52021	1.1179
Pa_gr 9		78E/5	27°49'58"	89°18'21"	305987	1717	6280	6220	6160	SE	SE	67021	0.0081
Pa_gr 10		78E/5	27°50'27"	89°19'5"	10192608	7739	6280	5240	4200	S	S	53012	0.9726
Pa_gr 11		78E/5	27°50'7"	89°20'22"	1852618	2461	6787	5934	5080	SE	SE	67021	0.0974
Pa_gr 12		78E/6	27°43'31"	89°24'17"	441023	1116	5480	5240	5000	SW	SW	60011	0.0133
Pa_gr 13		78E/6	27°42'50"	89°24'34"	238379	745	5340	5180	5020	W	W	63021	0.0056
Pa_gr 14		78E/6	27°42'24"	89°24'28"	229265	854	5320	5160	5000	NW	NW	63021	0.0053
Pa_gr 15		78E/6	27°42'5"	89°24'29"	184438	725	5400	5160	4920	NW	NW	63021	0.0037
Pa_gr 16		78E/6	27°40'40"	89°25'23"	322449	1070	5589	5275	4960	NW	NW	63021	0.0085
Pa_gr 17		78E/6	27°40'23"	89°25'11"	620797	995	5642	5261	4880	NW	NW	63021	0.0216
Pa_gr 18		78E/6	27°40'5"	89°24'28"	431430	1148	5280	5100	4920	NE	NE	63021	0.0129
Pa_gr 19		78E/6	27°36'14"	89°21'53"	203782	510	5570	5365	5160	N	N	67021	0.0043
Pa_gr 20		78E/6	27°36'22"	89°21'29"	264085	1106	5570	5265	4960	NW	NW	63021	0.0063
Pa_gr 21		78E/6	27°36'7"	89°21'34"	93635	802	5570	5425	5280	SW	SW	67021	0.0013

Glacier Inventory of Thim Chu Basin

Total Number :15   Total Area : 8.41 (km²)   Ice Reserve : 0.33 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Thim_gr 1		78E/6	27°40'50"	89°25'14"	1094285	1808	5642	5241	4840	NE	NE	63021	0.0472
Thim_gr 2		78E/6	27°40'41"	89°25'35"	73035	415	5589	5455	5320	NE	NE	67021	0.0009
Thim_gr 3		78E/6	27°41'2"	89°25'56"	1039545	1410	5487	5214	4940	NE	NE	63021	0.0442
Thim_gr 4		78E/6	27°42'5"	89°25'54"	1195938	1475	5360	5200	5040	NE	NE	63021	0.0539
Thim_gr 5		78E/6	27°43'27"	89°25'40"	1768580	2254	5520	5290	5060	E	E	63021	0.0917
Thim_gr 6		78E/6	27°43'50"	89°24'51"	36505	408	5680	5620	5560	SE	SE	67021	0.0004
Thim_gr 7		78E/9	27°46'43"	89°30'10"	584096	628	5253	5172	5090	SW	SW	67321	0.0196
Thim_gr 8		78E/9	27°45'58"	89°30'47"	436356	855	5240	5203	5165	SW	SW	67021	0.0133
Thim_gr 9		78E/9	27°45'19"	89°31'33"	464734	675	5240	5200	5160	S	S	67021	0.0142
Thim_gr 10		78E/9	27°45'47"	89°31'4"	250643	720	5320	5180	5040	NE	NE	60021	0.0059
Thim_gr 11		78E/10	27°44'58"	89°31'52"	183399	653	5280	5180	5080	SW	SW	60021	0.0037
Thim_gr 12		78E/10	27°44'12"	89°32'42"	92945	630	5280	5220	5160	NE	NE	60321	0.0013
Thim_gr 13		78E/10	27°45'15"	89°32'8"	330214	660	5429	5275	5120	SE	SE	60021	0.0089
Thim_gr 14		78E/9	27°45'22"	89°32'29"	631098	1202	5320	5180	5040	E	E	60021	0.0221
Thim_gr 15		78E/9	27°45'42"	89°32'59"	239684	679	5320	5265	5210	NE	NE	60021	0.0056

Glacier Inventory of Thim Chu Basin

Total Number :15 Total Area : 8.41 (km²) Ice Reserve : 0.33 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Thim_gr 1		78E/6	27°40'50"	89°25'14"	1094285	1808	5642	5241	4840	NE	NE	63021	0.0472
Thim_gr 2		78E/6	27°40'41"	89°25'35"	73035	415	5589	5455	5320	NE	NE	67021	0.0009
Thim_gr 3		78E/6	27°41'2"	89°25'56"	1039545	1410	5487	5214	4940	NE	NE	63021	0.0442
Thim_gr 4		78E/6	27°42'5"	89°25'54"	1195938	1475	5360	5200	5040	NE	NE	63021	0.0539
Thim_gr 5		78E/6	27°43'27"	89°25'40"	1768580	2254	5520	5290	5060	E	E	63021	0.0917
Thim_gr 6		78E/6	27°43'50"	89°24'51"	36505	408	5680	5620	5560	SE	SE	67021	0.0004
Thim_gr 7		78E/9	27°46'43"	89°30'10"	584096	628	5253	5172	5090	SW	SW	67321	0.0196
Thim_gr 8		78E/9	27°45'58"	89°30'47"	436356	855	5240	5203	5165	SW	SW	67021	0.0133
Thim_gr 9		78E/9	27°45'19"	89°31'33"	464734	675	5240	5200	5160	S	S	67021	0.0142
Thim_gr 10		78E/9	27°45'47"	89°31'4"	250643	720	5320	5180	5040	NE	NE	60021	0.0059
Thim_gr 11		78E/10	27°44'58"	89°31'52"	183399	653	5280	5180	5080	SW	SW	60021	0.0037
Thim_gr 12		78E/10	27°44'12"	89°32'42"	92945	630	5280	5220	5160	NE	NE	60321	0.0013
Thim_gr 13		78E/10	27°45'15"	89°32'8"	330214	660	5429	5275	5120	SE	SE	60021	0.0089
Thim_gr 14		78E/9	27°45'22"	89°32'29"	631098	1202	5320	5180	5040	E	E	60021	0.0221
Thim_gr 15		78E/9	27°45'42"	89°32'59"	239684	679	5320	5265	5210	NE	NE	60021	0.0056

Glacier Inventory of Mo Chu Basin

Total Number :118   Total Area : 169.55 (km²)   Ice Reserve : 11.34 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Mo_gr 1		78E/10	27°44'48"	89°35'30"	298426	941	5360	5210	5060	NE	NE	63021	0.0077
Mo_gr 2		78E/9	27°45'16"	89°32'50"	917679	1762	5492	5186	4880	N	N	60021	0.0373
Mo_gr 3		78E/9	27°45'19"	89°31'50"	557992	2242	5253	5107	4960	NE	NE	67021	0.0187
Mo_gr 4		78E/9	27°46'50"	89°30'20"	185263	510	5000	5010	5020	NE	NE	67021	0.0040
Mo_gr 5		78E/9	27°50'33"	89°31'32"	646166	1505	5260	5130	5000	S	S	60021	0.0230
Mo_gr 6		78E/9	27°50'58"	89°31'57"	784728	1874	5280	5060	4840	SE	SE	60021	0.0297
Mo_gr 7		78E/9	27°51'43"	89°31'27"	330532	1143	5305	5073	4840	E	E	67021	0.0089
Mo_gr 8		78E/9	27°51'32"	89°31'36"	90484	842	5180	5010	4840	NW	NW	67021	0.0013
Mo_gr 9		78E/9	27°51'31"	89°31'4"	834759	2097	5305	5053	4800	W	W	60021	0.0324
Mo_gr 10		78E/6	27°44'25"	89°25'18"	474396	1048	5480	5320	5160	NE	NE	63021	0.0146
Mo_gr 11		78E/5	27°50'12"	89°21'22"	2214481	2492	6789	5835	4880	SE	SE	60021	0.1242
Mo_gr 12		78E/5	27°51'38"	89°21'10"	8676316	7302	6789	5455	4120	E	E	52021	0.7850
Mo_gr 13		78E/5	27°52'31"	89°22'3"	538129	2121	6526	5723	4920	SE	SE	60021	0.0178
Mo_gr 14		78E/5	27°52'3"	89°23'19"	2095086	2054	6526	5643	4760	SE	SE	60021	0.1158
Mo_gr 15		78E/5	27°52'23"	89°23'60"	1229713	1978	5800	5060	4320	SE	SE	63021	0.0557
Mo_gr 16		78E/5	27°53'54"	89°23'9"	88417	450	5120	4980	4840	E	E	64021	0.0013
Mo_gr 17		78E/5	27°53'10"	89°24'27"	475477	1371	5720	5500	5280	SE	SE	60021	0.0151
Mo_gr 18		78E/5	27°53'4"	89°24'57"	2132568	2128	5784	5232	4680	NE	NE	60321	0.1181
Mo_gr 19		77H/8	28°0'46"	89°27'28"	769884	990	5894	5427	4960	S	S	63021	0.0292
Mo_gr 20		77H/8	28°0'29"	89°28'60"	541209	1259	5800	5400	5000	S	S	63021	0.0178
Mo_gr 21		77H/8	28°0'52"	89°28'60"	156892	891	5476	5338	5200	S	S	70021	0.0031
Mo_gr 22		77H/8	28°1'0"	89°29'5"	84061	512	5476	5198	4920	SE	SE	70021	0.0011
Mo_gr 23		77H/8	28°1'31"	89°28'52"	2598508	3839	6056	5348	4640	E	E	52021	0.1548
Mo_gr 24		77H/8	28°2'52"	89°28'38"	163909	881	5760	5480	5200	SE	SE	67021	0.0031

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Mo_gr 25		77H/8	28°2'50"	89°28'56"	658126	1245	5680	5420	5160	SE	SE	60021	0.0235
Mo_gr 26		77H/8	28°3'11"	89°29'35"	200655	898	5800	5540	5280	SE	SE	63021	0.0043
Mo_gr 27		77H/8	28°3'23"	89°29'47"	178078	525	5600	5460	5320	SE	SE	67021	0.0037
Mo_gr 28		77H/12	28°4'59"	89°29'18"	70399	542				S	S	63021	0.0009
Mo_gr 29		77H/12	28°5'56"	89°30'13"	1839227	1860	6400	5740	5080	S	S	63321	0.0967
Mo_gr 30		77H/12	28°4'38"	89°31'47"	2810921	4592			4400	S	S	53012	0.1720
Mo_gr 31		77H/12	28°1'45"	89°34'34"	178530	523	5400	5280	5160	SW	SW	63021	0.0037
Mo_gr 32		77H/12	28°1'1"	89°35'25"	231444	971	5600	5480	5360	SW	SW	67021	0.0053
Mo_gr 33		77H/12	28°1'21"	89°35'2"	382838	1117			5160	SW	SW	63021	0.0108
Mo_gr 34		77H/12	28°0'48"	89°35'49"	111015	595			5040	W	W	67021	0.0018
Mo_gr 35		77H/12	28°0'32"	89°36'10"	54866	546	5265	5153	5040	SW	SW	37021	0.0005
Mo_gr 36		77H/12	28°0'41"	89°36'14"	120497	566	5265	5133	5000	NE	NE	63021	0.0020
Mo_gr 37		77H/12	28°0'37"	89°36'58"	1457740	1913				SE	SE	60021	0.0705
Mo_gr 38		77H/12	28°1'11"	89°37'26"	700782	1452	5564	5282	5000	E	E	60021	0.0255
Mo_gr 39		77H/12	28°2'5"	89°38'9"	165212	978	5290	5185	5080	NW	NW	67021	0.0034
Mo_gr 40		77H/12	28°1'8"	89°37'48"	889901	1692	5564	5162	4760	N	N	60021	0.0357
Mo_gr 41		77H/12	28°2'10"	89°37'23"	84514	441	5290	5185	5080	NW	NW	67021	0.0011
Mo_gr 42		77H/12	28°1'17"	89°36'22"	1703346	2206	5180	5090	5000	NW	NW	60021	0.0868
Mo_gr 43		77H/12	28°1'26"	89°35'31"	1020252	1532			5040	N	N	60321	0.0431
Mo_gr 44		77H/12	28°1'56"	89°34'53"	439217	1174			5000	N	N	60021	0.0133
Mo_gr 45		77H/12	28°1'33"	89°34'57"	25272	233				NW	NW	37021	0.0002
Mo_gr 46		77H/12	28°4'28"	89°32'51"	1745157	2475			5000	SE	SE	60321	0.0903
Mo_gr 47	Shinchula Gla	77H/12	28°5'26"	89°33'23"	8089446	5172	6632	5376	4120	SE	SE	52012	0.7144
Mo_gr 48		77H/12	28°5'23"	89°34'49"	168818	617			5040	S	S	63021	0.0034
Mo_gr 49	Gangchula Gl	77H/12	28°6'29"	89°34'25"	4877986	5291			4200	SE	SE	53012	0.3625
Mo_gr 50		77H/12	28°7'56"	89°34'22"	3326129	2909			4240	SE	SE	60321	0.2165
Mo_gr 51		77H/12	28°8'46"	89°35'24"	5998305	4316	6191	5136	4080	SW	SW	52012	0.4786
Mo_gr 52		77H/12	28°8'6"	89°37'57"	5316372	5034	6191	5416	4640	SW	SW	52012	0.4072
Mo_gr 53		77H/12	28°9'46"	89°37'6"	463840	1174			5640	SW	SW	60021	0.0142
Mo_gr 54		77H/12	28°8'2"	89°38'16"	615046	2019			5400	W	W	60321	0.0216
Mo_gr 55		77H/12	28°7'20"	89°38'33"	605915	1428				SW	SW	60321	0.0211
Mo_gr 56		77H/12	28°8'11"	89°38'32"	370520	1801				NE	NE	63321	0.0104
Mo_gr 57		77H/12	28°9'4"	89°38'43"	2742744	2536				SE	SE	60021	0.1663
Mo_gr 58		77H/12	28°10'59"	89°38'3"	441824	952				SE	SE	60021	0.0133
Mo_gr 59		77H/12	28°10'43"	89°39'11"	376672	1572				S	S	60021	0.0108
Mo_gr 60		77H/12	28°9'11"	89°40'52"	983283	1527				W	W	60021	0.0407

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Mo_gr 61		77H/12	28°9'37"	89°40'26"	831976	1750				NE	NE	60021	0.0324
Mo_gr 62		77H/12	28°10'32"	89°40'26"	1205826	1843				E	E	60021	0.0545
Mo_gr 63		77H/12	28°10'1"	89°43'16"	611372	996				SW	SW	60021	0.0211
Mo_gr 64		77H/12	28°9'2"	89°43'59"	102911	694				S	S	67021	0.0015
Mo_gr 65		77H/12	28°10'17"	89°43'4"	102262	772				SE	SE	67321	0.0015
Mo_gr 66	Kebekhin Gla	77H/12	28°10'1"	89°45'38"	3398817	4378				SW	SW	53012	0.2227
Mo_gr 67		77H/16	28°9'2"	89°46'59"	154352	662				NW	NW	67021	0.0028
Mo_gr 68		77H/16	28°9'35"	89°45'52"	245984	869				NW	NW	63021	0.0059
Mo_gr 69		77H/16	28°9'39"	89°45'19"	930619	1754				SE	SE	62021	0.0379
Mo_gr 70		77H/16	28°9'47"	89°45'41"	206442	1002						60021	0.0046
Mo_gr 71		77H/16	28°9'32"	89°46'53"	428823	956				SE	SE	60021	0.0129
Mo_gr 72		77H/16	28°10'8"	89°47'4"	287782	988				SE	SE	60021	0.0074
Mo_gr 73		77H/16	28°10'50"	89°46'52"	2645851	2100			5280	E	E	63021	0.1589
Mo_gr 74		77H/16	28°10'18"	89°48'38"	562172	1206	5240	5060	4880	SE	SE	60051	0.0187
Mo_gr 75		77H/16	28°10'36"	89°48'39"	291247	915				NE	NE	67021	0.0074
Mo_gr 76		77H/16	28°11'7"	89°48'45"	734516	1269				N	N	60021	0.0271
Mo_gr 77	Masagang Gl	77H/16	28°12'16"	89°47'2"	4808931	5121				NE	NE	52012	0.3555
Mo_gr 78		77H/16	28°14'8"	89°48'36"	575301	1484	6310			S	S	60021	0.0196
Mo_gr 79		77H/16	28°13'43"	89°49'43"	2622639	2420				SW	SW	60321	0.1565
Mo_gr 80		77H/16	28°12'44"	89°49'52"	250644	754				NE	NE	63021	0.0059
Mo_gr 81		77H/16	28°12'2"	89°53'0"	1088199	1443	5760	5520	5280	NW	NW	60321	0.0472
Mo_gr 82		77H/16	28°10'11"	89°53'58"	3581359	2488	6480	5880	5280	NW	NW	60321	0.2388
Mo_gr 83		77H/16	28°9'23"	89°53'39"	6545842	3244				W	W	60321	0.5384
Mo_gr 84		77H/16	28°8'17"	89°52'13"	12766528	5597			4520	NW	NW	52012	1.3144
Mo_gr 85		77H/16	28°8'8"	89°51'34"	557775	1101			5240	NE	NE	60321	0.0187
Mo_gr 86		77H/16	28°8'7"	89°51'57"	120699	456			5200	NE	NE	63021	0.0020
Mo_gr 87		77H/16	28°8'49"	89°50'11"	646193	1876				NW	NW	63021	0.0230
Mo_gr 88		77H/16	28°7'16"	89°50'59"	4530151	4124				NW	NW	51012	0.3280
Mo_gr 89		77H/16	28°7'23"	89°49'59"	92544	491				NE	NE	64021	0.0013
Mo_gr 90		77H/16	28°7'13"	89°49'8"	1203685	1613			4920	N	N	60021	0.0539
Mo_gr 91		77H/16	28°6'1"	89°49'35"	1197985	2287				SW	SW	63021	0.0539
Mo_gr 92		77H/16	28°5'56"	89°48'47"	2399063	2459				SW	SW	62321	0.1389
Mo_gr 93		77H/16	28°4'35"	89°47'37"	289734	977	5400	5160	4920	NW	NW	63021	0.0074
Mo_gr 94		77H/16	28°5'34"	89°49'26"	868439	1401			5000	S	S	63021	0.0346
Mo_gr 95		77H/16	28°4'37"	89°49'35"	315654	1406			5120	SW	SW	60021	0.0085
Mo_gr 96		77H/16	28°5'34"	89°50'27"	13217456	8060			4440	SW	SW	52012	1.3765

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Mo_gr 97		77H/16	28°5'37"	89°51'6"	2813947	3452			4960	SW	SW	63021	0.1720
Mo_gr 98		77H/16	28°4'31"	89°51'16"	511507	1087			4920	W	W	63021	0.0164
Mo_gr 99		77H/16	28°3'26"	89°51'58"	250631	778				W	W	60021	0.0059
Mo_gr 100		77H/16	28°3'40"	89°51'23"	696635	2176			5000	W	W	60021	0.0255
Mo_gr 101		77H/16	28°2'40"	89°52'33"	536711	1071	5913	5457	5000	SW	SW	63021	0.0178
Mo_gr 102		77H/16	28°1'28"	89°52'52"	476895	1663	6790	5995	5200	SW	SW	60021	0.0151
Mo_gr 103		77H/16	28°1'11"	89°52'30"	290396	908			5565	W	W	63021	0.0074
Mo_gr 104		77H/16	28°1'44"	89°52'33"	1060050	1360	5790			SW	SW	60021	0.0454
Mo_gr 105		77H/16	28°1'34"	89°53'4"	1603941	1895	5764			SW	SW	60021	0.0799
Mo_gr 106		77H/16	28°0'49"	89°53'13"	1400301	2225	5685			W	W	63021	0.0666
Mo_gr 107		78E/13	27°59'7"	89°53'34"	844166	1677	5360	5180	5000	SW	SW	63021	0.0329
Mo_gr 108		78E/13	27°59'38"	89°54'19"	2366774	2544	5520	5360	5200	W	W	60021	0.1365
Mo_gr 109		78E/13	27°58'21"	89°54'30"	924155	1482	5520	5340	5160	W	W	63021	0.0373
Mo_gr 110		78E/13	27°58'20"	89°53'9"	343938	1090	5200	5100	5000	SW	SW	63021	0.0092
Mo_gr 111		78E/13	27°58'17"	89°54'7"	342574	858	5480	5320	5160	SW	SW	63021	0.0092
Mo_gr 112		78E/13	27°57'28"	89°53'19"	5585488	4963	5480	5160	4840	W	W	63021	0.4352
Mo_gr 113		78E/13	27°57'49"	89°51'32"	316323	1092	5240	5080	4920	NE	NE	67021	0.0085
Mo_gr 114		78E/13	27°56'46"	89°51'43"	922825	2041	5337	5029	4720	SW	SW	67021	0.0373
Mo_gr 115		78E/13	27°56'46"	89°52'44"	189971	907	5166	5083	5000	SW	SW	67021	0.0040
Mo_gr 116		78E/13	27°56'46"	89°53'49"	224691	826	5400	5260	5120	SW	SW	63021	0.0049
Mo_gr 117		78E/13	27°56'25"	89°53'21"	754729	2060	5200	5040	4880	SW	SW	63021	0.0281
Mo_gr 118		78E/13	27°53'31"	89°50'56"	318025	822	5201	5081	4960	SW	SW	60021	0.0085

Glacier Inventory of Pho Chu Basin

Total Number :154 Total Area : 333.56 (km²) Ice Reserve : 31.87 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Pho_gr 1		78E/13	27°53'51"	89°50'58"	373043	1024	5160	4980	4800	E	E	63021	0.0105
Pho_gr 2		78E/13	27°56'6"	89°54'5"	1087939	1774	5200	4660	4120	SE	SE	62021	0.0471
Pho_gr 3		78E/13	27°56'37"	89°54'22"	200511	771	5040	5020	5000	E	E	79052	0.0043
Pho_gr 4		78E/13	27°56'10"	89°54'48"	279777	921	5120	5100	5080	SE	SE	63021	0.0079
Pho_gr 5		78E/13	27°57'4"	89°55'27"	424949	1064	5440	5350	5260	SW	SW	63021	0.0127
Pho_gr 6		78E/13	27°57'38"	89°55'52"	579830	1136	5480	5400	5320	SW	SW	63021	0.0196
Pho_gr 7		78E/13	27°57'42"	89°55'17"	613648	1208	5450	5265	5080	SW	SW	60021	0.0213
Pho_gr 8		78E/13	27°56'12"	89°56'53"	2275055	2182	5450	5235	5020	SW	SW	60321	0.1393
Pho_gr 9		78E/13	27°55'43"	89°56'47"	1787356	2634	5320	5120	4920	S	S	63021	0.0930
Pho_gr 10		78E/13	27°53'18"	89°57'55"	1332447	1546	5200	5100	5000	SW	SW	63021	0.0622
Pho_gr 11		78E/13	27°54'29"	89°57'17"	87360	501	5120	5075	5030	NE	NE	75021	0.0012
Pho_gr 12		78E/13	27°54'2"	89°57'38"	273070	976	5160	5080	5000	NW	NW	60021	0.0068
Pho_gr 13		78E/13	27°57'17"	89°58'24"	203830	945	4640	4560	4480	NE	NE	69052	0.0044
Pho_gr 14		78E/13	27°56'28"	89°57'51"	478787	1465	5160	5000	4840	NE	NE	63021	0.0150
Pho_gr 15		78E/13	27°56'57"	89°56'49"	102462	534	4760	4640	4520	NE	NE	63021	0.0016
Pho_gr 16		78E/13	27°57'4"	89°57'19"	117596	805	5200	5050	4900	NE	NE	63051	0.0020
Pho_gr 17		78E/13	27°57'52"	89°56'6"	158550	790	5120	5080	5040	NE	NE	60021	0.0031
Pho_gr 18		78E/13	27°57'40"	89°56'28"	229673	725	5280	5140	5000	NE	NE	63021	0.0053
Pho_gr 19		78E/13	27°57'10"	89°56'28"	111024	636	5200	5160	5120	NE	NE	63021	0.0018
Pho_gr 20		78E/13	27°57'55"	89°55'40"	111012	1152	5200	5160	5120	NE	NE	63021	0.0018
Pho_gr 21		78E/13	27°58'57"	89°55'40"	115824	458	5100	5090	5080	SE	SE	64051	0.0019
Pho_gr 22		78E/13	27°58'18"	89°55'45"	2136534	2529	5400	5360	5320	NE	NE	62021	0.1186
Pho_gr 23		78E/13	27°58'23"	89°56'50"	163106	646	5220	5170	5120	SE	SE	63021	0.0032
Pho_gr 24		78E/13	27°59'9"	89°57'9"	1115630	3192	5120	4770	4420	NE	NE	63021	0.0487
Pho_gr 25		78E/13	27°59'21"	89°57'55"	1520348	2538	5200	5040	4880	NE	NE	60021	0.0745
Pho_gr 26		78E/13	28°0'41"	89°56'33"	2368633	3573	5400	5200	5000	NE	NE	62021	0.1364
Pho_gr 27		77H/16	28°0'47"	89°54'10"	511100	1831			4800	NE	NE	63021	0.0164
Pho_gr 28		77H/16	28°0'40"	89°54'26"	1166145	2423	5685	5530	5375	E	E	63021	0.0518

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Pho_gr 29		77H/16	28°0'16"	89°54'59"	695073	1789	5528	5304	5080	E	E	60021	0.0253
Pho_gr 30		77H/16	28°1'40"	89°53'21"	167268	1062	5528	5384	5240	NE	NE	60021	0.0033
Pho_gr 31		77H/16	28°1'0"	89°53'59"	1312188	2110	5795	5498	5200	SE	SE	60021	0.0609
Pho_gr 32		77H/16	28°2'21"	89°54'45"	3078870	2624	5855	5368	4880	NE	NE	60021	0.1947
Pho_gr 33		77H/16	28°3'11"	89°53'17"	3040989	3171	5855	5468	5080	NE	NE	63021	0.1823
Pho_gr 34		77H/16	28°4'52"	89°52'16"	687477	1278	5320	5060	4800	NE	NE	60021	0.0249
Pho_gr 35		77H/16	28°4'14"	89°52'16"	1285399	2351	5360	5020	4680	NE	NE	63021	0.0592
Pho_gr 36		77H/16	28°4'54"	89°51'43"	525292	1150	5360	5080	4800	NE	NE	60021	0.0171
Pho_gr 37		77H/16	28°5'10"	89°52'24"	142441	596				SE	SE	63021	0.0026
Pho_gr 38		77H/16	28°5'43"	89°52'42"	650813	1851				SW	SW	60021	0.0231
Pho_gr 39		77H/16	28°6'46"	89°52'2"	1401358	2063				SE	SE	60021	0.0666
Pho_gr 40		77H/16	28°6'4"	89°53'28"	187749	811				SE	SE	60021	0.0039
Pho_gr 41		77H/16	28°6'43"	89°52'60"	4290986	3792				E	E	63021	0.3049
Pho_gr 42		77H/16	28°7'23"	89°53'29"	156242	595				SW	SW	74021	0.0030
Pho_gr 43		77H/16	28°7'49"	89°53'53"	800982	1303				SE	SE	60021	0.0308
Pho_gr 44	Tarina Gal	77H/16	28°8'2"	89°54'47"	15983083	7463				S	S	52021	1.6179
Pho_gr 45		77H/16	28°9'57"	89°53'10"	1068779	1922				W	W	60021	0.0459
Pho_gr 46		77H/16	28°9'32"	89°53'51"	232334	944				SW	SW	60021	0.0053
Pho_gr 47		77H/16	28°9'45"	89°54'36"	580241	1182				S	S	60021	0.0197
Pho_gr 48		77H/16	28°9'16"	89°55'0"	860471	1890				SE	SE	63021	0.0340
Pho_gr 49		77H/16	28°8'21"	89°55'13"	14965008	7529				SW	SW	51012	1.6278
Pho_gr 50		77H/16	28°8'43"	89°55'3"	270146	652				NE	NE	60021	0.0066
Pho_gr 51		77H/16	28°8'42"	89°55'42"	470948	1040				NW	NW	60021	0.0147
Pho_gr 52		77H/16	28°8'47"	89°56'16"	1489590	2503				S	S	63021	0.0725
Pho_gr 53		77H/16	28°6'4"	89°57'58"	1598509	2149				SE	SE	60021	0.0798
Pho_gr 54		77H/16	28°6'51"	89°55'21"	1225642	1541				SW	SW	63021	0.0554
Pho_gr 55		77H/16	28°5'35"	89°56'45"	1783182	2227				W	W	60021	0.0927
Pho_gr 56		77H/16	28°6'8"	89°57'31"	389337	967				W	W	63021	0.0112
Pho_gr 57		77H/16	28°6'7"	89°58'9"	807788	1611				SW	SW	63021	0.0312
Pho_gr 58		77H/16	28°5'29"	89°58'28"	236443	697				NE	NE	74021	0.0055
Pho_gr 59		77H/16	28°4'26"	89°58'50"	728776	1244				SE	SE	60021	0.0270
Pho_gr 60		77H/16	28°4'29"	89°58'15"	961645	1406				SE	SE	60021	0.0397
Pho_gr 61		77H/16	28°4'11"	89°59'13"	1718860	2437				E	E	60021	0.0881
Pho_gr 62		77H/16	28°4'23"	89°59'38"	636720	1370				SE	SE	60021	0.0224
Pho_gr 63		77H/16	28°5'6"	89°59'7"	1227509	1512				SE	SE	60021	0.0556
Pho_gr 64		77H/16	28°5'52"	89°58'45"	209789	722				SE	SE	60021	0.0046
Pho_gr 65		77H/16	28°6'52"	89°58'37"	342417	1092				NE	NE	60021	0.0093
Pho_gr 66		77H/16	28°6'10"	89°59'56"	461329	945				NE	NE	60021	0.0142
Pho_gr 67		77H/16	28°7'56"	89°58'47"	1244227	1660				E	E	60021	0.0566
Pho_gr 68	Wachey	77H/16	28°8'48"	89°58'11"	38522311	20117			4120	SE	SE	52012	5.6976
Pho_gr 69		77L/4	28°8'38"	89°58'44"	3123286	1985	6674	5797	4920	SW	SW	60012	0.1985

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Pho_gr 70		77L/4	28°9'15"	89°58'23"	619792	825	5560	5300	5040	W	W	60021	0.0216
Pho_gr 71		77L/4	28°9'9"	89°59'49"	138587	432	5471	5376	5280	S	S	67021	0.0025
Pho_gr 72	Chunami	77L/4	28°9'2"	90°1'3"	17877178	10354	6949	5539	4128	SE	SE	53012	2.0564
Pho_gr 73		77L/4	28°6'2"	90°3'17"	6904237	4096	6949	5835	4720	SW	SW	60021	0.5777
Pho_gr 74		77L/4	28°5'42"	90°2'55"	885607	1376	5720	5360	5000	SW	SW	63021	0.0354
Pho_gr 75		77L/4	28°7'33"	90°3'52"	1802466	1818	6320	5520	4720	SE	SE	63021	0.0940
Pho_gr 76	Tsoju	77L/4	28°7'17"	90°7'55"	49268247	16212			4120	S	S	52012	7.8821
Pho_gr 77		77L/4	28°6'54"	90°7'40"	418352	1053				SW	SW	60321	0.0124
Pho_gr 78		77L/4	28°7'15"	90°8'10"	509064	1134				SW	SW	60021	0.0164
Pho_gr 79	Bechung/Thar	77L/4	28°7'57"	90°9'58"	12224611	6286			4174	S	S	52012	1.2320
Pho_gr 80	Raphstreng	77L/8	28°8'46"	90°11'1"	3802362	3378				S	S	63021	0.3855
Pho_gr 81	ThorThormi	77L/8	28°7'57"	90°11'25"	16865926	5595				S	S	52021	1.9037
Pho_gr 82	Lugge	77L/8	28°7'40"	90°13'1"	2114272	2468				S	S	63021	0.1169
Pho_gr 83	DrukChong	77L/8	28°7'59"	90°14'49"	11228005	6199				S	S	53021	1.1071
Pho_gr 84	Yaksagang	77L/8	28°6'49"	90°16'52"	7751219	3684				NW	NW	53521	0.6733
Pho_gr 85		77L/8	28°7'26"	90°18'24"	4889466	6534				NW	NW	53521	0.3635
Pho_gr 86		77L/8	28°6'27"	90°19'6"	395909	916				NE	NE	60021	0.0115
Pho_gr 87		77L/8	28°4'15"	90°21'57"	128680	505				NE	NE	60021	0.0022
Pho_gr 88		77L/8	28°3'59"	90°20'29"	625459	1110				NW	NW	60021	0.0218
Pho_gr 89		77L/8	28°2'52"	90°19'59"	1407235	1604				SW	SW	60021	0.0670
Pho_gr 90		77L/8	28°3'23"	90°19'10"	3758587	2804				NW	NW	60021	0.2550
Pho_gr 91		77L/8	28°2'17"	90°19'53"	3081477	2488				NW	NW	60021	0.1949
Pho_gr 92		77L/8	28°2'41"	90°19'23"	1928530	1632				N	N	60021	0.1031
Pho_gr 93		77L/8	28°1'45"	90°19'37"	106134	518				NW	NW	63021	0.0017
Pho_gr 94		77L/8	28°1'8"	90°18'21"	632397	1124				W	W	63021	0.0222
Pho_gr 95		77L/8	28°2'2"	90°17'43"	397608	1111				W	W	63021	0.0115
Pho_gr 96		77L/8	28°2'22"	90°16'26"	250446	828				SW	SW	63021	0.0060
Pho_gr 97		77L/8	28°1'56"	90°16'51"	1277103	1863				SW	SW	60021	0.0587
Pho_gr 98		77L/8	28°1'2"	90°17'38"	893812	1658				W	W	63021	0.0359
Pho_gr 99		77L/8	28°1'2"	90°17'20"	131546	720				SW	SW	63021	0.0023
Pho_gr 100		77I/5	28°0'27"	90°17'57"	1556247	1945	5880	5600	5320	N	N	63021	0.0769
Pho_gr 101		77I/5	28°0'16"	90°17'30"	2602876	2819	5560	5380	5200	N	N	60021	0.1551
Pho_gr 102		77I/5	28°0'49"	90°17'25"	1244540	1996	5638	5389	5140	N	N	63021	0.0566
Pho_gr 103		77I/5	27°59'30"	90°18'2"	165529	640	5600	5440	5280	NE	NE	67021	0.0033
Pho_gr 104		77I/5	27°58'12"	90°17'56"	121565	579	5540	5450	5360	NE	NE	63021	0.0021
Pho_gr 105		77L/8	27°58'57"	90°15'48"	50223	545				NE	NE	60021	0.0005
Pho_gr 106		77L/8	27°59'38"	90°15'18"	297737	1241				SW	SW	67021	0.0076
Pho_gr 107		77L/4	27°59'30"	90°15'36"	637254	1882				NW	NW	63021	0.0224
Pho_gr 108		78I/1	27°59'22"	90°15'49"	248131	985	5320	5200	5080	SW	SW	63021	0.0059
Pho_gr 109		78I/1	28°1'18"	90°12'42"	616210	1112	5500	5350	5200	SE	SE	60021	0.0214
Pho_gr 110		78I/1	28°1'22"	90°9'26"	2774084	2472	5360	5180	5000	SE	SE	60021	0.1691

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Pho_gr 111		78I/1	27°59'27"	90°6'2"	67570	368	4800	4720	4640	NW	NW	67021	0.0008
Pho_gr 112		78I/1	27°57'55"	90°5'48"	128252	654	4800	4700	4600	SW	SW	67021	0.0022
Pho_gr 113		78I/1	27°58'60"	90°6'20"	108692	576	4640	4540	4440	SE	SE	67021	0.0017
Pho_gr 114		78I/1	27°57'3"	90°8'42"	570535	1056	5320	4830	4340	NE	NE	60021	0.0192
Pho_gr 115		78I/1	27°57'14"	90°8'34"	1598591	1944	5600	5360	5120	NE	NE	60021	0.0798
Pho_gr 116		78I/1	27°58'7"	90°8'4"	924274	1798	5600	5360	5120	NE	NE	63021	0.0376
Pho_gr 117		78I/1	27°58'4"	90°8'22"	315228	651	5440	5320	5200	NE	NE	60021	0.0083
Pho_gr 118		77L/4	27°58'33"	90°7'52"	1455426	2730				SE	SE	60021	0.0702
Pho_gr 119		77L/4	27°59'9"	90°7'20"	457915	1060				SE	SE	67321	0.0141
Pho_gr 120		77L/4	27°59'39"	90°7'58"	213778	763				SW	SW	67021	0.0047
Pho_gr 121		77L/4	28°1'33"	90°8'3"	178961	791				NE	NE	67021	0.0037
Pho_gr 122		77L/4	28°1'11"	90°10'32"	144316	719				NW	NW	37021	0.0027
Pho_gr 123		77L/4	28°0'39"	90°10'44"	138497	723				SE	SE	37021	0.0025
Pho_gr 124		78I/1	28°0'51"	90°10'56"	1988430	2643	5320	5150	4980	W	W	60021	0.1075
Pho_gr 125		78I/5	28°1'24"	90°13'16"	2698054	3690	5638	5309	4980	NW	NW	60071	0.1619
Pho_gr 126		78I/1	28°1'35"	90°13'18"	399574	1013	5450	5305	5160	SW	SW	63021	0.0116
Pho_gr 127		78I/5	28°0'48"	90°14'20"	4214631	3209	5720	5440	5160	SW	SW	60021	0.2976
Pho_gr 128		78I/5	27°58'1"	90°15'33"	1600803	1234	5600	5400	5200	W	W	60021	0.0800
Pho_gr 129		78I/5	27°57'56"	90°14'58"	5086131	3526	5710	5425	5140	W	W	60021	0.3833
Pho_gr 130		78I/5	27°57'1"	90°16'52"	139023	840	5582	5381	5180	NW	NW	63021	0.0025
Pho_gr 131		78I/1	27°56'8"	90°16'36"	3234792	2458	5650	5385	5120	NE	NE	60021	0.2082
Pho_gr 132		78I/1	27°55'52"	90°16'38"	658862	1792	5480	5360	5240	NE	NE	63021	0.0235
Pho_gr 133		78I/1	27°54'19"	90°15'43"	219149	760	5480	5380	5280	SE	SE	60021	0.0049
Pho_gr 134		78I/1	27°54'30"	90°14'34"	481411	1107	5400	5300	5200	NW	NW	60021	0.0151
Pho_gr 135		78I/1	27°55'13"	90°14'19"	3810311	3325	5560	5180	4800	NW	NW	62021	0.2597
Pho_gr 136		78I/1	27°55'55"	90°13'34"	58839	389	5200	5100	5000	W	W	75021	0.0007
Pho_gr 137		78I/1	27°55'15"	90°13'38"	1043305	1273	5280	5105	4930	NW	NW	60021	0.0444
Pho_gr 138		78I/1	27°54'38"	90°13'56"	1476323	1724	5650	5235	4820	SW	SW	52021	0.0716
Pho_gr 139		78I/1	27°54'23"	90°12'38"	1532916	2536	5200	5160	5120	W	W	67021	0.0754
Pho_gr 140		78I/1	27°54'43"	90°12'1"	838756	1930	5200	5060	4920	SW	SW	63021	0.0328
Pho_gr 141		78I/1	27°53'22"	90°13'47"	437648	1082	5280	5160	5040	NW	NW	67021	0.0132
Pho_gr 142		78I/1	27°53'14"	90°13'1"	160236	715	5240	5195	5150	NW	NW	67021	0.0031
Pho_gr 143		78I/1	27°52'28"	90°13'42"	196632	559	5240	5220	5200	SE	SE	79021	0.0042
Pho_gr 144		78I/1	27°51'51"	90°12'59"	186676	570	5240	5180	5120	N	N	67021	0.0039
Pho_gr 145		78I/1	27°51'30"	90°12'57"	41443	332	5360	5360	5360	E	E	67021	0.0004
Pho_gr 146		78I/1	27°52'17"	90°14'31"	953576	1612	5650	5425	5200	SE	SE	60021	0.0392
Pho_gr 147		78I/5	27°52'14"	90°14'52"	1067014	1446	5582	5361	5140	SE	SE	60021	0.0458
Pho_gr 148		78I/5	27°53'54"	90°13'19"	106821	450	5388	5254	5120	NW	NW	37021	0.0017
Pho_gr 149		78I/5	27°54'13"	90°14'1"	1394782	1697	5478	5239	5000	NW	NW	60021	0.0662
Pho_gr 150		78I/5	27°53'23"	90°15'45"	343967	946	5280	5140	5000	NW	NW	63021	0.0094
Pho_gr 151		78I/1	27°50'38"	90°15'25"	202925	854	5050	4945	4840	NW	NW	60021	0.0044

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Pho_gr 152		78I/1	27°50'5"	90°15'9"	131176	612	5120	5040	4960	W	W	67021	0.0023
Pho_gr 153		78I/1	27°49'50"	90°14'55"	74632	404	5160	5060	4960	NW	NW	75021	0.0010
Pho_gr 154		78I/1	27°49'37"	90°14'41"	104855	574	5120	4980	4840	NW	NW	75021	0.0016

Glacier Inventory of Mangde Chu Basin

Total Number :140 Total Area :146.69 (km²) Ice Reserve : 11.92 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
mangd_gr 1		78I/5	27°49'55"	90°15'49"	678949	1590	5420	5230	5040	SW	SW	63021	0.0245
mangd_gr 2		78I/5	27°49'45"	90°16'16"	685226	988	5420	5250	5080	S	S	60021	0.0250
mangd_gr 3		78I/5	27°50'3"	90°16'30"	578560	1442	5478	5209	4940	SE	SE	63021	0.0196
mangd_gr 4		78I/5	27°50'28"	90°16'21"	113727	525	5360	5240	5120	E	E	63021	0.0018
mangd_gr 5		78I/5	27°50'36"	90°16'13"	129913	582	5320	5200	5080	N	N	63021	0.0023
mangd_gr 6		78I/5	27°54'21"	90°15'40"	546682	1087	5582	5411	5240	NE	NE	60021	0.0182
mangd_gr 7		78I/5	27°54'50"	90°17'11"	367614	1557	5710	5475	5240	SW	SW	60021	0.0104
mangd_gr 8		78I/5	27°54'36"	90°17'8"	555390	1503	5710	5455	5200	SW	SW	60021	0.0187
mangd_gr 9		78I/5	27°54'17"	90°17'13"	135159	500	5460	5410	5360	SE	SE	60021	0.0025
mangd_gr 10		78I/5	27°54'4"	90°18'12"	4280531	2741	5688	5344	5000	S	S	62021	0.3038
mangd_gr 11		78I/5	27°53'0"	90°18'53"	2524357	2135	5040	5180	5320	W	W	62021	0.1484
mangd_gr 12		78I/5	27°52'27"	90°18'29"	1161459	1747	5400	5220	5040	SW	SW	63021	0.0514
mangd_gr 13		78I/5	27°52'22"	90°19'16"	879956	1609	5560	5340	5120	SW	SW	63021	0.0351
mangd_gr 14		78I/5	27°52'0"	90°19'29"	439063	1046	5560	5380	5200	S	S	63021	0.0133
mangd_gr 15		78I/5	27°51'12"	90°19'38"	958267	1790	5480	5300	5120	SW	SW	63021	0.0396
mangd_gr 16		78I/5	27°50'43"	90°19'19"	187607	946	5320	5220	5120	W	W	63021	0.0040
mangd_gr 17		78I/5	27°49'43"	90°19'24"	244902	865	5200	5100	5000	NW	NW	37021	0.0056
mangd_gr 18		78I/5	27°49'29"	90°19'13"	186853	504	5450	5205	4960	NW	NW	37021	0.0040
mangd_gr 19		78I/5	27°49'10"	90°19'12"	269533	569	5450	5205	4960	NW	NW	37021	0.0066
mangd_gr 20		78I/5	27°48'52"	90°19'4"	278611	756	5260	5130	5000	SW	SW	37021	0.0070
mangd_gr 21		78I/5	27°48'51"	90°19'22"	210685	800	5320	5150	4980	S	S	37021	0.0046
mangd_gr 22		78I/5	27°49'22"	90°19'38"	854340	1869	5260	5170	5080	E	E	37021	0.0335
mangd_gr 23		78I/5	27°51'12"	90°20'20"	1004807	1449	5400	5235	5070	S	S	60021	0.0419
mangd_gr 24		78I/5	27°49'43"	90°22'40"	109558	490	5200	5110	5020	N	N	63021	0.0018
mangd_gr 25		78I/5	27°49'39"	90°22'16"	343490	1192	5400	5260	5120	NE	NE	37021	0.0092
mangd_gr 26		78I/5	27°50'53"	90°22'1"	134867	475	5240	5160	5080	N	N	65021	0.0023
mangd_gr 27		78I/5	27°51'12"	90°21'40"	177545	810	5160	5120	5080	N	N	60021	0.0037
mangd_gr 28		78I/5	27°51'17"	90°20'54"	131359	688	5280	5200	5120	E	E	63021	0.0023
mangd_gr 29		78I/5	27°51'34"	90°20'23"	754090	1452	5400	5220	5040	NE	NE	63021	0.0281

A	B	C	D	E	F	G	H	I	J	K	L	M	N
mangd_gr 30		78I/5	27°52'15"	90°20'10"	2191683	1635	5540	5310	5080	SE	SE	62021	0.1226
mangd_gr 31		78I/5	27°52'42"	90°20'57"	159960	546	5160	5090	5020	NE	NE	63021	0.0031
mangd_gr 32		78I/5	27°52'54"	90°21'17"	95850	445	5400	5300	5200	NE	NE	64021	0.0015
mangd_gr 33		78I/5	27°53'14"	90°21'7"	69187	439	5400	5330	5260	S	S	65021	0.0009
mangd_gr 34		78I/5	27°53'1"	90°20'51"	78911	465	5400	5300	5200	NW	NW	65021	0.0011
mangd_gr 35		78I/5	27°52'56"	90°20'34"	54741	406	5400	5300	5200	NW	NW	65021	0.0005
mangd_gr 36		78I/5	27°52'58"	90°19'39"	788230	1264	5400	5280	5160	NE	NE	60021	0.0302
mangd_gr 37		78I/5	27°53'54"	90°19'6"	1386991	2086	5688	5464	5240	SE	SE	60021	0.0659
mangd_gr 38		78I/5	27°54'16"	90°19'46"	282765	963	5400	5360	5320	SE	SE	60021	0.0070
mangd_gr 39		78I/5	27°54'38"	90°19'39"	131451	648	5440	5355	5270	NW	NW	65021	0.0023
mangd_gr 40		78I/5	27°54'46"	90°18'59"	2069371	2208	5480	5360	5240	NE	NE	60021	0.1136
mangd_gr 41		78I/5	27°55'6"	90°18'11"	946267	1762	5710	5565	5420	E	E	60021	0.0390
mangd_gr 42		78I/5	27°55'28"	90°17'47"	792922	1788	5710	5445	5180	N	N	63021	0.0302
mangd_gr 43		78I/5	27°56'0"	90°17'8"	331505	1886	5660	5530	5400	E	E	67021	0.0089
mangd_gr 44		78I/5	27°57'58"	90°17'37"	4075724	2613	5760	5540	5320	S	S	60021	0.2848
mangd_gr 45		78I/5	27°56'55"	90°18'22"	949959	1444	5649	5505	5360	SW	SW	60021	0.0390
mangd_gr 46		78I/5	27°57'23"	90°18'60"	2349274	2277	5649	5485	5320	SE	SE	63021	0.1350
mangd_gr 47		78I/5	27°56'49"	90°19'44"	35924	366	5560	5520	5480	SE	SE	79021	0.0004
mangd_gr 48		78I/5	27°57'8"	90°19'51"	43355	305	5572	5531	5490	SE	SE	65021	0.0004
mangd_gr 49		78I/5	27°57'16"	90°19'55"	75249	567	5572	5406	5240	NE	NE	65021	0.0011
mangd_gr 50		78I/5	27°57'56"	90°20'16"	63464	396	5480	5400	5320	NW	NW	65021	0.0007
mangd_gr 51		78I/5	27°57'54"	90°19'28"	1759974	1832	5868	5868	5868	NE	NE	60021	0.0910
mangd_gr 52		78I/5	27°58'17"	90°18'45"	95081	595	5868	5868	5868	E	E	67021	0.0015
mangd_gr 53		78I/5	27°58'54"	90°19'52"	96157	424	5440	5440	5440	N	N	65021	0.0015
mangd_gr 54		78I/5	27°58'46"	90°18'50"	2583959	3187	5868	5868	5868	NE	NE	63021	0.1532
mangd_gr 55		78I/5	27°59'51"	90°19'9"	1107827	1627	5583	5583	5583	NE	NE	60021	0.0484
mangd_gr 56		77L/8	28°0'33"	90°18'5"	676933	1251				S	S	60021	0.0245
mangd_gr 57		77L/8	28°0'55"	90°18'58"	1852178	2532				S	S	60021	0.0974
mangd_gr 58		77L/8	28°1'7"	90°20'6"	1492257	1838				S	S	60021	0.0725
mangd_gr 59		77L/8	28°0'5"	90°20'49"	78495	485				SW	SW	65021	0.0011
mangd_gr 60		77L/8	28°0'58"	90°20'27"	326459	1081				SE	SE	60021	0.0089
mangd_gr 61		77L/8	28°1'15"	90°20'49"	329366	1300				SE	SE	60021	0.0089
mangd_gr 62		77L/8	28°1'47"	90°20'59"	1652847	2316				E	E	60021	0.0834
mangd_gr 63		77L/8	28°2'24"	90°20'47"	2441231	2105				NE	NE	60021	0.1420
mangd_gr 64		77L/8	28°3'9"	90°21'11"	212377	1233				SW	SW	67021	0.0046
mangd_gr 65		77L/8	28°3'7"	90°22'27"	3931041	3371				S	S	60021	0.2708
mangd_gr 66		77L/8	28°2'6"	90°22'39"	129020	909				W	W	67021	0.0023
mangd_gr 67		77L/8	28°1'57"	90°22'48"	237917	940				E	E	67021	0.0056
mangd_gr 68		77L/8	28°2'30"	90°23'9"	733889	1422				S	S	60021	0.0271
mangd_gr 69		77L/8	28°2'52"	90°23'34"	2995390	3598				S	S	60021	0.1880
mangd_gr 70		77L/8	28°0'55"	90°23'26"	3589321	4180				NW	NW	60021	0.2397

A	B	C	D	E	F	G	H	I	J	K	L	M	N
mangd_gr 71		78I/5	27°59'17"	90°22'5"	206685	538	5440	5280	5120	W	W	64021	0.0046
mangd_gr 72		78I/5	27°58'57"	90°21'56"	179176	674	5560	5440	5320	W	W	63021	0.0037
mangd_gr 73		78I/5	27°59'31"	90°22'17"	41355	407	5600	5540	5480	S	S	37021	0.0004
mangd_gr 74		78I/5	27°59'47"	90°22'32"	421293	1334			5240	NE	NE	63021	0.0125
mangd_gr 75		78I/5	27°59'46"	90°23'23"	1635662	1874	5600	5424	5248	SW	SW	60021	0.0827
mangd_gr 76		78I/5	27°58'52"	90°23'41"	1653386	1817	5600	5420	5240	W	W	60021	0.0834
mangd_gr 77		78I/5	27°58'27"	90°23'15"	58541	295	5480	5430	5380	NW	NW	65021	0.0007
mangd_gr 78		78I/5	27°58'15"	90°23'9"	98234	459	5520	5440	5360	NW	NW	65021	0.0015
mangd_gr 79		78I/5	27°58'5"	90°22'57"	84603	372	5440	5380	5320	NW	NW	65021	0.0011
mangd_gr 80		78I/5	27°57'42"	90°22'41"	511927	903	5640	5460	5280	NW	NW	62021	0.0164
mangd_gr 81		78I/5	27°57'21"	90°22'32"	110758	530	5480	5400	5320	NW	NW	63021	0.0018
mangd_gr 82		78I/5	27°56'60"	90°22'27"	33340	276	5440	5400	5360	NW	NW	65021	0.0002
mangd_gr 83		78I/5	27°57'15"	90°22'59"	364137	1124	5880	5640	5400	SW	SW	63021	0.0100
mangd_gr 84		78I/5	27°57'15"	90°23'6"	232347	935	5880	5640	5400	SW	SW	63021	0.0053
mangd_gr 85		78I/5	27°56'44"	90°23'17"	400307	808	5686	5503	5320	W	W	63021	0.0116
mangd_gr 86		78I/5	27°56'18"	90°23'5"	393523	714	5500	5390	5280	NW	NW	63021	0.0112
mangd_gr 87		78I/5	27°55'59"	90°22'44"	58725	489	5380	5290	5200	W	W	65021	0.0007
mangd_gr 88		78I/5	27°55'59"	90°23'14"	298488	811	5480	5400	5320	S	S	63021	0.0077
mangd_gr 89		78I/5	27°55'47"	90°23'33"	45186	241	5440	5400	5360	W	W	37021	0.0005
mangd_gr 90		78I/5	27°55'33"	90°23'40"	42509	404	5440	5380	5320	SW	SW	67021	0.0004
mangd_gr 91		78I/5	27°54'46"	90°24'4"	175961	1195	5400	5340	5280	SW	SW	67021	0.0037
mangd_gr 92		78I/5	27°54'17"	90°24'18"	107727	437	5360	5280	5200	W	W	63021	0.0018
mangd_gr 93		78I/5	27°53'54"	90°24'34"	74218	420	5400	5280	5160	SW	SW	63021	0.0009
mangd_gr 94		78I/5	27°53'24"	90°24'51"	353413	1176	5240	5180	5120	SW	SW	60021	0.0096
mangd_gr 95		78I/5	27°52'20"	90°26'20"	257487	1126	5160	5000	4840	SE	SE	63021	0.0063
mangd_gr 96		78I/5	27°52'39"	90°25'56"	77572	551	4600	4550	4500	NE	NE	65021	0.0011
mangd_gr 97		78I/5	27°52'45"	90°27'13"	49817	400	5280	5160	5040	NW	NW	65021	0.0005
mangd_gr 98		78I/5	27°53'40"	90°25'6"	994130	1623	5400	5190	4980	NE	NE	62021	0.0413
mangd_gr 99		78I/5	27°54'16"	90°24'48"	556836	1124	5400	5240	5080	NE	NE	63021	0.0187
mangd_gr 100		78I/5	27°54'24"	90°24'26"	29586	293	5320	5260	5200	NE	NE	63021	0.0002
mangd_gr 101		78I/5	27°55'9"	90°24'11"	1368883	1859	5500	5330	5160	S	S	60021	0.0646
mangd_gr 102		78I/5	27°55'19"	90°24'49"	36878	268	5260	5250	5240	NE	NE	79021	0.0004
mangd_gr 103		78I/5	27°55'16"	90°25'7"	17124	182	5120	5080	5040	NE	NE	79021	0.0001
mangd_gr 104		78I/5	27°55'53"	90°23'60"	852540	1583	5600	5340	5080	NE	NE	63021	0.0335
mangd_gr 105		78I/5	27°56'17"	90°23'48"	1800422	2989	5640	5430	5220	SE	SE	60021	0.0939
mangd_gr 106		78I/5	27°56'53"	90°24'33"	979406	1516	5641	5461	5280	SE	SE	62021	0.0407
mangd_gr 107		78I/5	27°56'44"	90°25'3"	396000	945	5460	5370	5280	SW	SW	63021	0.0116
mangd_gr 108		78I/5	27°56'34"	90°25'16"	88311	386	5320	5265	5210	S	S	63021	0.0013
mangd_gr 109		78I/5	27°56'6"	90°25'59"	51340	327	5230	5205	5180	NE	NE	75021	0.0005
mangd_gr 110		78I/5	27°56'55"	90°25'19"	226255	663	5460	5350	5240	NE	NE	63021	0.0053
mangd_gr 111		78I/5	27°57'11"	90°25'15"	405354	954	5460	5345	5230	NE	NE	60021	0.0121

A	B	C	D	E	F	G	H	I	J	K	L	M	N
mangd_gr 112		78I/5	27°57'27"	90°24'46"	778429	1704	5600	5460	5320	NE	NE	60021	0.0297
mangd_gr 113		78I/5	27°58'0"	90°25'56"	699488	1790	5480	5315	5150	NE	NE	63021	0.0255
mangd_gr 114		78I/5	27°57'56"	90°25'24"	55525	486	5480	5380	5280	N	N	77021	0.0007
mangd_gr 115		78I/5	27°57'44"	90°23'60"	3971366	3369	5800	5510	5220	NE	NE	63021	0.2745
mangd_gr 116		78I/5	27°58'48"	90°24'26"	762290	1323	5560	5440	5320	SE	SE	63021	0.0286
mangd_gr 117		78I/5	27°59'24"	90°28'0"	44114224	10561	7600	6160	4720	S	S	52021	6.8102
mangd_gr 118		78I/5	27°59'58"	90°24'3"	3304694	3131			5230	SE	SE	60021	0.2139
mangd_gr 119		77L/8	28°0'12"	90°24'39"	151452	515				NE	NE	64021	0.0028
mangd_gr 120		77L/8	28°0'39"	90°24'9"	375014	836				NE	NE	63021	0.0108
mangd_gr 121		77L/8	28°1'18"	90°24'25"	861248	1374				E	E	63021	0.0340
mangd_gr 122		77L/8	28°1'44"	90°24'20"	374876	797				N	N	63021	0.0104
mangd_gr 123		77L/8	28°1'39"	90°26'34"	168653	640				SW	SW	63021	0.0034
mangd_gr 124		77L/8	28°1'6"	90°26'32"	3389667	3298	6580			SW	SW	60021	0.2218
mangd_gr 125		77L/8	28°0'50"	90°27'16"	1697434	2426				S	S	60021	0.0868
mangd_gr 126		77L/8	28°0'47"	90°27'56"	158591	524	5680	5540	5400	S	S	65021	0.0031
mangd_gr 127		77L/8	28°0'58"	90°29'44"	537513	1229				S	S	60021	0.0178
mangd_gr 128		78I/5	27°59'30"	90°29'40"	56771	436	5360	5300	5240	NW	NW	65021	0.0007
mangd_gr 129		78I/5	27°57'48"	90°29'29"	106773	486	5320	5235	5150	SW	SW	65021	0.0018
mangd_gr 130		78I/9	27°55'51"	90°31'7"	1326066	1628	5520	5305	5090	W	W	63021	0.0620
mangd_gr 131		78I/9	27°54'41"	90°30'38"	177991	769	5400	5255	5110	N	N	65021	0.0037
mangd_gr 132		78I/9	27°54'43"	90°30'12"	310366	862	5320	5235	5150	NW	NW	63021	0.0081
mangd_gr 133		78I/9	27°54'2"	90°30'39"	1123796	2358	5500	5250	5000	W	W	60021	0.0490
mangd_gr 134		78I/5	27°53'38"	90°29'44"	199638	880	5400	5205	5010	W	W	63021	0.0043
mangd_gr 135		78I/5	27°53'36"	90°30'14"	984514	1961	5400	5215	5030	SW	SW	63021	0.0407
mangd_gr 136		78I/9	27°53'30"	90°30'53"	231363	959	5160	5055	4950	SW	SW	63021	0.0053
mangd_gr 137		78I/9	27°53'58"	90°33'38"	2088618	2206	5566	5273	4980	S	S	62021	0.1151
mangd_gr 138		78I/9	27°50'8"	90°34'19"	101988	398	5280	5130	4980	NW	NW	65021	0.0015
mangd_gr 139		78I/9	27°49'50"	90°34'34"	451617	904	5360	5160	4960	SW	SW	63021	0.0137
mangd_gr 140		78I/9	27°49'32"	90°34'38"	123235	487	5220	5260	5300	SW	SW	65021	0.0020

Glacier Inventory of Chamkhar Chu Basin

Total Number : 94 Total Area : 104.10 (km²) Ice Reserve : 8.11(km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Cham_gr 1		78I/9	27°50'3"	90°35'7"	593360.93	580	5439	5269.5	5100	SE	SE	60021	0.0201
Cham_gr 2		78I/9	27°50'27"	90°35'42"	1062578.70	1780	5320	5130	4940	NE	NE	63021	0.0454
Cham_gr 3		78I/9	27°50'41"	90°34'22"	650286.17	1295	5260	5117.5	4975	NE	NE	63021	0.0230
Cham_gr 4		78I/9	27°54'16"	90°34'4"	339428.24	675	5280	5175	5070	NE	NE	63021	0.0092
Cham_gr 5		78I/9	27°54'11"	90°34'23"	99203.76	495	5140	5110	5080	NE	NE	63021	0.0015
Cham_gr 6		78I/9	27°54'48"	90°33'32"	263009.96	495	5360	5175	4990	NW	NW	60021	0.0063
Cham_gr 7		78I/9	27°54'18"	90°33'35"	412015.60	1155	5345	5157.5	4970	N	N	60021	0.0121
Cham_gr 8		78I/9	27°55'52"	90°31'27"	228131.72	575	5480	5290	5100	SE	SE	63021	0.0053
Cham_gr 9		78I/9	27°55'57"	90°31'45"	567944.59	1160	5480	5265	5050	NE	NE	63021	0.0192
Cham_gr 10		78I/9	27°56'42"	90°31'4"	175160.48	605	5230	5200	5170	NE	NE	63021	0.0037
Cham_gr 11		78I/9	27°56'25"	90°31'24"	60417.67	340	5400	5320	5240	N	N	75021	0.0007
Cham_gr 12		78I/9	27°56'57"	90°30'26"	154667.40	415	5420	5260	5100	NW	NW	75021	0.0028
Cham_gr 13		78I/9	27°58'2"	90°30'52"	46771.00	375	5360	5330	5300	SW	SW	75021	0.0005
Cham_gr 14		78I/9	27°59'54"	90°29'20"	201053.77	660	5400	5335	5270	NE	NE	63021	0.0043
Cham_gr 15		78I/9	27°59'26"	90°30'35"	2184267.34	2845	5445	5322.5	5200	SW	SW	62021	0.1219
Cham_gr 16		78I/9	27°59'12"	90°31'28"	217377.46	670	5480	5370	5260	SE	SE	63021	0.0049
Cham_gr 17		78I/9	27°59'19"	90°31'8"	513327.13	820	5400	5285	5170	SW	SW	62021	0.0164
Cham_gr 18		78I/9	27°58'20"	90°31'24"	346736.21	420	5430	5305	5180	W	W	60021	0.0096
Cham_gr 19		78I/9	27°58'50"	90°31'35"	485556.85	1250	5430	5355	5280	SE	SE	63021	0.0155
Cham_gr 20		78I/9	27°58'5"	90°32'58"	728058.34	2105	5440	5190	4940	NE	NE	63021	0.0271
Cham_gr 21		78I/9	27°59'45"	90°31'9"	108927.20	600	5460	5300	5140	NE	NE	63021	0.0018
Cham_gr 22		78I/9	27°59'43"	90°31'34"	433970.28	1150	5520	5340	5160	NE	NE	63021	0.0129
Cham_gr 23		78I/9	27°59'14"	90°31'52"	439355.10	1230	5440	5300	5160	SE	SE	63021	0.0133
Cham_gr 24		77L/12	28°1'12"	90°30'1"	761182.67	935	6200	5770	5340	SE	SE	60021	0.0286
Cham_gr 25		78I/9	27°59'51"	90°32'49"	26710211.54	8875	6000	5291	4582	SE	SE	52012	3.5054

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Cham_gr 26		77L/12	28°2'46"	90°33'22"	599884.26	1225	5800	5540	5280	SW	SW	60021	0.0206
Cham_gr 27		77L/12	28°2'19"	90°34'1"	1343973.97	1540	5800	5515	5230	SW	SW	60021	0.0627
Cham_gr 28		77L/12	28°1'40"	90°34'22"	762982.74	1450	5600	5450	5300	SW	SW	63021	0.0286
Cham_gr 29		77L/12	28°0'1"	90°35'55"	817154.02	1980	5780	5550	5320	SW	SW	60021	0.0318
Cham_gr 30		78I/9	27°59'44"	90°34'50"	214823.52	695	5400	5292.5	5185	NW	NW	63021	0.0046
Cham_gr 31		78I/9	27°59'33"	90°34'28"	296241.99	1030	5490	5355	5220	NW	NW	63021	0.0077
Cham_gr 32		78I/9	27°59'21"	90°34'5"	104665.50	405	5400	5330	5260	NW	NW	63021	0.0015
Cham_gr 33		78I/9	27°59'55"	90°34'29"	213961.95	690	5500	5405	5310	NE	NE	75021	0.0046
Cham_gr 34		78I/9	28°0'12"	90°35'9"	174745.08	495	5320	5250	5180	NE	NE	60021	0.0034
Cham_gr 35		77L/12	28°1'25"	90°35'5"	200438.36	600	5540	5450	5360	SE	SE	63021	0.0043
Cham_gr 36		77L/12	28°1'42"	90°35'8"	181514.57	815	5540	5430	5320	SE	SE	63021	0.0037
Cham_gr 37		78I/9	27°59'47"	90°36'44"	359767.47	840	5455	5342.5	5230	NW	NW	63021	0.0100
Cham_gr 38		78I/9	27°59'43"	90°36'15"	1067348.11	1180	5525	5367.5	5210	W	W	60021	0.0460
Cham_gr 39		78I/9	27°57'40"	90°35'29"	670440.77	805	5550	5365	5180	W	W	60021	0.0240
Cham_gr 40		78I/9	27°58'58"	90°36'54"	759228.75	985	5430	5250	5070	SW	SW	63021	0.0286
Cham_gr 41		78I/9	27°58'31"	90°37'42"	823431.18	1270	5430	5265	5100	SW	SW	60021	0.0318
Cham_gr 42		78I/9	27°58'2"	90°39'0"	170252.60	695	5290	5235	5180	NE	NE	75022	0.0034
Cham_gr 43		78I/9	27°58'5"	90°39'19"	75033.61	475	5235	5162.5	5090	NW	NW	63021	0.0011
Cham_gr 44		78I/9	27°58'18"	90°38'54"	178514.45	580	5480	5285	5090	NW	NW	63021	0.0037
Cham_gr 45		78I/9	27°58'3"	90°38'58"	278995.18	1135	5350	5165	4980	NE	NE	75021	0.0070
Cham_gr 46		78I/9	27°59'46"	90°37'9"	115250.52	540	5300	5210	5120	NE	NE	75021	0.0020
Cham_gr 47		78I/9	27°59'23"	90°37'19"	448832.38	960	5310	5205	5100	NE	NE	60021	0.0137
Cham_gr 48		78I/9	27°59'7"	90°37'45"	188330.21	670	5380	5320	5260	NE	NE	63021	0.0040
Cham_gr 49		78I/9	28°0'58"	90°36'1"	198438.28	435	5500	5350	5200	NE	NE	77021	0.0043
Cham_gr 50		77L/12	28°0'56"	90°36'52"	5793296.32	5805	5800	5385	4970	SE	SE	60021	0.4562
Cham_gr 51		77L/12	28°0'29"	90°39'58"	182376.14	765	5460	5330	5200	NE	NE	75021	0.0037
Cham_gr 52		77L/12	28°0'12"	90°39'45"	134943.57	615	5420	5260	5100	NE	NE	75021	0.0023
Cham_gr 53		77L/12	28°1'27"	90°38'7"	508757.73	915	5445	5352.5	5260	NE	NE	60021	0.0164
Cham_gr 54		77L/12	28°1'53"	90°37'11"	157298.26	590	5450	5395	5340	NE	NE	75021	0.0031
Cham_gr 55		77L/12	28°1'41"	90°37'28"	31031.94	250	5550	5477.5	5405	N	N	75021	0.0002
Cham_gr 56		77L/12	28°1'28"	90°37'24"	89480.31	580	5430	5360	5290	NW	NW	75021	0.0013
Cham_gr 57		77L/12	28°2'42"	90°36'8"	721365.78	1125	5710	5515	5320	SE	SE	60021	0.0266
Cham_gr 58		77L/12	28°2'33"	90°37'41"	219854.48	670	5620	5430	5240	SW	SW	75021	0.0049
Cham_gr 59		77L/12	28°2'4"	90°39'43"	550143.91	690	5240	5075	4910	NE	NE	60021	0.0182
Cham_gr 60		77L/12	28°3'57"	90°40'45"	2943911.49	2545	5760	5410	5060	SE	SE	62031	0.1829
Cham_gr 61		77L/12	28°2'40"	90°41'38"	5949656.09	4570	5960	5450	4940	SW	SW	63021	0.4732
Cham_gr 62		77L/12	28°2'27"	90°42'36"	487572.31	665	5560	5380	5200	E	E	60021	0.0155

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Cham_gr 63		77L/12	28°3'25"	90°42'17"	171806.51	390	5845	5682.5	5520	SE	SE	60021	0.0034
Cham_gr 64		77L/12	28°3'40"	90°42'29"	380445.18	545	5845	5622.5	5400	SW	SW	60021	0.0108
Cham_gr 65		77L/12	28°3'52"	90°42'19"	281087.57	475	5480	5400	5320	SE	SE	60021	0.0070
Cham_gr 66		77L/12	28°3'19"	90°43'26"	2689563.39	2500	5500	5327.5	5155	SE	SE	62021	0.1622
Cham_gr 67		77L/12	28°3'10"	90°44'15"	533127.88	970	6000	5640	5280	SW	SW	60021	0.0173
Cham_gr 68		77L/12	28°2'55"	90°43'48"	1189198.88	945	6085	5642.5	5200	NW	NW	60021	0.0532
Cham_gr 69		77L/12	28°2'7"	90°44'24"	319981.35	465	5660	5460	5260	SW	SW	60021	0.0085
Cham_gr 70		77L/12	28°2'19"	90°44'9"	255271.21	555	5950	5605	5260	SE	SE	60021	0.0063
Cham_gr 71		77L/12	28°1'4"	90°44'25"	12454779.37	7985	6200	5500	4800	SW	SW	52012	1.2707
Cham_gr 72		77L/12	28°0'57"	90°43'30"	1723096.02	605	5560	5385	5210	NW	NW	67021	0.0882
Cham_gr 73		78I/9	27°59'44"	90°43'52"	605053.68	1390	5400	5135	4870	S	S	63021	0.0211
Cham_gr 74		78I/9	28°0'28"	90°44'0"	810738.40	1120	5400	5255	5110	SE	SE	63021	0.0313
Cham_gr 75		78I/13	28°1'9"	90°47'48"	5823728.24	5775				SW	SW	52012	0.4594
Cham_gr 76		78I/13	28°1'21"	90°46'52"	287410.88	880				SE	SE	63021	0.0074
Cham_gr 77		78I/13	28°2'43"	90°48'5"	2044415.89	1660				SW	SW	60021	0.1113
Cham_gr 78		78I/13	27°58'56"	90°46'15"	256102.01	405				NW	NW	67021	0.0063
Cham_gr 79		78I/13	27°58'40"	90°46'6"	172652.69	350				NW	NW	67021	0.0034
Cham_gr 80		78I/13	27°57'46"	90°45'53"	109696.46	290				NW	NW	75021	0.0018
Cham_gr 81		78I/13	27°56'60"	90°45'41"	328658.60	650				NW	NW	60021	0.0089
Cham_gr 82		78I/13	27°56'51"	90°45'16"	1042101.00	1255				W	W	60021	0.0442
Cham_gr 83		78I/9	27°55'47"	90°44'26"	489033.90	875	5370	5275	5180	NW	NW	60021	0.0155
Cham_gr 84		78I/9	27°55'30"	90°44'7"	381075.97	755	5340	5177.5	5015	NW	NW	60021	0.0108
Cham_gr 85		78I/9	27°54'40"	90°44'51"	271287.20	740	5340	5240	5140	SW	SW	60021	0.0066
Cham_gr 86		78I/9	27°54'42"	90°44'16"	142128.46	635	5280	5170	5060	SE	SE	75021	0.0025
Cham_gr 87		78I/9	27°55'1"	90°45'10"	330304.82	165	5340	5270	5200	SE	SE	60021	0.0089
Cham_gr 88		78I/13	27°55'2"	90°46'54"	553436.34	945				SW	SW	60021	0.0182
Cham_gr 89		78I/13	27°54'47"	90°46'49"	240916.82	375				NW	NW	67021	0.0056
Cham_gr 90		78I/13	27°54'32"	90°46'21"	358967.44	540				W	W	60021	0.0100
Cham_gr 91		78I/13	27°54'54"	90°46'6"	135035.88	550				SW	SW	62021	0.0025
Cham_gr 92		78I/13	27°53'54"	90°47'36"	503249.83	920				NE	NE	60021	0.0160
Cham_gr 93		78I/13	27°54'50"	90°47'1"	69371.86	240				SE	SE	75021	0.0009
Cham_gr 94		78I/13	27°54'27"	90°47'34"	3379020.27	2320				SE	SE	60021	0.2209

Glacier Inventory of Kuri Chu Basin

Total Number :51 Total Area : 87.62 (km²) Ice Reserve : 6.48 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	O
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
kuri_gr 1		78I/13	27°55'14"	90°47'14"	350465	900				N	N	63021	0.0096
kuri_gr 2		78I/13	27°55'55"	90°46'18"	229447	550				N	N	63021	0.0053
kuri_gr 3		78I/13	27°56'23"	90°46'23"	664804	950				SE	SE	60021	0.0235
kuri_gr 4		78I/13	27°56'31"	90°46'46"	955697	1700				NE	NE	60021	0.0396
kuri_gr 5		78I/13	27°58'38"	90°47'15"	161332	300				S	S	60021	0.0031
kuri_gr 6		78I/13	27°58'15"	90°47'21"	176638	700				NE	NE	63021	0.0037
kuri_gr 7		78M/1	27°52'22"	91°1'31"	963772	350	4280	4180	4080	NE	NE	60021	0.0396
kuri_gr 8		78M/1	27°53'36"	91°0'31"	397011	650	4680	4430	4180	SE	SE	67021	0.0116
kuri_gr 9		78M/1	27°53'25"	91°0'38"	130718	200	4680	4640	4600	NW	NW	67021	0.0023
kuri_gr 10		78M/1	28°0'45"	90°49'33"	5101023	6600	5765			SE	SE	52012	0.3847
kuri_gr 11		77P/8	28°1'25"	90°49'58"	1524130	1550	5400	5250	5100	S	S	60021	0.0745
kuri_gr 12		77P/8	28°2'30"	90°50'14"	1110718	900	5400	5200	5000	S	S	63021	0.0484
kuri_gr 13		77P/8	28°1'54"	90°51'60"	6001303	6150			4640	SE	SE	52021	0.4786
kuri_gr 14		77P/8	28°0'48"	91°5'2"	392106	1000	4610			N	N	60021	0.0112
kuri_gr 15		77P/8	28°2'52"	91°15'49"	114255	900				S	S	75021	0.0018
kuri_gr 16		77P/8	28°2'28"	91°18'11"	1702330	1250				W	W	60021	0.0868
kuri_gr 17		78M/5	27°58'22"	91°15'48"	814577	950				NE	NE	60021	0.0313
kuri_gr 18		78M/5	27°57'41"	91°15'20"	603763	950				W	W	60021	0.0206
kuri_gr 19		78M/5	27°56'6"	91°15'40"	602748	1000				NW	NW	60021	0.0206
kuri_gr 20		78M/5	27°54'11"	91°14'59"	379205	400	4530	4515	4500	SE	SE	60021	0.0108
kuri_gr 21		78M/5	27°56'10"	91°15'6"	286739	500	5010	4805	4600	SE	SE	60021	0.0074
kuri_gr 22		78M/5	27°56'32"	91°15'12"	115161	750				E	E	75021	0.0020
kuri_gr 23		78M/5	27°56'9"	91°15'21"	154568	600				SE	SE	67021	0.0028

A	B	C	D	E	F	G	H	I	J	K	L	M	O
kuri_gr 24		78M/5	27°58'19"	91°15'8"	859779	400				NE	NE	60021	0.0340
kuri_gr 25		78M/5	27°58'6"	91°16'40"	719034	650				E	E	52021	0.0266
kuri_gr 26		78M/5	27°59'51"	91°16'36"	667193	1500				NE	NE	60021	0.0240
kuri_gr 27		77P/8	28°1'49"	91°17'40"	239350	850				SE	SE	63021	0.0056
kuri_gr 28		77P/8	28°1'19"	91°18'33"	216905	1100				S	S	60021	0.0049
kuri_gr 29		77P/8	28°1'39"	91°18'10"	245582	450				SW	SW	60021	0.0059
kuri_gr 30		77P/8	27°59'12"	91°19'27"	101291	800				W	W	64021	0.0015
kuri_gr 31		77P/8	27°59'35"	91°19'28"	204691	350				NW	NW	60021	0.0043
kuri_gr 32		77P/8	27°56'37"	91°17'22"	38189	300				W	W	70022	0.0004
kuri_gr 33		77P/8	27°54'24"	91°17'60"	2358137	2150				NE	NE	52021	0.1358
kuri_gr 34		77P/8	27°56'53"	91°17'42"	166142	450				SE	SE	60021	0.0034
kuri_gr 35		77P/8	27°57'57"	91°17'9"	308262	400				SE	SE	60021	0.0081
kuri_gr 36		77P/8	27°59'20"	91°20'37"	2747791	1700				NE	NE	60021	0.1671
kuri_gr 37		77P/8	28°0'29"	91°19'46"	7397292	3450				SE	SE	61021	0.6340
kuri_gr 38		77P/8	28°2'36"	91°19'56"	12839940	4700				SE	SE	61021	1.3240
kuri_gr 39		77P/8	28°1'25"	91°21'34"	2255924	1800				SW	SW	60021	0.1280
kuri_gr 40		77P/8	28°0'29"	91°21'57"	124329	650				SW	SW	75021	0.0020
kuri_gr 41		77P/8	28°0'53"	91°21'51"	130952	250				SW	SW	75021	0.0023
kuri_gr 42		77P/8	28°1'25"	91°22'30"	6046880	2650				SE	SE	60021	0.4839
kuri_gr 43		77P/8	28°1'44"	91°23'39"	2235291	750				SW	SW	60021	0.1265
kuri_gr 44		77P/8	28°0'29"	91°24'48"	304592	650				SW	SW	60021	0.0077
kuri_gr 45		77P/8	28°0'56"	91°24'45"	1092928	1350				SE	SE	60021	0.0472
kuri_gr 46		77P/8	28°0'43"	91°25'47"	1710374	1400				SW	SW	60021	0.0875
kuri_gr 47		77P/8	28°0'23"	91°27'13"	2424659	1150				SW	SW	60021	0.1405
kuri_gr 48		78M/5	27°58'20"	91°28'59"	1897836	1350				SW	SW	60021	0.1011
kuri_gr 49		78M/5	27°56'39"	91°28'45"	13890009	2150				NW	NW	60021	1.4702
kuri_gr 50		78M/5	27°57'41"	91°25'33"	1571300	2150				NE	NE	60021	0.0779
kuri_gr 51		78M/5	27°57'5"	91°25'55"	1895993	2450				NE	NE	60021	0.1011

Glacier Inventory of Mangde Chu Basin

Total Number :140 Total Area :146.69 (km²) Ice Reserve : 11.92 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
mangd_gr 1		78I/5	27°49'55"	90°15'49"	678949	1590	5420	5230	5040	SW	SW	63021	0.0245
mangd_gr 2		78I/5	27°49'45"	90°16'16"	685226	988	5420	5250	5080	S	S	60021	0.0250
mangd_gr 3		78I/5	27°50'3"	90°16'30"	578560	1442	5478	5209	4940	SE	SE	63021	0.0196
mangd_gr 4		78I/5	27°50'28"	90°16'21"	113727	525	5360	5240	5120	E	E	63021	0.0018
mangd_gr 5		78I/5	27°50'36"	90°16'13"	129913	582	5320	5200	5080	N	N	63021	0.0023
mangd_gr 6		78I/5	27°54'21"	90°15'40"	546682	1087	5582	5411	5240	NE	NE	60021	0.0182
mangd_gr 7		78I/5	27°54'50"	90°17'11"	367614	1557	5710	5475	5240	SW	SW	60021	0.0104
mangd_gr 8		78I/5	27°54'36"	90°17'8"	555390	1503	5710	5455	5200	SW	SW	60021	0.0187
mangd_gr 9		78I/5	27°54'17"	90°17'13"	135159	500	5460	5410	5360	SE	SE	60021	0.0025
mangd_gr 10		78I/5	27°54'4"	90°18'12"	4280531	2741	5688	5344	5000	S	S	62021	0.3038
mangd_gr 11		78I/5	27°53'0"	90°18'53"	2524357	2135	5040	5180	5320	W	W	62021	0.1484
mangd_gr 12		78I/5	27°52'27"	90°18'29"	1161459	1747	5400	5220	5040	SW	SW	63021	0.0514
mangd_gr 13		78I/5	27°52'22"	90°19'16"	879956	1609	5560	5340	5120	SW	SW	63021	0.0351
mangd_gr 14		78I/5	27°52'0"	90°19'29"	439063	1046	5560	5380	5200	S	S	63021	0.0133
mangd_gr 15		78I/5	27°51'12"	90°19'38"	958267	1790	5480	5300	5120	SW	SW	63021	0.0396
mangd_gr 16		78I/5	27°50'43"	90°19'19"	187607	946	5320	5220	5120	W	W	63021	0.0040
mangd_gr 17		78I/5	27°49'43"	90°19'24"	244902	865	5200	5100	5000	NW	NW	37021	0.0056
mangd_gr 18		78I/5	27°49'29"	90°19'13"	186853	504	5450	5205	4960	NW	NW	37021	0.0040
mangd_gr 19		78I/5	27°49'10"	90°19'12"	269533	569	5450	5205	4960	NW	NW	37021	0.0066
mangd_gr 20		78I/5	27°48'52"	90°19'4"	278611	756	5260	5130	5000	SW	SW	37021	0.0070
mangd_gr 21		78I/5	27°48'51"	90°19'22"	210685	800	5320	5150	4980	S	S	37021	0.0046
mangd_gr 22		78I/5	27°49'22"	90°19'38"	854340	1869	5260	5170	5080	E	E	37021	0.0335
mangd_gr 23		78I/5	27°51'12"	90°20'20"	1004807	1449	5400	5235	5070	S	S	60021	0.0419
mangd_gr 24		78I/5	27°49'43"	90°22'40"	109558	490	5200	5110	5020	N	N	63021	0.0018
mangd_gr 25		78I/5	27°49'39"	90°22'16"	343490	1192	5400	5260	5120	NE	NE	37021	0.0092
mangd_gr 26		78I/5	27°50'53"	90°22'1"	134867	475	5240	5160	5080	N	N	65021	0.0023
mangd_gr 27		78I/5	27°51'12"	90°21'40"	177545	810	5160	5120	5080	N	N	60021	0.0037
mangd_gr 28		78I/5	27°51'17"	90°20'54"	131359	688	5280	5200	5120	E	E	63021	0.0023
mangd_gr 29		78I/5	27°51'34"	90°20'23"	754090	1452	5400	5220	5040	NE	NE	63021	0.0281

A	B	C	D	E	F	G	H	I	J	K	L	M	N
mangd_gr 30		78I/5	27°52'15"	90°20'10"	2191683	1635	5540	5310	5080	SE	SE	62021	0.1226
mangd_gr 31		78I/5	27°52'42"	90°20'57"	159960	546	5160	5090	5020	NE	NE	63021	0.0031
mangd_gr 32		78I/5	27°52'54"	90°21'17"	95850	445	5400	5300	5200	NE	NE	64021	0.0015
mangd_gr 33		78I/5	27°53'14"	90°21'7"	69187	439	5400	5330	5260	S	S	65021	0.0009
mangd_gr 34		78I/5	27°53'1"	90°20'51"	78911	465	5400	5300	5200	NW	NW	65021	0.0011
mangd_gr 35		78I/5	27°52'56"	90°20'34"	54741	406	5400	5300	5200	NW	NW	65021	0.0005
mangd_gr 36		78I/5	27°52'58"	90°19'39"	788230	1264	5400	5280	5160	NE	NE	60021	0.0302
mangd_gr 37		78I/5	27°53'54"	90°19'6"	1386991	2086	5688	5464	5240	SE	SE	60021	0.0659
mangd_gr 38		78I/5	27°54'16"	90°19'46"	282765	963	5400	5360	5320	SE	SE	60021	0.0070
mangd_gr 39		78I/5	27°54'38"	90°19'39"	131451	648	5440	5355	5270	NW	NW	65021	0.0023
mangd_gr 40		78I/5	27°54'46"	90°18'59"	2069371	2208	5480	5360	5240	NE	NE	60021	0.1136
mangd_gr 41		78I/5	27°55'6"	90°18'11"	946267	1762	5710	5565	5420	E	E	60021	0.0390
mangd_gr 42		78I/5	27°55'28"	90°17'47"	792922	1788	5710	5445	5180	N	N	63021	0.0302
mangd_gr 43		78I/5	27°56'0"	90°17'8"	331505	1886	5660	5530	5400	E	E	67021	0.0089
mangd_gr 44		78I/5	27°57'58"	90°17'37"	4075724	2613	5760	5540	5320	S	S	60021	0.2848
mangd_gr 45		78I/5	27°56'55"	90°18'22"	949959	1444	5649	5505	5360	SW	SW	60021	0.0390
mangd_gr 46		78I/5	27°57'23"	90°18'60"	2349274	2277	5649	5485	5320	SE	SE	63021	0.1350
mangd_gr 47		78I/5	27°56'49"	90°19'44"	35924	366	5560	5520	5480	SE	SE	79021	0.0004
mangd_gr 48		78I/5	27°57'8"	90°19'51"	43355	305	5572	5531	5490	SE	SE	65021	0.0004
mangd_gr 49		78I/5	27°57'16"	90°19'55"	75249	567	5572	5406	5240	NE	NE	65021	0.0011
mangd_gr 50		78I/5	27°57'56"	90°20'16"	63464	396	5480	5400	5320	NW	NW	65021	0.0007
mangd_gr 51		78I/5	27°57'54"	90°19'28"	1759974	1832	5868	5868	5868	NE	NE	60021	0.0910
mangd_gr 52		78I/5	27°58'17"	90°18'45"	95081	595	5868	5868	5868	E	E	67021	0.0015
mangd_gr 53		78I/5	27°58'54"	90°19'52"	96157	424	5440	5440	5440	N	N	65021	0.0015
mangd_gr 54		78I/5	27°58'46"	90°18'50"	2583959	3187	5868	5868	5868	NE	NE	63021	0.1532
mangd_gr 55		78I/5	27°59'51"	90°19'9"	1107827	1627	5583	5583	5583	NE	NE	60021	0.0484
mangd_gr 56		77L/8	28°0'33"	90°18'5"	676933	1251				S	S	60021	0.0245
mangd_gr 57		77L/8	28°0'55"	90°18'58"	1852178	2532				S	S	60021	0.0974
mangd_gr 58		77L/8	28°1'7"	90°20'6"	1492257	1838				S	S	60021	0.0725
mangd_gr 59		77L/8	28°0'5"	90°20'49"	78495	485				SW	SW	65021	0.0011
mangd_gr 60		77L/8	28°0'58"	90°20'27"	326459	1081				SE	SE	60021	0.0089
mangd_gr 61		77L/8	28°1'15"	90°20'49"	329366	1300				SE	SE	60021	0.0089
mangd_gr 62		77L/8	28°1'47"	90°20'59"	1652847	2316				E	E	60021	0.0834
mangd_gr 63		77L/8	28°2'24"	90°20'47"	2441231	2105				NE	NE	60021	0.1420
mangd_gr 64		77L/8	28°3'9"	90°21'11"	212377	1233				SW	SW	67021	0.0046
mangd_gr 65		77L/8	28°3'7"	90°22'27"	3931041	3371				S	S	60021	0.2708
mangd_gr 66		77L/8	28°2'6"	90°22'39"	129020	909				W	W	67021	0.0023
mangd_gr 67		77L/8	28°1'57"	90°22'48"	237917	940				E	E	67021	0.0056
mangd_gr 68		77L/8	28°2'30"	90°23'9"	733889	1422				S	S	60021	0.0271
mangd_gr 69		77L/8	28°2'52"	90°23'34"	2995390	3598				S	S	60021	0.1880
mangd_gr 70		77L/8	28°0'55"	90°23'26"	3589321	4180				NW	NW	60021	0.2397

A	B	C	D	E	F	G	H	I	J	K	L	M	N
mangd_gr 71		78I/5	27°59'17"	90°22'5"	206685	538	5440	5280	5120	W	W	64021	0.0046
mangd_gr 72		78I/5	27°58'57"	90°21'56"	179176	674	5560	5440	5320	W	W	63021	0.0037
mangd_gr 73		78I/5	27°59'31"	90°22'17"	41355	407	5600	5540	5480	S	S	37021	0.0004
mangd_gr 74		78I/5	27°59'47"	90°22'32"	421293	1334			5240	NE	NE	63021	0.0125
mangd_gr 75		78I/5	27°59'46"	90°23'23"	1635662	1874	5600	5424	5248	SW	SW	60021	0.0827
mangd_gr 76		78I/5	27°58'52"	90°23'41"	1653386	1817	5600	5420	5240	W	W	60021	0.0834
mangd_gr 77		78I/5	27°58'27"	90°23'15"	58541	295	5480	5430	5380	NW	NW	65021	0.0007
mangd_gr 78		78I/5	27°58'15"	90°23'9"	98234	459	5520	5440	5360	NW	NW	65021	0.0015
mangd_gr 79		78I/5	27°58'5"	90°22'57"	84603	372	5440	5380	5320	NW	NW	65021	0.0011
mangd_gr 80		78I/5	27°57'42"	90°22'41"	511927	903	5640	5460	5280	NW	NW	62021	0.0164
mangd_gr 81		78I/5	27°57'21"	90°22'32"	110758	530	5480	5400	5320	NW	NW	63021	0.0018
mangd_gr 82		78I/5	27°56'60"	90°22'27"	33340	276	5440	5400	5360	NW	NW	65021	0.0002
mangd_gr 83		78I/5	27°57'15"	90°22'59"	364137	1124	5880	5640	5400	SW	SW	63021	0.0100
mangd_gr 84		78I/5	27°57'15"	90°23'6"	232347	935	5880	5640	5400	SW	SW	63021	0.0053
mangd_gr 85		78I/5	27°56'44"	90°23'17"	400307	808	5686	5503	5320	W	W	63021	0.0116
mangd_gr 86		78I/5	27°56'18"	90°23'5"	393523	714	5500	5390	5280	NW	NW	63021	0.0112
mangd_gr 87		78I/5	27°55'59"	90°22'44"	58725	489	5380	5290	5200	W	W	65021	0.0007
mangd_gr 88		78I/5	27°55'59"	90°23'14"	298488	811	5480	5400	5320	S	S	63021	0.0077
mangd_gr 89		78I/5	27°55'47"	90°23'33"	45186	241	5440	5400	5360	W	W	37021	0.0005
mangd_gr 90		78I/5	27°55'33"	90°23'40"	42509	404	5440	5380	5320	SW	SW	67021	0.0004
mangd_gr 91		78I/5	27°54'46"	90°24'4"	175961	1195	5400	5340	5280	SW	SW	67021	0.0037
mangd_gr 92		78I/5	27°54'17"	90°24'18"	107727	437	5360	5280	5200	W	W	63021	0.0018
mangd_gr 93		78I/5	27°53'54"	90°24'34"	74218	420	5400	5280	5160	SW	SW	63021	0.0009
mangd_gr 94		78I/5	27°53'24"	90°24'51"	353413	1176	5240	5180	5120	SW	SW	60021	0.0096
mangd_gr 95		78I/5	27°52'20"	90°26'20"	257487	1126	5160	5000	4840	SE	SE	63021	0.0063
mangd_gr 96		78I/5	27°52'39"	90°25'56"	77572	551	4600	4550	4500	NE	NE	65021	0.0011
mangd_gr 97		78I/5	27°52'45"	90°27'13"	49817	400	5280	5160	5040	NW	NW	65021	0.0005
mangd_gr 98		78I/5	27°53'40"	90°25'6"	994130	1623	5400	5190	4980	NE	NE	62021	0.0413
mangd_gr 99		78I/5	27°54'16"	90°24'48"	556836	1124	5400	5240	5080	NE	NE	63021	0.0187
mangd_gr 100		78I/5	27°54'24"	90°24'26"	29586	293	5320	5260	5200	NE	NE	63021	0.0002
mangd_gr 101		78I/5	27°55'9"	90°24'11"	1368883	1859	5500	5330	5160	S	S	60021	0.0646
mangd_gr 102		78I/5	27°55'19"	90°24'49"	36878	268	5260	5250	5240	NE	NE	79021	0.0004
mangd_gr 103		78I/5	27°55'16"	90°25'7"	17124	182	5120	5080	5040	NE	NE	79021	0.0001
mangd_gr 104		78I/5	27°55'53"	90°23'60"	852540	1583	5600	5340	5080	NE	NE	63021	0.0335
mangd_gr 105		78I/5	27°56'17"	90°23'48"	1800422	2989	5640	5430	5220	SE	SE	60021	0.0939
mangd_gr 106		78I/5	27°56'53"	90°24'33"	979406	1516	5641	5461	5280	SE	SE	62021	0.0407
mangd_gr 107		78I/5	27°56'44"	90°25'3"	396000	945	5460	5370	5280	SW	SW	63021	0.0116
mangd_gr 108		78I/5	27°56'34"	90°25'16"	88311	386	5320	5265	5210	S	S	63021	0.0013
mangd_gr 109		78I/5	27°56'6"	90°25'59"	51340	327	5230	5205	5180	NE	NE	75021	0.0005
mangd_gr 110		78I/5	27°56'55"	90°25'19"	226255	663	5460	5350	5240	NE	NE	63021	0.0053
mangd_gr 111		78I/5	27°57'11"	90°25'15"	405354	954	5460	5345	5230	NE	NE	60021	0.0121

A	B	C	D	E	F	G	H	I	J	K	L	M	N
mangd_gr 112		78I/5	27°57'27"	90°24'46"	778429	1704	5600	5460	5320	NE	NE	60021	0.0297
mangd_gr 113		78I/5	27°58'0"	90°25'56"	699488	1790	5480	5315	5150	NE	NE	63021	0.0255
mangd_gr 114		78I/5	27°57'56"	90°25'24"	55525	486	5480	5380	5280	N	N	77021	0.0007
mangd_gr 115		78I/5	27°57'44"	90°23'60"	3971366	3369	5800	5510	5220	NE	NE	63021	0.2745
mangd_gr 116		78I/5	27°58'48"	90°24'26"	762290	1323	5560	5440	5320	SE	SE	63021	0.0286
mangd_gr 117		78I/5	27°59'24"	90°28'0"	44114224	10561	7600	6160	4720	S	S	52021	6.8102
mangd_gr 118		78I/5	27°59'58"	90°24'3"	3304694	3131			5230	SE	SE	60021	0.2139
mangd_gr 119		77L/8	28°0'12"	90°24'39"	151452	515				NE	NE	64021	0.0028
mangd_gr 120		77L/8	28°0'39"	90°24'9"	375014	836				NE	NE	63021	0.0108
mangd_gr 121		77L/8	28°1'18"	90°24'25"	861248	1374				E	E	63021	0.0340
mangd_gr 122		77L/8	28°1'44"	90°24'20"	374876	797				N	N	63021	0.0104
mangd_gr 123		77L/8	28°1'39"	90°26'34"	168653	640				SW	SW	63021	0.0034
mangd_gr 124		77L/8	28°1'6"	90°26'32"	3389667	3298	6580			SW	SW	60021	0.2218
mangd_gr 125		77L/8	28°0'50"	90°27'16"	1697434	2426				S	S	60021	0.0868
mangd_gr 126		77L/8	28°0'47"	90°27'56"	158591	524	5680	5540	5400	S	S	65021	0.0031
mangd_gr 127		77L/8	28°0'58"	90°29'44"	537513	1229				S	S	60021	0.0178
mangd_gr 128		78I/5	27°59'30"	90°29'40"	56771	436	5360	5300	5240	NW	NW	65021	0.0007
mangd_gr 129		78I/5	27°57'48"	90°29'29"	106773	486	5320	5235	5150	SW	SW	65021	0.0018
mangd_gr 130		78I/9	27°55'51"	90°31'7"	1326066	1628	5520	5305	5090	W	W	63021	0.0620
mangd_gr 131		78I/9	27°54'41"	90°30'38"	177991	769	5400	5255	5110	N	N	65021	0.0037
mangd_gr 132		78I/9	27°54'43"	90°30'12"	310366	862	5320	5235	5150	NW	NW	63021	0.0081
mangd_gr 133		78I/9	27°54'2"	90°30'39"	1123796	2358	5500	5250	5000	W	W	60021	0.0490
mangd_gr 134		78I/5	27°53'38"	90°29'44"	199638	880	5400	5205	5010	W	W	63021	0.0043
mangd_gr 135		78I/5	27°53'36"	90°30'14"	984514	1961	5400	5215	5030	SW	SW	63021	0.0407
mangd_gr 136		78I/9	27°53'30"	90°30'53"	231363	959	5160	5055	4950	SW	SW	63021	0.0053
mangd_gr 137		78I/9	27°53'58"	90°33'38"	2088618	2206	5566	5273	4980	S	S	62021	0.1151
mangd_gr 138		78I/9	27°50'8"	90°34'19"	101988	398	5280	5130	4980	NW	NW	65021	0.0015
mangd_gr 139		78I/9	27°49'50"	90°34'34"	451617	904	5360	5160	4960	SW	SW	63021	0.0137
mangd_gr 140		78I/9	27°49'32"	90°34'38"	123235	487	5220	5260	5300	SW	SW	65021	0.0020

Glacier Inventory of Chamkhar Chu Basin

Total Number : 94 Total Area : 104.10 (km²) Ice Reserve : 8.11(km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Cham_gr 1		78I/9	27°50'3"	90°35'7"	593360.93	580	5439	5269.5	5100	SE	SE	60021	0.0201
Cham_gr 2		78I/9	27°50'27"	90°35'42"	1062578.70	1780	5320	5130	4940	NE	NE	63021	0.0454
Cham_gr 3		78I/9	27°50'41"	90°34'22"	650286.17	1295	5260	5117.5	4975	NE	NE	63021	0.0230
Cham_gr 4		78I/9	27°54'16"	90°34'4"	339428.24	675	5280	5175	5070	NE	NE	63021	0.0092
Cham_gr 5		78I/9	27°54'11"	90°34'23"	99203.76	495	5140	5110	5080	NE	NE	63021	0.0015
Cham_gr 6		78I/9	27°54'48"	90°33'32"	263009.96	495	5360	5175	4990	NW	NW	60021	0.0063
Cham_gr 7		78I/9	27°54'18"	90°33'35"	412015.60	1155	5345	5157.5	4970	N	N	60021	0.0121
Cham_gr 8		78I/9	27°55'52"	90°31'27"	228131.72	575	5480	5290	5100	SE	SE	63021	0.0053
Cham_gr 9		78I/9	27°55'57"	90°31'45"	567944.59	1160	5480	5265	5050	NE	NE	63021	0.0192
Cham_gr 10		78I/9	27°56'42"	90°31'4"	175160.48	605	5230	5200	5170	NE	NE	63021	0.0037
Cham_gr 11		78I/9	27°56'25"	90°31'24"	60417.67	340	5400	5320	5240	N	N	75021	0.0007
Cham_gr 12		78I/9	27°56'57"	90°30'26"	154667.40	415	5420	5260	5100	NW	NW	75021	0.0028
Cham_gr 13		78I/9	27°58'2"	90°30'52"	46771.00	375	5360	5330	5300	SW	SW	75021	0.0005
Cham_gr 14		78I/9	27°59'54"	90°29'20"	201053.77	660	5400	5335	5270	NE	NE	63021	0.0043
Cham_gr 15		78I/9	27°59'26"	90°30'35"	2184267.34	2845	5445	5322.5	5200	SW	SW	62021	0.1219
Cham_gr 16		78I/9	27°59'12"	90°31'28"	217377.46	670	5480	5370	5260	SE	SE	63021	0.0049
Cham_gr 17		78I/9	27°59'19"	90°31'8"	513327.13	820	5400	5285	5170	SW	SW	62021	0.0164
Cham_gr 18		78I/9	27°58'20"	90°31'24"	346736.21	420	5430	5305	5180	W	W	60021	0.0096
Cham_gr 19		78I/9	27°58'50"	90°31'35"	485556.85	1250	5430	5355	5280	SE	SE	63021	0.0155
Cham_gr 20		78I/9	27°58'5"	90°32'58"	728058.34	2105	5440	5190	4940	NE	NE	63021	0.0271
Cham_gr 21		78I/9	27°59'45"	90°31'9"	108927.20	600	5460	5300	5140	NE	NE	63021	0.0018
Cham_gr 22		78I/9	27°59'43"	90°31'34"	433970.28	1150	5520	5340	5160	NE	NE	63021	0.0129
Cham_gr 23		78I/9	27°59'14"	90°31'52"	439355.10	1230	5440	5300	5160	SE	SE	63021	0.0133
Cham_gr 24		77L/12	28°1'12"	90°30'1"	761182.67	935	6200	5770	5340	SE	SE	60021	0.0286
Cham_gr 25		78I/9	27°59'51"	90°32'49"	26710211.54	8875	6000	5291	4582	SE	SE	52012	3.5054

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Cham_gr 26		77L/12	28°2'46"	90°33'22"	599884.26	1225	5800	5540	5280	SW	SW	60021	0.0206
Cham_gr 27		77L/12	28°2'19"	90°34'1"	1343973.97	1540	5800	5515	5230	SW	SW	60021	0.0627
Cham_gr 28		77L/12	28°1'40"	90°34'22"	762982.74	1450	5600	5450	5300	SW	SW	63021	0.0286
Cham_gr 29		77L/12	28°0'1"	90°35'55"	817154.02	1980	5780	5550	5320	SW	SW	60021	0.0318
Cham_gr 30		78I/9	27°59'44"	90°34'50"	214823.52	695	5400	5292.5	5185	NW	NW	63021	0.0046
Cham_gr 31		78I/9	27°59'33"	90°34'28"	296241.99	1030	5490	5355	5220	NW	NW	63021	0.0077
Cham_gr 32		78I/9	27°59'21"	90°34'5"	104665.50	405	5400	5330	5260	NW	NW	63021	0.0015
Cham_gr 33		78I/9	27°59'55"	90°34'29"	213961.95	690	5500	5405	5310	NE	NE	75021	0.0046
Cham_gr 34		78I/9	28°0'12"	90°35'9"	174745.08	495	5320	5250	5180	NE	NE	60021	0.0034
Cham_gr 35		77L/12	28°1'25"	90°35'5"	200438.36	600	5540	5450	5360	SE	SE	63021	0.0043
Cham_gr 36		77L/12	28°1'42"	90°35'8"	181514.57	815	5540	5430	5320	SE	SE	63021	0.0037
Cham_gr 37		78I/9	27°59'47"	90°36'44"	359767.47	840	5455	5342.5	5230	NW	NW	63021	0.0100
Cham_gr 38		78I/9	27°59'43"	90°36'15"	1067348.11	1180	5525	5367.5	5210	W	W	60021	0.0460
Cham_gr 39		78I/9	27°57'40"	90°35'29"	670440.77	805	5550	5365	5180	W	W	60021	0.0240
Cham_gr 40		78I/9	27°58'58"	90°36'54"	759228.75	985	5430	5250	5070	SW	SW	63021	0.0286
Cham_gr 41		78I/9	27°58'31"	90°37'42"	823431.18	1270	5430	5265	5100	SW	SW	60021	0.0318
Cham_gr 42		78I/9	27°58'2"	90°39'0"	170252.60	695	5290	5235	5180	NE	NE	75022	0.0034
Cham_gr 43		78I/9	27°58'5"	90°39'19"	75033.61	475	5235	5162.5	5090	NW	NW	63021	0.0011
Cham_gr 44		78I/9	27°58'18"	90°38'54"	178514.45	580	5480	5285	5090	NW	NW	63021	0.0037
Cham_gr 45		78I/9	27°58'3"	90°38'58"	278995.18	1135	5350	5165	4980	NE	NE	75021	0.0070
Cham_gr 46		78I/9	27°59'46"	90°37'9"	115250.52	540	5300	5210	5120	NE	NE	75021	0.0020
Cham_gr 47		78I/9	27°59'23"	90°37'19"	448832.38	960	5310	5205	5100	NE	NE	60021	0.0137
Cham_gr 48		78I/9	27°59'7"	90°37'45"	188330.21	670	5380	5320	5260	NE	NE	63021	0.0040
Cham_gr 49		78I/9	28°0'58"	90°36'1"	198438.28	435	5500	5350	5200	NE	NE	77021	0.0043
Cham_gr 50		77L/12	28°0'56"	90°36'52"	5793296.32	5805	5800	5385	4970	SE	SE	60021	0.4562
Cham_gr 51		77L/12	28°0'29"	90°39'58"	182376.14	765	5460	5330	5200	NE	NE	75021	0.0037
Cham_gr 52		77L/12	28°0'12"	90°39'45"	134943.57	615	5420	5260	5100	NE	NE	75021	0.0023
Cham_gr 53		77L/12	28°1'27"	90°38'7"	508757.73	915	5445	5352.5	5260	NE	NE	60021	0.0164
Cham_gr 54		77L/12	28°1'53"	90°37'11"	157298.26	590	5450	5395	5340	NE	NE	75021	0.0031
Cham_gr 55		77L/12	28°1'41"	90°37'28"	31031.94	250	5550	5477.5	5405	N	N	75021	0.0002
Cham_gr 56		77L/12	28°1'28"	90°37'24"	89480.31	580	5430	5360	5290	NW	NW	75021	0.0013
Cham_gr 57		77L/12	28°2'42"	90°36'8"	721365.78	1125	5710	5515	5320	SE	SE	60021	0.0266
Cham_gr 58		77L/12	28°2'33"	90°37'41"	219854.48	670	5620	5430	5240	SW	SW	75021	0.0049
Cham_gr 59		77L/12	28°2'4"	90°39'43"	550143.91	690	5240	5075	4910	NE	NE	60021	0.0182
Cham_gr 60		77L/12	28°3'57"	90°40'45"	2943911.49	2545	5760	5410	5060	SE	SE	62031	0.1829
Cham_gr 61		77L/12	28°2'40"	90°41'38"	5949656.09	4570	5960	5450	4940	SW	SW	63021	0.4732
Cham_gr 62		77L/12	28°2'27"	90°42'36"	487572.31	665	5560	5380	5200	E	E	60021	0.0155

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Cham_gr 63		77L/12	28°3'25"	90°42'17"	171806.51	390	5845	5682.5	5520	SE	SE	60021	0.0034
Cham_gr 64		77L/12	28°3'40"	90°42'29"	380445.18	545	5845	5622.5	5400	SW	SW	60021	0.0108
Cham_gr 65		77L/12	28°3'52"	90°42'19"	281087.57	475	5480	5400	5320	SE	SE	60021	0.0070
Cham_gr 66		77L/12	28°3'19"	90°43'26"	2689563.39	2500	5500	5327.5	5155	SE	SE	62021	0.1622
Cham_gr 67		77L/12	28°3'10"	90°44'15"	533127.88	970	6000	5640	5280	SW	SW	60021	0.0173
Cham_gr 68		77L/12	28°2'55"	90°43'48"	1189198.88	945	6085	5642.5	5200	NW	NW	60021	0.0532
Cham_gr 69		77L/12	28°2'7"	90°44'24"	319981.35	465	5660	5460	5260	SW	SW	60021	0.0085
Cham_gr 70		77L/12	28°2'19"	90°44'9"	255271.21	555	5950	5605	5260	SE	SE	60021	0.0063
Cham_gr 71		77L/12	28°1'4"	90°44'25"	12454779.37	7985	6200	5500	4800	SW	SW	52012	1.2707
Cham_gr 72		77L/12	28°0'57"	90°43'30"	1723096.02	605	5560	5385	5210	NW	NW	67021	0.0882
Cham_gr 73		78I/9	27°59'44"	90°43'52"	605053.68	1390	5400	5135	4870	S	S	63021	0.0211
Cham_gr 74		78I/9	28°0'28"	90°44'0"	810738.40	1120	5400	5255	5110	SE	SE	63021	0.0313
Cham_gr 75		78I/13	28°1'9"	90°47'48"	5823728.24	5775				SW	SW	52012	0.4594
Cham_gr 76		78I/13	28°1'21"	90°46'52"	287410.88	880				SE	SE	63021	0.0074
Cham_gr 77		78I/13	28°2'43"	90°48'5"	2044415.89	1660				SW	SW	60021	0.1113
Cham_gr 78		78I/13	27°58'56"	90°46'15"	256102.01	405				NW	NW	67021	0.0063
Cham_gr 79		78I/13	27°58'40"	90°46'6"	172652.69	350				NW	NW	67021	0.0034
Cham_gr 80		78I/13	27°57'46"	90°45'53"	109696.46	290				NW	NW	75021	0.0018
Cham_gr 81		78I/13	27°56'60"	90°45'41"	328658.60	650				NW	NW	60021	0.0089
Cham_gr 82		78I/13	27°56'51"	90°45'16"	1042101.00	1255				W	W	60021	0.0442
Cham_gr 83		78I/9	27°55'47"	90°44'26"	489033.90	875	5370	5275	5180	NW	NW	60021	0.0155
Cham_gr 84		78I/9	27°55'30"	90°44'7"	381075.97	755	5340	5177.5	5015	NW	NW	60021	0.0108
Cham_gr 85		78I/9	27°54'40"	90°44'51"	271287.20	740	5340	5240	5140	SW	SW	60021	0.0066
Cham_gr 86		78I/9	27°54'42"	90°44'16"	142128.46	635	5280	5170	5060	SE	SE	75021	0.0025
Cham_gr 87		78I/9	27°55'1"	90°45'10"	330304.82	165	5340	5270	5200	SE	SE	60021	0.0089
Cham_gr 88		78I/13	27°55'2"	90°46'54"	553436.34	945				SW	SW	60021	0.0182
Cham_gr 89		78I/13	27°54'47"	90°46'49"	240916.82	375				NW	NW	67021	0.0056
Cham_gr 90		78I/13	27°54'32"	90°46'21"	358967.44	540				W	W	60021	0.0100
Cham_gr 91		78I/13	27°54'54"	90°46'6"	135035.88	550				SW	SW	62021	0.0025
Cham_gr 92		78I/13	27°53'54"	90°47'36"	503249.83	920				NE	NE	60021	0.0160
Cham_gr 93		78I/13	27°54'50"	90°47'1"	69371.86	240				SE	SE	75021	0.0009
Cham_gr 94		78I/13	27°54'27"	90°47'34"	3379020.27	2320				SE	SE	60021	0.2209

Glacier Inventory of Kuri Chu Basin

Total Number :51 Total Area : 87.62 (km²) Ice Reserve : 6.48 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	O
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
kuri_gr 1		78I/13	27°55'14"	90°47'14"	350465	900				N	N	63021	0.0096
kuri_gr 2		78I/13	27°55'55"	90°46'18"	229447	550				N	N	63021	0.0053
kuri_gr 3		78I/13	27°56'23"	90°46'23"	664804	950				SE	SE	60021	0.0235
kuri_gr 4		78I/13	27°56'31"	90°46'46"	955697	1700				NE	NE	60021	0.0396
kuri_gr 5		78I/13	27°58'38"	90°47'15"	161332	300				S	S	60021	0.0031
kuri_gr 6		78I/13	27°58'15"	90°47'21"	176638	700				NE	NE	63021	0.0037
kuri_gr 7		78M/1	27°52'22"	91°1'31"	963772	350	4280	4180	4080	NE	NE	60021	0.0396
kuri_gr 8		78M/1	27°53'36"	91°0'31"	397011	650	4680	4430	4180	SE	SE	67021	0.0116
kuri_gr 9		78M/1	27°53'25"	91°0'38"	130718	200	4680	4640	4600	NW	NW	67021	0.0023
kuri_gr 10		78M/1	28°0'45"	90°49'33"	5101023	6600	5765			SE	SE	52012	0.3847
kuri_gr 11		77P/8	28°1'25"	90°49'58"	1524130	1550	5400	5250	5100	S	S	60021	0.0745
kuri_gr 12		77P/8	28°2'30"	90°50'14"	1110718	900	5400	5200	5000	S	S	63021	0.0484
kuri_gr 13		77P/8	28°1'54"	90°51'60"	6001303	6150			4640	SE	SE	52021	0.4786
kuri_gr 14		77P/8	28°0'48"	91°5'2"	392106	1000	4610			N	N	60021	0.0112
kuri_gr 15		77P/8	28°2'52"	91°15'49"	114255	900				S	S	75021	0.0018
kuri_gr 16		77P/8	28°2'28"	91°18'11"	1702330	1250				W	W	60021	0.0868
kuri_gr 17		78M/5	27°58'22"	91°15'48"	814577	950				NE	NE	60021	0.0313
kuri_gr 18		78M/5	27°57'41"	91°15'20"	603763	950				W	W	60021	0.0206
kuri_gr 19		78M/5	27°56'6"	91°15'40"	602748	1000				NW	NW	60021	0.0206
kuri_gr 20		78M/5	27°54'11"	91°14'59"	379205	400	4530	4515	4500	SE	SE	60021	0.0108
kuri_gr 21		78M/5	27°56'10"	91°15'6"	286739	500	5010	4805	4600	SE	SE	60021	0.0074
kuri_gr 22		78M/5	27°56'32"	91°15'12"	115161	750				E	E	75021	0.0020
kuri_gr 23		78M/5	27°56'9"	91°15'21"	154568	600				SE	SE	67021	0.0028

A	B	C	D	E	F	G	H	I	J	K	L	M	O
kuri_gr 24		78M/5	27°58'19"	91°15'8"	859779	400				NE	NE	60021	0.0340
kuri_gr 25		78M/5	27°58'6"	91°16'40"	719034	650				E	E	52021	0.0266
kuri_gr 26		78M/5	27°59'51"	91°16'36"	667193	1500				NE	NE	60021	0.0240
kuri_gr 27		77P/8	28°1'49"	91°17'40"	239350	850				SE	SE	63021	0.0056
kuri_gr 28		77P/8	28°1'19"	91°18'33"	216905	1100				S	S	60021	0.0049
kuri_gr 29		77P/8	28°1'39"	91°18'10"	245582	450				SW	SW	60021	0.0059
kuri_gr 30		77P/8	27°59'12"	91°19'27"	101291	800				W	W	64021	0.0015
kuri_gr 31		77P/8	27°59'35"	91°19'28"	204691	350				NW	NW	60021	0.0043
kuri_gr 32		77P/8	27°56'37"	91°17'22"	38189	300				W	W	70022	0.0004
kuri_gr 33		77P/8	27°54'24"	91°17'60"	2358137	2150				NE	NE	52021	0.1358
kuri_gr 34		77P/8	27°56'53"	91°17'42"	166142	450				SE	SE	60021	0.0034
kuri_gr 35		77P/8	27°57'57"	91°17'9"	308262	400				SE	SE	60021	0.0081
kuri_gr 36		77P/8	27°59'20"	91°20'37"	2747791	1700				NE	NE	60021	0.1671
kuri_gr 37		77P/8	28°0'29"	91°19'46"	7397292	3450				SE	SE	61021	0.6340
kuri_gr 38		77P/8	28°2'36"	91°19'56"	12839940	4700				SE	SE	61021	1.3240
kuri_gr 39		77P/8	28°1'25"	91°21'34"	2255924	1800				SW	SW	60021	0.1280
kuri_gr 40		77P/8	28°0'29"	91°21'57"	124329	650				SW	SW	75021	0.0020
kuri_gr 41		77P/8	28°0'53"	91°21'51"	130952	250				SW	SW	75021	0.0023
kuri_gr 42		77P/8	28°1'25"	91°22'30"	6046880	2650				SE	SE	60021	0.4839
kuri_gr 43		77P/8	28°1'44"	91°23'39"	2235291	750				SW	SW	60021	0.1265
kuri_gr 44		77P/8	28°0'29"	91°24'48"	304592	650				SW	SW	60021	0.0077
kuri_gr 45		77P/8	28°0'56"	91°24'45"	1092928	1350				SE	SE	60021	0.0472
kuri_gr 46		77P/8	28°0'43"	91°25'47"	1710374	1400				SW	SW	60021	0.0875
kuri_gr 47		77P/8	28°0'23"	91°27'13"	2424659	1150				SW	SW	60021	0.1405
kuri_gr 48		78M/5	27°58'20"	91°28'59"	1897836	1350				SW	SW	60021	0.1011
kuri_gr 49		78M/5	27°56'39"	91°28'45"	13890009	2150				NW	NW	60021	1.4702
kuri_gr 50		78M/5	27°57'41"	91°25'33"	1571300	2150				NE	NE	60021	0.0779
kuri_gr 51		78M/5	27°57'5"	91°25'55"	1895993	2450				NE	NE	60021	0.1011

Glacier Inventory of Dangme Chu Basin

Total Number :25 Total Area :38.54 (km²) Ice Reserve : 2.26 (km³)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Total Area (m2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Reserve of Ice (Km3)
Dangm_Gr 1		78M/5	27°51'50"	91°22'24"	3994007	2139				E	E	60021	0.2764
Dangm_Gr 2		78M/5	27°52'9"	91°23'25"	3035561	1832				E	E	60021	0.1914
Dangm_Gr 3		78M/5	27°52'12"	91°23'59"	578991	760				E	E	60021	0.0196
Dangm_Gr 4		78M/5	27°53'9"	91°23'30"	804612	1477				E	E	60021	0.0308
Dangm_Gr 5		78M/5	27°54'8"	91°23'5"	404618	1089				E	E	60021	0.0116
Dangm_Gr 6		78M/5	27°54'16"	91°23'32"	902732	1398				E	E	60021	0.0362
Dangm_Gr 7		78M/5	27°55'8"	91°23'11"	2026586	1856				E	E	60021	0.1106
Dangm_Gr 8		78M/5	27°56'26"	91°23'13"	1214540	1100				E	E	60021	0.0545
Dangm_Gr 9		78M/5	27°57'21"	91°23'0"	2528403	2200				E	E	60021	0.1492
Dangm_Gr 10		78M/5	27°57'6"	91°24'47"	204269	473				SW	SW	60021	0.0043
Dangm_Gr 11		78M/5	27°57'16"	91°24'28"	641546	925				SW	SW	60021	0.0225
Dangm_Gr 12		78M/5	27°57'57"	91°24'13"	1828987	1840				SW	SW	60021	0.0960
Dangm_Gr 13		78M/5	27°56'23"	91°25'52"	109741	757				SE	SE	75021	0.0018
Dangm_Gr 14		78M/5	27°57'37"	91°25'1"	114114	580				SE	SE	76021	0.0018
Dangm_Gr 15		78M/5	27°56'3"	91°26'55"	505940	1362				SW	SW	63021	0.0164
Dangm_Gr 16		78M/5	27°56'27"	91°26'39"	1107391	1380				SW	SW	60321	0.0484
Dangm_Gr 17		78M/5	27°55'21"	91°27'42"	5596061	4306				SW	SW	60021	0.4362
Dangm_Gr 18		78M/5	27°55'30"	91°27'2"	726343	1580				SW	SW	60021	0.0271
Dangm_Gr 19		78M/5	27°54'29"	91°28'50"	3944728	4433				SW	SW	60021	0.2717
Dangm_Gr 20		78M/5	27°53'6"	91°28'44"	493148	1568				SE	SE	60021	0.0155
Dangm_Gr 21		78M/5	27°53'7"	91°29'56"	654698	2096				E	E	60021	0.0230
Dangm_Gr 22		78M/5	27°54'7"	91°29'31"	978001	1506				NE	NE	60021	0.0407
Dangm_Gr 23		78M/5	27°55'3"	91°29'5"	879381	982				E	E	60021	0.0351
Dangm_Gr 24		78M/5	27°55'17"	91°29'57"	4035054	2382				SE	SE	60021	0.2811
Dangm_Gr 25		78M/5	27°55'32"	91°30'59"	1236782	1658				SE	SE	60021	0.0563

Glacier Inventory of Northern Basin

Total Number : 59 Total Area : 387.73 (km^2) Ice Reserve : 51.72 (km^3)

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Glacier Number	Glacier Name	Map Code 60	Latitude	Longitude	Area (m^2)	Mean Length (m)	Elevation Heighest (m)	Elevation Mean (m)	Elevation Tongue (m)	Orientation Accumulation	Orientation Ablation	Classification	Thickness (m)	Reserve of Ice (Km^3)
Out_gr 1		77L/8	28°9'7"	90°29'4"	9087946	4990	*	*	*	SE	SE	52012	91.85	0.8349
Out_gr 2		77L/8	28°9'40"	90°29'44"	1002352	910	*	*	*	E	E	53012	41.89	0.0419
Out_gr 3		77L/8	28°10'46"	90°28'20"	3689633	2935	*	*	*	NW	NW	52012	67.40	0.2487
Out_gr 4		77L/8	28°6'31"	90°29'9"	11276592	9360	*	*	*	NW	NW	51012	98.75	1.1139
Out_gr 5		77L/8	28°6'48"	90°26'10"	5364072	3235	*	*	*	NE	NE	63021	76.73	0.4113
Out_gr 6		77L/8	28°7'54"	90°26'7"	195530	425	*	*	*	NE	NE	64021	21.51	0.0043
Out_gr 7		77L/8	28°6'43"	90°25'31"	4061357	4790	*	*	*	NE	NE	53022	69.69	0.283
Out_gr 8		77L/8	28°7'24"	90°25'41"	1809716	2825	*	*	*	NE	NE	67021	52.26	0.0946
Out_gr 9		77L/8	28°7'48"	90°23'13"	716656	1180	*	*	*	N	N	67021	36.90	0.0266
Out_gr 10		77L/8	28°6'47"	90°23'53"	257960	935	*	*	*	SW	SW	67021	24.20	0.0063
Out_gr 11		77L/8	28°6'2"	90°24'50"	121909	290	*	*	*	SE	SE	67021	16.85	0.002
Out_gr 12		77L/8	28°6'33"	90°24'56"	173277	565	*	*	*	SW	SW	75021	19.95	0.0034
Out_gr 13		77L/8	28°7'58"	90°21'28"	48137361	9840	*	*	*	NE	NE	51012	158.80	7.6444
Out_gr 14		77L/8	28°5'38"	90°24'49"	176312	375	*	*	*	SW	SW	67021	20.49	0.0037
Out_gr 15		77L/8	28°5'8"	90°25'53"	294479	445	*	*	*	SE	SE	67021	25.38	0.0074
Out_gr 16		77L/8	28°5'26"	90°25'26"	191958	675	*	*	*	SW	SW	64021	21.01	0.004
Out_gr 17		77L/8	28°5'17"	90°26'8"	2569363	1790	*	*	*	W	W	67021	59.31	0.1524
Out_gr 18		77L/8	28°9'38"	90°21'7"	1713248	1695	*	*	*	SE	SE	60021	51.18	0.0875
Out_gr 19		77L/8	28°9'54"	90°21'41"	909315	1545	*	*	*	SE	SE	67021	40.41	0.0368
Out_gr 20		77L/8	28°9'21"	90°22'54"	2207723	2005	*	*	*	SE	SE	60021	56.18	0.1242
Out_gr 21		77L/8	28°11'38"	90°24'35"	946202	555	*	*	*	E	E	37021	41.08	0.039
Out_gr 22		77L/8	28°11'42"	90°22'28"	9867591	6855	*	*	*	NE	NE	52022	94.43	0.932
Out_gr 23		77L/8	28°11'5"	90°21'9"	1300392	750	*	*	*	NW	NW	37021	46.25	0.0601
Out_gr 24		77L/8	28°14'39"	90°18'33"	6325834	2090	*	*	*	NW	NW	53012	81.24	0.5142
Out_gr 25		77L/8	28°13'20"	90°17'39"	2954047	2725	*	*	*	NW	NW	63021	62.29	0.1838
Out_gr 26		77L/8	28°12'15"	90°18'55"	11917021	6570	*	*	*	W	W	63012	100.59	1.1991
Out_gr 27		77L/8	28°14'28"	90°14'3"	99766333	12710	*	*	*	NW	NW	51012	200.37	19.9906
Out_gr 28		77L/4	28°12'48"	90°13'27"	1229252	1715	*	*	*	NE	NE	67021	45.30	0.0557

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Out_gr 29		77L/4	28°11'33"	90°13'56"	242422	440	*	*	*	S	S	67021	23.36	0.0056
Out_gr 30		77L/4	28°11'48"	90°11'51"	445300	305	*	*	*	E	E	67021	30.56	0.0137
Out_gr 31		77L/4	28°13'57"	90°11'53"	5198097	4440	*	*	*	N	N	60021	75.94	0.3949
Out_gr 32		77L/4	28°13'41"	90°10'14"	13126309	8070	*	*	*	NE	NE	53021	103.89	1.364
Out_gr 33		77L/4	28°12'21"	90°8'43"	20822155	3560	*	*	*	NE	NE	60021	120.97	2.5187
Out_gr 34		77L/4	28°11'24"	90°6'2"	27604531	8585	*	*	*	N	N	52012	132.65	3.6611
Out_gr 35		77L/4	28°11'7"	90°5'20"	133784	200	*	*	*	SE	SE	67021	17.53	0.0023
Out_gr 36		77L/4	28°11'3"	90°5'30"	260289	635	*	*	*	NE	NE	67021	24.20	0.0063
Out_gr 37		77L/4	28°11'56"	90°4'54"	86119	530	*	*	*	NE	NE	75021	14.52	0.0013
Out_gr 38		77L/4	28°10'19"	90°4'48"	2287680	3620	*	*	*	NE	NE	53022	56.91	0.1303
Out_gr 39		77L/4	28°11'46"	90°3'48"	315534	540	*	*	*	N	N	67021	26.48	0.0085
Out_gr 40		77L/4	28°11'41"	90°3'32"	204619	285	*	*	*	SW	SW	67021	21.51	0.0043
Out_gr 41		77L/4	28°10'42"	90°3'25"	588450	595	*	*	*	SW	SW	67021	34.10	0.0201
Out_gr 42		77L/4	28°12'33"	90°2'26"	32930846	10990	*	*	*	NE	NE	52012	140.48	4.626
Out_gr 43		77L/4	28°13'56"	90°1'19"	312448	500	*	*	*	SE	SE	67021	26.13	0.0081
Out_gr 44		77L/4	28°13'53"	90°1'34"	303614	380	*	*	*	NW	NW	67021	25.76	0.0077
Out_gr 45		77L/4	28°13'13"	90°1'12"	883467	1125	*	*	*	NW	NW	67021	39.89	0.0351
Out_gr 46		77L/4	28°12'35"	89°59'4"	14144131	8550	*	*	*	NW	NW	53012	106.48	1.5056
Out_gr 47		77H/16	28°13'45"	89°59'54"	233107	860	*	*	*	NE	NE	67021	22.92	0.0053
Out_gr 48		77H/16	28°13'22"	89°59'14"	855465	1070	*	*	*	NW	NW	67021	39.54	0.034
Out_gr 49		77H/16	28°12'17"	89°58'27"	7898905	6400	*	*	*	NE	NE	53012	87.60	0.692
Out_gr 50		77H/16	28°12'11"	89°57'49"	5128597	6070	*	*	*	NE	NE	53012	75.58	0.3877
Out_gr 51		77H/16	28°12'27"	89°56'55"	1639881	3270	*	*	*	NE	NE	53012	50.40	0.0827
Out_gr 52		77H/16	28°14'14"	89°56'0"	154511	765	*	*	*	NE	NE	64021	18.80	0.0028
Out_gr 53		77H/16	28°12'56"	89°55'57"	1918607	3930	*	*	*	NW	NW	53012	53.39	0.1025
Out_gr 54		77H/16	28°12'10"	89°55'53"	903182	1235	*	*	*	NW	NW	67021	40.23	0.0362
Out_gr 55		77H/16	28°12'60"	89°54'20"	213702	860	*	*	*	SW	SW	75021	22.00	0.0046
Out_gr 56		77H/16	28°12'23"	89°55'30"	238827	460	*	*	*	S	S	67021	23.36	0.0056
Out_gr 57		77H/16	28°11'40"	89°54'36"	14575521	9025	*	*	*	NW	NW	63021	107.56	1.5683
Out_gr 58		77H/16	28°14'24"	89°51'5"	1612134	1270	*	*	*	N	N	60021	50.06	0.0806
Out_gr 59		77H/16	28°14'16"	89°50'11"	4207327	1795	*	*	*	NE	NE	60021	70.58	0.2971

Annex 2
Database of Glacial Lake Inventory

Glacial Lake Inventory of Amo Chu Basin

Total Number :71   Total Area : 1.83 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Amo_gl 1		78E/4	27°0'35"	89°6'28"	11725	190			2280	NE	Cs	E
Amo_gl 2	Jethi Pokhari	78E/4	27°4'14"	89°5'34"	12034	140			3200	NE	Cs	E
Amo_gl 3		78E/4	27°4'50"	89°4'42"	5777	110			3320	NE	Cs	E
Amo_gl 4	Kanchi Pokhari	78E/4	27°5'49"	89°4'13"	12279	200			3180	NW	Ds	E
Amo_gl 5	Maili Pokhari	78E/4	27°4'43"	89°4'37"	10243	150			3120	NW	Cs	E
Amo_gl 6		78A/15	27°16'56"	88°56'24"	119801	750				N	Ds	V
Amo_gl 7		78A/15	27°16'2"	88°55'37"	12499	170				N	Ds	V
Amo_gl 8		78A/15	27°16'0"	88°55'48"	13834	210				W	Ds	V
Amo_gl 9		78A/15	27°18'23"	88°55'24"	10512	140				SE	Ds	E
Amo_gl 10		78A/15	27°19'15"	88°56'17"	24193	250				SE	Ds	E
Amo_gl 11		78A/15	27°19'38"	88°56'10"	61615	310				SE	Ds	E
Amo_gl 12		78E/2	27°32'50"	89°0'32"	3744	90			4200	NW	Cs	E
Amo_gl 13		78E/2	27°31'52"	89°4'33"	4442	90			4556	W	Ds	V
Amo_gl 14		78E/2	27°31'48"	89°4'18"	2437	60			4590	NW	Cs	E
Amo_gl 15		78E/2	27°31'44"	89°4'15"	1531	70			4590	NW	Ds	E
Amo_gl 16		78E/2	27°31'57"	89°3'21"	3352	100			4480	NW	Cs	E
Amo_gl 17		78E/2	27°30'54"	89°4'19"	243538	1010			4144	W	Ds	V
Amo_gl 18		78E/2	27°30'35"	89°5'30"	86304	500			4400	SW	Ds	V
Amo_gl 19		78E/2	27°30'46"	89°5'50"	7938	140			4520	S	Cs	E
Amo_gl 20		78E/2	27°30'36"	89°5'54"	35839	320			4520	S	Cs	E
Amo_gl 21		78E/2	27°30'22"	89°6'58"	48754	280			4630	SW	Cs	E
Amo_gl 22		78E/2	27°30'4"	89°6'36"	9842	170			4520	SW	Cs	E
Amo_gl 23		78E/2	27°30'19"	89°6'37"	19093	230			4560	W	Cs	E
Amo_gl 24		78E/3	27°29'6"	89°4'54"	126664	660			4120	NW	Ds	C
Amo_gl 25		78E/3	27°29'45"	89°3'7"	13461	180			4320	SW	Cs	E
Amo_gl 26		78E/3	27°29'43"	89°5'18"	7029	130			4320	SE	Ds	E
Amo_gl 27		78E/3	27°29'56"	89°5'16"	4613	90			4315	SW	Ds	V
Amo_gl 28		78E/3	27°29'43"	89°5'51"	92696	450			4560	SE	Ds	C
Amo_gl 29		78E/3	27°28'24"	89°4'3"	44015	290			4285	N	Ds	C
Amo_gl 30		78E/3	27°28'29"	89°2'27"	12695	160			4120	NW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Amo_gl 31		78E/3	27°27'7"	89°3'48"	13366	190			4160	SW	Ds	V
Amo_gl 32		78E/3	27°27'47"	89°3'39"	11700	130			4200	SW	Cs	E
Amo_gl 33		78E/3	27°27'52"	89°3'41"	8578	180			4210	SW	Cs	E
Amo_gl 34		78E/3	27°27'54"	89°5'52"	6790	100			4320	SW	Ds	V
Amo_gl 35		78E/3	27°27'18"	89°6'25"	4623	75			4280	S	Cs	E
Amo_gl 36		78E/3	27°27'32"	89°6'33"	13252	145			4280	SW	Ds	V
Amo_gl 37		78E/3	27°27'38"	89°6'45"	22791	190			4360	SW	Ds	V
Amo_gl 38		78E/3	27°25'53"	89°5'30"	10396	160			4080	NW	Cs	E
Amo_gl 39		78E/3	27°25'42"	89°4'27"	105309	610			3925	NW	Ds	V
Amo_gl 40		78E/3	27°23'9"	89°3'14"	13127	130			4080	NW	Ds	V
Amo_gl 41		78E/3	27°24'19"	89°5'6"	4552	95			4160	SW	Cs	E
Amo_gl 42		78E/3	27°24'19"	89°6'57"	40210	305			4162	SE	Ds	E
Amo_gl 43		78E/3	27°25'11"	89°7'41"	36013	220			4150	SW	Cs	E
Amo_gl 44		78E/3	27°25'26"	89°8'42"	6530	65			4080	SW	Cs	E
Amo_gl 45		78E/3	27°25'50"	89°8'17"	8716	105			4160	SW	Ds	E
Amo_gl 46		78E/3	27°24'6"	89°9'59"	4626	90			4160	SW	Ds	E
Amo_gl 47		78E/3	27°25'14"	89°9'0"	7197	120			4120	SW	Ds	E
Amo_gl 48		78E/3	27°24'20"	89°9'28"	17416	200			4060	NW	Ds	E
Amo_gl 49		78E/3	27°24'31"	89°9'16"	6086	85			4170	NW	Cs	E
Amo_gl 50		78E/3	27°24'32"	89°9'5"	141971	660			4176	NW	Ds	C
Amo_gl 51		78E/3	27°23'58"	89°7'26"	14434	115			3960	W	Ds	E
Amo_gl 52		78E/3	27°23'49"	89°8'26"	5220	75			4200	SW	Ds	E
Amo_gl 53		78E/3	27°23'34"	89°9'4"	5125	95			4200	SW	Ds	V
Amo_gl 54		78E/3	27°22'35"	89°9'46"	4531	70			4000	W	Ds	V
Amo_gl 55		78E/3	27°22'50"	89°9'41"	17979	195			4040	W	Ds	V
Amo_gl 56		78E/3	27°22'19"	89°10'58"	4509	75			4320	S	Cs	E
Amo_gl 57		78E/3	27°22'31"	89°10'52"	4402	90			4280	SW	Ds	E
Amo_gl 58		78E/3	27°22'40"	89°10'32"	3588	85			4290	W	Ds	E
Amo_gl 59		78E/3	27°22'49"	89°8'14"	51794	295			3940	W	Ds	V
Amo_gl 60		78E/3	27°22'11"	89°9'5"	7139	110			4000	W	Ds	V
Amo_gl 61		78E/3	27°22'25"	89°9'7"	26667	295			4040	W	Ds	V
Amo_gl 62		78E/3	27°21'46"	89°9'54"	5590	130			4280	NW	Ds	V
Amo_gl 63		78E/3	27°21'48"	89°9'49"	2513	70			4285	NW	Ds	E
Amo_gl 64		78E/3	27°21'16"	89°9'27"	6401	90			4320	NW	Cs	E
Amo_gl 65		78E/3	27°21'30"	89°9'12"	3692	75			4400	NW	Cs	E
Amo_gl 66		78E/3	27°20'10"	89°9'54"	5761	80			4200	W	Ds	E
Amo_gl 67		78E/3	27°21'35"	89°9'5"	3753	75			4360	W	Cs	E
Amo_gl 68		78E/3	27°20'23"	89°9'20"	2856	60			4150	W	Cs	E
Amo_gl 69		78E/3	27°19'31"	89°8'31"	103175	640			4083	W	Ds	V
Amo_gl 70		78E/3	27°19'7"	89°9'40"	2829	70			4270	W	Cs	E
Amo_gl 71		78E/3	27°19'20"	89°9'30"	2290	60			4360	NW	Cs	E

Glacial Lake Inventory of Ha Chu Basin

Total Number : 53   Total Area : 1.83 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
ha_gl 1		78E/3	27°17'35"	89°11'22"	7090	115			4270	SE	Cs	E
ha_gl 2		78E/3	27°17'3"	89°12'45"	3533	50			4040	NE	Ds	E
ha_gl 3		78E/3	27°17'26"	89°11'54"	6723	60			4130	NE	Ds	V
ha_gl 4		78E/3	27°21'7"	89°10'21"	4880	95			4320	SE	Ds	E
ha_gl 5		78E/3	27°21'0"	89°10'24"	20480	115			4360	SE	Cs	E
ha_gl 6		78E/3	27°21'44"	89°10'42"	21552	250			4080	E	Ds	V
ha_gl 7		78E/3	27°21'35"	89°10'30"	3952	95			4240	N	Cs	E
ha_gl 8		78E/3	27°21'48"	89°10'53"	5752	105			4080	NE	Ds	E
ha_gl 9		78E/3	27°22'5"	89°13'29"	11137	135			4160	SW	Ds	E
ha_gl 10		78E/3	27°23'52"	89°10'12"	4546	75			4315	NW	Ds	E
ha_gl 11		78E/3	27°25'28"	89°9'41"	33108	190			4040	NE	Ds	E
ha_gl 12		78E/3	27°25'16"	89°9'50"	33947	255			4030	NE	Ds	E
ha_gl 13		78E/3	27°26'56"	89°7'44"	4580	75			4040	SE	Ds	E
ha_gl 14		78E/3	27°27'10"	89°7'31"	8847	140			4080	SE	Cs	E
ha_gl 15		78E/3	27°28'43"	89°6'31"	16491	145			4160	NE	Ds	E
ha_gl 16		78E/3	27°28'32"	89°6'55"	49278	350			4160	NE	Ds	E
ha_gl 17		78E/3	27°28'3"	89°6'59"	16011	110			4360	SE	Cs	E
ha_gl 18		78E/3	27°29'33"	89°6'34"	26639	190			4240	SE	Cs	E
ha_gl 19		78E/2	27°30'44"	89°6'42"	4745	175			4640	SE	Cs	E
ha_gl 20		78E/2	27°31'2"	89°7'20"	29453	180			4560	N	Cs	E
ha_gl 21		78E/3	27°29'17"	89°8'31"	47778	285			4480	SW	Ds	E
ha_gl 22		78E/3	27°27'56"	89°7'49"	58125	380			3880	SW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
ha_gl 23		78E/3	27°28'25"	89°8'27"	77711	525			4120	SW	Ds	C
ha_gl 24		78E/3	27°28'11"	89°10'19"	11627	145			4240	SE	Cs	E
ha_gl 25		78E/3	27°29'5"	89°12'34"	8645	135			4160	NE	Ds	E
ha_gl 26		78E/3	27°29'41"	89°11'40"	57623	295			4120	NE	Ds	C
ha_gl 27		78E/2	27°30'5"	89°11'5"	38493	310			3888	NE	Ds	V
ha_gl 28		78E/3	27°29'32"	89°10'15"	37446	175			4160	NW	Cs	C
ha_gl 29		78E/3	27°28'58"	89°9'57"	8119	150			4240	N	Cs	E
ha_gl 30		78E/3	27°28'42"	89°9'56"	35499	195			4200	N	Cs	C
ha_gl 31		78E/3	27°29'8"	89°9'33"	234771	435			4050	E	Ds	E
ha_gl 32		78E/2	27°30'50"	89°8'36"	77870	215			4620	S	Cs	E
ha_gl 33		78E/2	27°30'52"	89°8'49"	34951	195			4680	S	Cs	E
ha_gl 34		78E/2	27°30'16"	89°9'34"	13754	140			4550	SW	Cs	E
ha_gl 35		78E/3	27°29'57"	89°9'54"	4329	65			4240	S	Ds	E
ha_gl 36		78E/2	27°32'13"	89°10'21"	23949	140			4456	NW	Cs	E
ha_gl 37		78E/2	27°32'11"	89°10'4"	467172	520			4430	N	Ds	C
ha_gl 38		78E/2	27°31'5"	89°9'44"	8158	125			4575	NW	Ds	E
ha_gl 39		78E/2	27°32'6"	89°8'1"	73489	295			4688	E	Cs	E
ha_gl 40		78E/2	27°33'19"	89°11'54"	11342	165			4320	SW	Ds	V
ha_gl 41		78E/2	27°34'42"	89°11'24"	10834	145			4520	SW	Ds	E
ha_gl 42		78E/2	27°33'26"	89°12'50"	14351	115			4760	W	Cs	E
ha_gl 43		78E/2	27°32'4"	89°14'51"	49477	410			4072	SW	Ds	V
ha_gl 44		78E/2	27°33'21"	89°14'27"	42919	325			4280	SW	Ds	V
ha_gl 45		78E/2	27°33'11"	89°14'26"	9851	110			4320	S	Cs	C
ha_gl 46		78E/2	27°32'49"	89°13'10"	5164	75			4280	NW	Cs	E
ha_gl 47		78E/2	27°31'25"	89°13'32"	11174	120			4320	NW	Cs	E
ha_gl 48		78E/2	27°31'41"	89°14'33"	3141	95			4180	SW	Ds	V
ha_gl 49		78E/2	27°31'47"	89°14'37"	5167	165			4190	SW	Ds	V
ha_gl 50		78E/2	27°32'47"	89°14'4"	6946	70			4480	S	Cs	E
ha_gl 51		78E/2	27°30'38"	89°14'55"	5125	90			4080	NW	Ds	V
ha_gl 52		78E/2	27°30'46"	89°14'54"	19856	125			4060	NW	Ds	E
ha_gl 53		78E/2	27°30'17"	89°14'10"	4124	40			3960	NW	Ds	V

Glacial Lake Inventory of Pa Chu Basin

Total Number :94   Total Area : 1.82 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Pa_gl 1		78E/6	27°31'27"	89°16'34"	12135	125			3960	NE	Ds	E
Pa_gl 2		78E/6	27°31'25"	89°16'29"	10646	125			3990	NE	Ds	E
Pa_gl 3		78E/2	27°34'11"	89°14'55"	6906	90			4720	N	Cs	E
Pa_gl 4		78E/2	27°35'57"	89°13'4"	32173	235			4680	NE	Ds	E
Pa_gl 5		78E/2	27°35'22"	89°13'54"	12135	115			4280	N	Cs	E
Pa_gl 6		78E/2	27°34'12"	89°13'48"	58126	360			4346	NW	Ds	E
Pa_gl 7		78E/2	27°34'49"	89°12'40"	3299	55			4520	NW	Ds	V
Pa_gl 8		78E/2	27°35'5"	89°11'59"	11807	130			4280	N	Ds	V
Pa_gl 9		78E/2	27°35'5"	89°11'14"	24984	170			4314	N	Ds	V
Pa_gl 10		78E/2	27°35'56"	89°9'48"	82116	390			4512	N	Ds	C
Pa_gl 11		78E/2	27°35'23"	89°9'21"	5785	90			4920	NE	Cs	E
Pa_gl 12		78E/2	27°36'34"	89°8'59"	13183	130			4582	NE	Ds	E
Pa_gl 13		78E/2	27°43'31"	89°12'1"	5009	50			4720	SW	Ds	V
Pa_gl 14		78E/2	27°43'51"	89°13'15"	5680	90			4680	SW	Ds	E
Pa_gl 15		78E/2	27°43'58"	89°13'10"	4029	115			4680	NW	Cs	E
Pa_gl 16		78E/2	27°40'35"	89°14'47"	3202	45			4480	E	Cs	E
Pa_gl 17		78E/2	27°42'50"	89°14'14"	20318	145			4440	SE	Ds	E
Pa_gl 18	Chhunta Tso	78E/6	27°42'16"	89°15'35"	60218	390			4630	SW	Ds	C
Pa_gl 19		78E/6	27°42'52"	89°15'47"	6314	100			4640	E	Cs	E
Pa_gl 20		78E/2	27°43'43"	89°14'14"	6586	95			4670	NE	Ds	V
Pa_gl 21		78E/2	27°44'36"	89°14'5"	12512	90			4760	NE	Ds	E
Pa_gl 22		78E/2	27°44'10"	89°14'7"	5637	110			4940	NE	Cs	E
Pa_gl 23		78E/2	27°44'47"	89°13'23"	10992	125			4960	NE	Cs	E
Pa_gl 24		78E/1	27°45'11"	89°14'38"	33501	330			4630	SE	Cs	E
Pa_gl 25		78E/1	27°45'36"	89°13'41"	43859	265			4960	SE	Ds	E
Pa_gl 26		78E/1	27°45'5"	89°14'50"	12965	130			4720	SE	Cs	E
Pa_gl 27		78E/1	27°46'50"	89°13'43"	2121	55	424	Pa_gr1	5040	N	Cs	E
Pa_gl 28		78E/5	27°47'45"	89°15'4"	17243	150	298	Pa_gr3	4440	SE	Ds	C

A	B	C	D	E	F	G	H	I	J	K	L	M
Pa_gl 29		78E/5	27°47'14"	89°16'21"	20369	190	384	Pa_gr4	4520	S	Ds	V
Pa_gl 30	Dhingdi Tso	78E/5	27°45'47"	89°17'46"	15757	130			4560	SE	Ds	V
Pa_gl 31		78E/5	27°45'35"	89°17'54"	37281	240			4630	SE	Ds	C
Pa_gl 32		78E/5	27°46'20"	89°17'1"	5020	80			4760	SE	Ds	E
Pa_gl 33		78E/5	27°46'14"	89°18'17"	39804	265	1273	Pa_gr6	4620	SE	Ds	V
Pa_gl 34		78E/5	27°46'1"	89°18'29"	45668	420	1154	Pa_gr6	4630	SE	Ds	V
Pa_gl 35	Labu Tso	78E/5	27°46'49"	89°17'51"	40384	325	570	Pa_gr6	4750	SE	Ds	C
Pa_gl 36		78E/5	27°46'49"	89°18'27"	8191	70			4670	SE	Cs	E
Pa_gl 37		78E/5	27°46'22"	89°19'14"	9029	95			4510	SE	Ds	E
Pa_gl 38		78E/5	27°46'14"	89°19'23"	5796	85			4550	SE	Ds	V
Pa_gl 39		78E/5	27°46'2"	89°19'27"	3273	55			4640	SW	Cs	V
Pa_gl 40		78E/5	27°46'12"	89°19'35"	15743	260			4680	SE	Ds	V
Pa_gl 41		78E/5	27°47'14"	89°19'43"	20494	110	0	Pa_gr8	4320	SW	Ds	M
Pa_gl 42		78E/5	27°47'58"	89°18'60"	7452	40	0	Pa_gr8	4520	SW	Ds	S
Pa_gl 43		78E/5	27°48'11"	89°21'9"	17215	100	60	Pa_gr10	4320	S	Ds	B
Pa_gl 44		78E/5	27°48'7"	89°21'39"	5278	90	0	Pa_gr10	4470	S	Ds	S
Pa_gl 45		78E/5	27°49'12"	89°21'8"	34353	165			4463	S	Ds	B
Pa_gl 46		78E/5	27°49'1"	89°21'15"	4004	90			4500	SE	Ds	B
Pa_gl 47		78E/5	27°49'56"	89°20'16"	9236	120	0	Pa_gr10	4500	SE	Ds	B
Pa_gl 48		78E/5	27°48'51"	89°21'50"	4125	75			4760	SW	Cs	E
Pa_gl 49		78E/5	27°48'5"	89°22'52"	6291	80			4790	SW	Ds	V
Pa_gl 50		78E/5	27°49'52"	89°21'21"	4867	90			4945	SE	Ds	E
Pa_gl 51		78E/5	27°49'1"	89°22'3"	3888	65			5020	S	Cs	S
Pa_gl 52		78E/5	27°48'19"	89°22'54"	3183	75			4860	SW	Ds	E
Pa_gl 53	Omji Tso	78E/5	27°46'16"	89°24'54"	35058	260			4844	NW	Ds	E
Pa_gl 54		78E/5	27°46'17"	89°23'40"	6577	102			4720	SW	Cs	V
Pa_gl 55		78E/5	27°46'44"	89°23'27"	20168	185			4850	NW	Ds	E
Pa_gl 56		78E/5	27°46'53"	89°23'24"	4369	75			4980	NW	Cs	E
Pa_gl 57		78E/5	27°46'1"	89°24'24"	4352	90			5060	NW	Cs	E
Pa_gl 58		78E/5	27°46'43"	89°23'18"	4329	80			4970	NW	Cs	E
Pa_gl 59	Tso Phu	78E/5	27°45'16"	89°22'58"	102038	690			4400	NW	Ds	V
Pa_gl 60		78E/5	27°45'23"	89°22'31"	66753	515			4416	NW	Ds	V
Pa_gl 61		78E/5	27°45'47"	89°23'48"	10527	175			4940	SW	Cs	E
Pa_gl 62		78E/5	27°45'2"	89°24'58"	5728	60			3990	SW	Cs	E
Pa_gl 63		78E/5	27°45'28"	89°24'42"	4567	80			5030	S	Cs	E
Pa_gl 64		78E/5	27°45'32"	89°24'39"	3364	60			5040	S	Cs	E
Pa_gl 65	Tomba Tso	78E/6	27°44'15"	89°21'59"	5416	75			4840	W	Cs	E
Pa_gl 66		78E/6	27°44'19"	89°24'54"	6337	140			4960	SW	Ds	E
Pa_gl 67		78E/6	27°42'16"	89°24'46"	2732	75	0	Pa_gr13	4840	SW	Ds	V
Pa_gl 68		78E/6	27°42'7"	89°24'24"	5244	90	350	Pa_gr14	4660	NW	Ds	V
Pa_gl 69		78E/6	27°42'59"	89°23'15"	15978	175	300	Pa_gr15	4660	NW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pa_gl 70	Wohney Tso	78E/6	27°41'44"	89°24'8"	172070	340	500	Pa_gr17/16	4800	W	Ds	V
Pa_gl 71		78E/6	27°41'1"	89°25'0"	11238	160	110	Pa_gr16	4880	NW	Ds	V
Pa_gl 72		78E/6	27°39'51"	89°23'45"	25706	280			4900	NW	Ds	E
Pa_gl 73	Shanakha Tso	78E/6	27°38'11"	89°17'54"	4179	55			4260	SW	Cs	E
Pa_gl 74	Chhochhey Tso	78E/6	27°36'19"	89°20'8"	19574	120			4346	SW	Ds	E
Pa_gl 75		78E/6	27°35'41"	89°21'34"	626	30			4840	NW	Ds	E
Pa_gl 76		78E/6	27°36'22"	89°20'0"	4049	60			4290	SW	Ds	E
Pa_gl 77		78E/6	27°34'55"	89°21'14"	26244	140			4440	W	Ds	E
Pa_gl 78		78E/6	27°32'37"	89°23'32"	5473	110			4070	NE	Cs	E
Pa_gl 79		78E/6	27°33'48"	89°22'9"	15343	170			4190	NE	Ds	E
Pa_gl 80	Darkey Pang T	78E/6	27°34'52"	89°22'6"	228503	525			4240	SE	Cs	C
Pa_gl 81	Laname Tso	78E/6	27°34'15"	89°24'15"	21524	140			4450	S	Cs	C
Pa_gl 82	Kerey Tso	78E/6	27°33'32"	89°24'44"	60612	245			4420	S	Ds	E
Pa_gl 83		78E/6	27°34'39"	89°24'19"	3752	60			4440	NW	Ds	E
Pa_gl 84		78E/6	27°35'17"	89°24'34"	4887	90			4295	SE	Ds	E
Pa_gl 85		78E/6	27°33'55"	89°29'30"	2356	55			4150	NW	Ds	V
Pa_gl 86		78E/6	27°33'2"	89°30'39"	5450	75			4240	S	Ds	V
Pa_gl 87		78E/10	27°33'4"	89°30'29"	2248	55			4260	NW	Ds	V
Pa_gl 88		78E/10	27°33'8"	89°30'45"	2548	55			4350	NW	Ds	V
Pa_gl 89		78E/10	27°33'17"	89°30'20"	306	20			4200	NW	Ds	V
Pa_gl 90		78E/10	27°33'19"	89°30'17"	504	30			4320	NW	Ds	E
Pa_gl 91		78E/10	27°33'53"	89°29'20"	1467	55			4260	W	Cs	E
Pa_gl 92		78E/10	27°33'58"	89°29'18"	4941	150			4275	SW	Cs	E
Pa_gl 93		78E/10	27°33'54"	89°29'8"	2370	75			4170	NW	Cs	E
Pa_gl 94		78E/10	27°32'46"	89°29'60"	1450	65			4170	NW	Cs	E

Glacial Lake Inventory of Thim Chu Basin

Total Number :74   Total Area : 2.82 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Thim_gl 1	Bimelang Tso	78E/10	27°32'31"	89°30'47"	70186	410			3870	SW	Ds	E
Thim_gl 2		78E/10	27°33'53"	89°30'60"	35617	240			4360	S	Ds	C
Thim_gl 3	Jene Tso	78E/10	27°31'28"	89°31'52"	39577	265			3980	SW	Ds	C
Thim_gl 4	Dung Tso Nu	78E/10	27°32'55"	89°31'1"	60951	355			4240	SW	Cs	C
Thim_gl 5		78E/10	27°30'59"	89°31'52"	16855	245			4080	W	Ds	E
Thim_gl 6		78E/10	27°30'12"	89°33'22"	19495	175			3990	NE	Ds	E
Thim_gl 7	Gyonge La Ts	78E/10	27°32'47"	89°32'13"	30277	235			4000	NE	Ds	C
Thim_gl 8		78E/10	27°31'23"	89°32'54"	5023	110			4180	NE	Ds	E
Thim_gl 9	Dung Tsho sh	78E/10	27°31'16"	89°32'50"	14043	175			4220	NE	Ds	E
Thim_gl 10		78E/10	27°33'29"	89°32'14"	16274	210			4150	SE	Cs	V
Thim_gl 11		78E/10	27°33'27"	89°32'41"	7882	115			4480	S	Ds	E
Thim_gl 12	Yanche Tso	78E/10	27°33'1"	89°34'22"	132843	570			4180	S	Ds	E
Thim_gl 13		78E/10	27°33'25"	89°34'55"	11837	170			4150	NE	Ds	V
Thim_gl 14		78E/10	27°35'28"	89°33'5"	75101	485			4186	N	Ds	V
Thim_gl 15		78E/10	27°34'53"	89°32'27"	4983	117			4350	N	Cs	V
Thim_gl 16		78E/10	27°35'52"	89°32'9"	6323	125			4260	N	Ds	E
Thim_gl 17	Pha Tso	78E/10	27°34'41"	89°31'27"	52105	270			4350	NE	Cs	E
Thim_gl 18		78E/10	27°34'44"	89°31'15"	3573	90			4460	E	Cs	E
Thim_gl 19	Nya Tso	78E/10	27°34'35"	89°31'1"	89317	495			4470	NE	Cs	E
Thim_gl 20		78E/10	27°33'47"	89°31'49"	35233	345			4470	NE	Ds	E
Thim_gl 21		78E/10	27°35'26"	89°31'50"	14440	200			4015	N	Ds	V
Thim_gl 22	Tso sumthi	78E/10	27°34'4"	89°31'60"	73672	470			4255	N	Ds	V
Thim_gl 23		78E/10	27°34'2"	89°31'47"	48315	370			4260	N	Ds	V
Thim_gl 24		78E/10	27°34'56"	89°30'38"	29693	220			4270	N	Ds	V
Thim_gl 25		78E/10	27°34'19"	89°31'28"	22884	230			4340	NW	Ds	V
Thim_gl 26	Kere Tso	78E/10	27°35'19"	89°30'24"	25796	235			4340	N	Cs	E
Thim_gl 27	Tso Nam	78E/10	27°34'8"	89°30'56"	258780	635			4425	NW	Cs	E
Thim_gl 28		78E/6	27°34'58"	89°29'35"	18612	300			4410	NE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Thim_gl 29	Santo Tso	78E/6	27°34'25"	89°29'58"	483126	1250			4320	NE	Cs	V
Thim_gl 30		78E/6	27°35'26"	89°28'52"	7965	165			4640	E	Ds	E
Thim_gl 31		78E/6	27°37'59"	89°29'10"	36825	210			4360	N	Ds	E
Thim_gl 32		78E/6	27°37'55"	89°28'8"	4526	105			4580	NW	Ds	V
Thim_gl 33	Ghonlana Tso	78E/6	27°38'50"	89°27'35"	386019	1610			4220	SE	Cs	V
Thim_gl 34		78E/10	27°39'36"	89°34'33"	9075	140			4480	N	Ds	V
Thim_gl 35		78E/10	27°39'34"	89°33'52"	28595	210			4380	NW	Ds	V
Thim_gl 36		78E/10	27°39'38"	89°33'20"	27240	465			4420	N	Ds	V
Thim_gl 37		78E/10	27°39'7"	89°33'45"	5242	85			4480	N	Cs	V
Thim_gl 38		78E/10	27°39'37"	89°32'26"	38481	295			4350	N	Ds	V
Thim_gl 39		78E/10	27°38'38"	89°32'36"	10078	155			4580	N	Ds	V
Thim_gl 40	Tso Map	78E/10	27°38'5"	89°32'41"	32378	240			4510	NW		V
Thim_gl 41	Tso Ser	78E/10	27°38'8"	89°31'32"	18125	235			4660	N	Ds	E
Thim_gl 42		78E/10	27°40'25"	89°29'47"	8394	135			4700	N	Cs	E
Thim_gl 43		78E/10	27°41'13"	89°28'2"	2850	70			4640	W	Ds	E
Thim_gl 44		78E/6	27°41'12"	89°27'28"	3044	70			4560	E	Ds	E
Thim_gl 45		78E/6	27°41'31"	89°25'36"	3870	80			4980	NE	Cs	E
Thim_gl 46		78E/6	27°41'29"	89°25'31"	4432	105			4985	NE	Cs	E
Thim_gl 47		78E/6	27°42'28"	89°25'28"	3870	110			5030	SE	Ds	E
Thim_gl 48	Khedo Tso	78E/5	27°45'3"	89°27'29"	39744	275			4720	SE	Ds	V
Thim_gl 49	Ken Tso	78E/5	27°45'49"	89°26'32"	10582	130			4740	E	Ds	V
Thim_gl 50		78E/5	27°45'35"	89°26'26"	3334	80			4840	NE	Ds	E
Thim_gl 51		78E/5	27°45'29"	89°27'45"	5846	110			4720	S	Ds	V
Thim_gl 52	Barzame Tso	78E/5	27°45'23"	89°27'51"	14265	210			4730	S	Cs	E
Thim_gl 53		78E/5	27°46'28"	89°27'4"	6488	130			4860	S	Cs	E
Thim_gl 54		78E/5	27°46'17"	89°27'9"	4367	100			4900	SE	Ds	E
Thim_gl 55	Dhinge Tso	78E/5	27°46'57"	89°27'9"	12935	185			4750	S	Ds	E
Thim_gl 56		78E/5	27°45'31"	89°28'23"	10328	160			4640	SW	Cs	V
Thim_gl 57		78E/5	27°45'20"	89°29'37"	62036	425			4880	SE	Cs	C
Thim_gl 58		78E/5	27°45'35"	89°30'37"	3825	95	205	Thim_gr8	4640	SW	Cs	E
Thim_gl 59		78E/9	27°46'37"	89°33'48"	4222	90			4950	SE	Cs	E
Thim_gl 60		78E/9	27°45'32"	89°34'44"	77532	475			4560	SW	Ds	E
Thim_gl 61		78E/9	27°45'13"	89°35'14"	17452	205			4720	SW	Ds	E
Thim_gl 62		78E/10	27°43'58"	89°34'51"	66468	605			4600	SW	Cs	V
Thim_gl 63		78E/10	27°44'49"	89°34'9"	3169	70			4760	SE	Ds	E
Thim_gl 64		78E/10	27°44'55"	89°34'27"	8042	115			4860	S	Cs	V
Thim_gl 65		78E/10	27°43'46"	89°36'17"	13636	160			4435	S	Ds	E
Thim_gl 66		78E/10	27°42'22"	89°37'51"	31150	310			4160	SW	Ds	V
Thim_gl 67		78E/10	27°43'35"	89°37'1"	7473	145			4380	SW	Ds	V
Thim_gl 68		78E/10	27°42'40"	89°37'11"	8738	125			4260	SW	Ds	V
Thim_gl 69		78E/10	27°42'59"	89°37'31"	19041	240			4350	SW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Thim_gl 70		78E/10	27°42'58"	89°37'39"	2622	80			4375	S	Ds	V
Thim_gl 71		78E/10	27°42'7"	89°38'38"	1589	50			4415	SW	Ds	V
Thim_gl 72		78E/10	27°42'6"	89°38'43"	3291	75			4420	SW	Ds	V
Thim_gl 73		78E/10	27°42'7"	89°38'51"	34077	285			4425	SW	Ds	V
Thim_gl 74		78E/10	27°41'8"	89°39'31"	11271	175			3980	SW	Ds	V

Glacial Lake Inventory of Mo Chu Basin

Total Number :380   Total Area : 9.78 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Mo_gl 1	Hoko Tso	78E/10	27°38'32"	89°44'19"	495758	1035			2240	SW	Ds	V
Mo_gl 2		78E/10	27°44'10"	89°38'20"	32275	250			4000	N	Ds	V
Mo_gl 3		78E/10	27°43'36"	89°37'55"	4322	105			4400	N	Ds	V
Mo_gl 4		78E/10	27°44'50"	89°36'15"	47065	340			4265	NE	Ds	C
Mo_gl 5		78E/9	27°46'52"	89°36'2"	16080	175			3880	SW	Ds	V
Mo_gl 6		78E/9	27°46'14"	89°37'52"	19079	250			4160	SE	Ds	V
Mo_gl 7		78E/9	27°47'18"	89°38'6"	22212	215			3960	S	Ds	V
Mo_gl 8		78E/9	27°47'32"	89°38'5"	3667	85			3920	S	Ds	V
Mo_gl 9		78E/9	27°47'35"	89°38'18"	5241	105			4080	S	Ds	E
Mo_gl 10		78E/9	27°47'51"	89°38'4"	22915	170			3960	S	Ds	E
Mo_gl 11		78E/9	27°47'50"	89°38'11"	8989	140			3920	S	Ds	V
Mo_gl 12		78E/9	27°48'8"	89°40'47"	27007	330			3881	S	Ds	V
Mo_gl 13		78E/9	27°48'53"	89°39'59"	46822	335			3960	SE	Ds	C
Mo_gl 14		78E/9	27°50'47"	89°40'36"	29716	195			3840	NW	Ds	E
Mo_gl 15		78E/9	27°50'25"	89°40'4"	8246	130			4000	NW	Ds	E
Mo_gl 16		78E/9	27°49'7"	89°40'27"	10934	165			4120	W	Cs	E
Mo_gl 17		78E/9	27°48'48"	89°38'50"	16161	195			4280	NE	Cs	E
Mo_gl 18		78E/9	27°48'54"	89°37'11"	72648	335			4240	NW	Ds	C
Mo_gl 19		78E/9	27°46'44"	89°32'54"	15236	250			4840	NW	Ds	E
Mo_gl 20		78E/9	27°46'8"	89°31'12"	16620	180	0	Mo_gr3	5060	NE	Ds	V
Mo_gl 21		78E/9	27°46'34"	89°31'37"	15655	195			4760	E	Ds	V
Mo_gl 22		78E/9	27°48'46"	89°31'32"	4336	75			5000	S	Cs	E
Mo_gl 23		78E/9	27°48'54"	89°31'50"	2438	55			5080	SE	Cs	E
Mo_gl 24		78E/9	27°48'48"	89°31'53"	41028	280			5080	SE	Cs	E
Mo_gl 25		78E/9	27°50'20"	89°33'27"	8131	110			4540	SE	Ds	E
Mo_gl 26		78E/9	27°50'12"	89°36'21"	120976	505			4160	SE	Ds	V
Mo_gl 27		78E/9	27°51'7"	89°35'19"	10286	155			4680	NE	Ds	V
Mo_gl 28		78E/9	27°51'12"	89°35'52"	9718	155			4800	S	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 29		78E/9	27°51'49"	89°35'25"	4788	85			4320	NW	Cs	V
Mo_gl 30		78E/9	27°51'55"	89°36'22"	19281	275			4440	SW	Ds	V
Mo_gl 31		78E/9	27°51'0"	89°37'40"	6105	100			4200	SW	Cs	E
Mo_gl 32		78E/9	27°51'11"	89°37'10"	19606	200			4000	W	Ds	V
Mo_gl 33		78E/9	27°51'6"	89°34'44"	11657	135			5000	NE	Ds	V
Mo_gl 34		78E/9	27°52'2"	89°33'28"	53731	305			4200	NE	Ds	V
Mo_gl 35		78E/9	27°51'5"	89°33'53"	23144	200			4480	NW	Ds	V
Mo_gl 36		78E/9	27°51'16"	89°33'13"	30816	340			4680	NW	Ds	V
Mo_gl 37		78E/9	27°51'11"	89°32'25"	5146	130	500	Mo_gr7	4800	N	Ds	V
Mo_gl 38		78E/9	27°52'55"	89°31'10"	5126	105			4720	NE	Ds	E
Mo_gl 39		78E/9	27°52'48"	89°31'21"	22145	220			4850	S	Ds	E
Mo_gl 40		78E/9	27°52'39"	89°31'25"	21112	230			4860	SE	Cs	E
Mo_gl 41		78E/9	27°52'25"	89°32'12"	3613	65			4760	NW	Cs	V
Mo_gl 42		78E/9	27°47'44"	89°28'8"	15277	230			4840	NE	Ds	E
Mo_gl 43		78E/9	27°47'38"	89°27'38"	12386	175			4690	N	Cs	E
Mo_gl 44	Gogome Tso	78E/9	27°46'41"	89°26'18"	14108	175			4750	W	Cs	V
Mo_gl 45		78E/5	27°46'38"	89°26'26"	10704	155			4750	S	Ds	V
Mo_gl 46		78E/5	27°46'55"	89°26'38"	9435	165			4840	SW	Ds	V
Mo_gl 47		78E/5	27°45'5"	89°25'10"	4971	100			4960	NE	Ds	E
Mo_gl 48		78E/5	27°45'12"	89°25'37"	9300	150			4920	E	Ds	V
Mo_gl 49		78E/5	27°45'47"	89°24'34"	3539	190			4980	E	Cs	E
Mo_gl 50		78E/5	27°45'20"	89°25'41"	4971	85			4920	NE	Ds	E
Mo_gl 51	Chokam Tso	78E/5	27°50'26"	89°23'19"	183642	590			4337	NE	Ds	V
Mo_gl 52		78E/5	27°49'47"	89°22'16"	4964	90			4740	NE	Cs	E
Mo_gl 53		78E/5	27°49'52"	89°22'34"	5072	120			4640	NE	Cs	E
Mo_gl 54		78E/5	27°49'48"	89°22'35"	8010	155			4640	NE	Cs	E
Mo_gl 55		78E/5	27°50'17"	89°22'7"	64280	545	675	Mo_gr11	4440	E	Cs	V
Mo_gl 56		78E/5	27°50'20"	89°23'52"	4829	115	0	Mo_gr12	4240	E	Ds	S
Mo_gl 57		78E/5	27°50'18"	89°23'56"	2904	80	0	Mo_gr12	4280	E	Ds	S
Mo_gl 58		78E/5	27°50'11"	89°23'58"	3019	70	0	Mo_gr12	4280	E	Cs	S
Mo_gl 59		78E/5	27°51'56"	89°22'3"	4072	90	0	Mo_gr12	4320	E	Cs	S
Mo_gl 60		78E/5	27°51'47"	89°23'4"	5288	110	86	Mo_gr12	4200	E	Cs	B
Mo_gl 61		78E/5	27°56'40"	89°25'29"	5227	80			4880	S	Cs	E
Mo_gl 62		78E/5	27°56'1"	89°26'24"	3323	125			4760	S	Cs	E
Mo_gl 63		78E/5	27°55'28"	89°27'40"	64584	305			4560	SE	Cs	C
Mo_gl 64		78E/5	27°56'44"	89°28'14"	27453	285			3960	SE	Cs	V
Mo_gl 65		78E/5	27°56'36"	89°26'42"	12325	150			4600	SE	Ds	V
Mo_gl 66		78E/5	27°56'20"	89°26'43"	16911	220			4820	SE	Ds	E
Mo_gl 67		78E/5	27°56'35"	89°26'50"	3904	100			4680	E	Ds	E
Mo_gl 68		78E/5	27°56'39"	89°26'60"	3107	100			4780	SE	Ds	E
Mo_gl 69		78E/5	27°56'59"	89°26'57"	52036	360			4600	E	Cs	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 70		78E/5	27°57'46"	89°26'22"	12312	195			4840	SE	Ds	V
Mo_gl 71		78E/5	27°57'52"	89°26'23"	11603	140			4840	S	Cs	E
Mo_gl 72		78E/5	27°57'20"	89°27'38"	22077	185			4520	E	Ds	V
Mo_gl 73		78E/5	27°57'23"	89°28'46"	3363	85			4760	SW	Cs	E
Mo_gl 74		78E/5	27°57'30"	89°28'56"	8152	150			4760	SE	Cs	E
Mo_gl 75		78E/5	27°58'34"	89°28'18"	5889	100			4720	N	Cs	V
Mo_gl 76		78E/5	27°58'11"	89°28'39"	3532	80			4960	E	Ds	E
Mo_gl 77		78E/5	27°58'13"	89°28'47"	12845	140			4960	SE	Ds	E
Mo_gl 78		77H/12	28°4'7"	89°31'12"	72796	500			4779	S	Cs	C
Mo_gl 79		77H/12	28°2'52"	89°31'3"	36118	240			4800	E	Cs	E
Mo_gl 80		77H/12	28°0'12"	89°33'57"	6483	100			4720	NE	Cs	E
Mo_gl 81		77H/12	28°2'10"	89°33'7"	6571	95			4420	S	Ds	E
Mo_gl 82		77H/12	28°2'2"	89°33'7"	16816	150			4420	SE	Cs	E
Mo_gl 83		78E/9	27°59'52"	89°33'21"	4390	80			4640	SW	Cs	V
Mo_gl 84		77H/12	28°0'38"	89°34'41"	15844	500			4700	SW	Cs	V
Mo_gl 85		77H/12	27°59'1"	89°35'50"	11366	205	650	Mo_gr33	4080	SW	Ds	E
Mo_gl 86		78E/9	27°59'44"	89°34'35"	10650	140			5040	W	Cs	E
Mo_gl 87		78E/9	27°58'17"	89°35'15"	5430	125			5420	NW	Cs	E
Mo_gl 88		78E/9	27°58'16"	89°35'25"	4802	125			4840	W	Ds	V
Mo_gl 89		78E/9	27°57'52"	89°34'26"	11251	95			4880	SW	Cs	V
Mo_gl 90		78E/9	27°57'11"	89°35'50"	3269	175			4760	S	Ds	E
Mo_gl 91		78E/9	27°57'39"	89°35'37"	3606	80			4800	SE	Ds	E
Mo_gl 92		78E/9	27°57'40"	89°35'42"	3910	95			4760	SW	Cs	V
Mo_gl 93		78E/9	27°57'45"	89°35'53"	10238	160			4800	S	Ds	E
Mo_gl 94		78E/9	27°56'4"	89°35'26"	4856	100			4400	NW	Ds	E
Mo_gl 95		78E/9	27°55'59"	89°35'54"	21483	215			4240	S	Ds	V
Mo_gl 96		78E/9	27°56'34"	89°36'51"	24468	290			4600	SE	Cs	E
Mo_gl 97		78E/9	27°57'36"	89°36'0"	21821	200			4600	E	Ds	E
Mo_gl 98		78E/9	27°57'23"	89°36'15"	27561	245			4640	E	Ds	V
Mo_gl 99		78E/9	27°57'57"	89°36'34"	13386	160			4640	SW	Ds	V
Mo_gl 100		78E/9	27°57'59"	89°36'48"	8840	140			4560	S	Ds	E
Mo_gl 101		78E/9	27°57'8"	89°37'32"	4106	90			4680	W	Ds	E
Mo_gl 102		78E/9	27°57'59"	89°37'14"	19612	240			4480	SW	Cs	V
Mo_gl 103		78E/9	27°57'54"	89°37'23"	11724	160			4600	S	Cs	V
Mo_gl 104		78E/9	27°57'49"	89°37'30"	5450	120			4620	SE	Ds	V
Mo_gl 105		78E/9	27°57'22"	89°38'20"	33835	445			4420	E	Ds	V
Mo_gl 106		78E/9	27°57'1"	89°38'40"	34828	250			4600	SE	Ds	V
Mo_gl 107		78E/9	27°55'12"	89°38'42"	2755	80			4400	W	Ds	V
Mo_gl 108		78E/9	27°55'20"	89°38'18"	88654	490			4240	SW	Ds	V
Mo_gl 109		78E/9	27°55'32"	89°38'34"	17255	175			4360	SW	Ds	E
Mo_gl 110		78E/9	27°54'13"	89°38'42"	7051	130			4280	SE	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 111		78E/9	27°54'31"	89°38'47"	6382	135			4280	SE	Ds	E
Mo_gl 112		78E/9	27°54'1"	89°39'54"	22287	230			4320	SW	Ds	E
Mo_gl 113		78E/9	27°55'56"	89°38'2"	15952	200			4360	SE	Ds	E
Mo_gl 114		78E/9	27°54'17"	89°39'37"	117917	460			4200	SW	Ds	C
Mo_gl 115		78E/9	27°54'43"	89°39'8"	41284	330			4080	SW	Cs	C
Mo_gl 116		78E/9	27°54'10"	89°40'3"	17964	215			4000	SE	Ds	E
Mo_gl 117		78E/9	27°54'4"	89°40'16"	5511	105			4080	SE	Ds	E
Mo_gl 118		78E/9	27°55'1"	89°39'46"	19072	220			4280	N	Ds	E
Mo_gl 119		78E/9	27°55'1"	89°39'30"	10549	150			5120	N	Ds	E
Mo_gl 120		78E/9	27°55'37"	89°38'47"	10164	190			5000	E	Ds	E
Mo_gl 121		78E/9	27°56'10"	89°39'51"	98602	495			4320	S	Cs	C
Mo_gl 122		78E/9	27°57'10"	89°39'6"	4133	80			4440	SE	Ds	V
Mo_gl 123		78E/9	27°56'38"	89°39'40"	5139	105			4280	S	Ds	E
Mo_gl 124		78E/9	27°56'4"	89°40'26"	6159	95			4120	SW	Ds	E
Mo_gl 125		78E/9	27°56'9"	89°40'30"	2749	80			4130	SW	Cs	E
Mo_gl 126		78E/9	27°56'5"	89°40'36"	26899	225			4160	S	Ds	E
Mo_gl 127		78E/9	27°56'4"	89°40'49"	22672	260			4240	S	Cs	E
Mo_gl 128		78E/9	27°56'54"	89°39'60"	4012	90			4400	S	Cs	E
Mo_gl 129		78E/9	27°57'58"	89°39'1"	2938	80			4400	S	Cs	E
Mo_gl 130		78E/9	27°56'9"	89°40'47"	1769	70			4200	S	Cs	E
Mo_gl 131		78E/9	27°56'4"	89°40'17"	7098	140			4120	S	Cs	E
Mo_gl 132		78E/9	27°56'16"	89°40'9"	2695	65			4120	S	Cs	E
Mo_gl 133		78E/9	27°56'46"	89°40'9"	25231	190			4080	SW	Cs	E
Mo_gl 134		78E/9	27°56'19"	89°41'7"	24279	205			4200	SW	Cs	C
Mo_gl 135		78E/9	27°56'24"	89°42'16"	7145	145			4160	SW	Ds	E
Mo_gl 136		78E/9	27°56'38"	89°42'16"	7908	140			4200	SW	Ds	E
Mo_gl 137		78E/9	27°55'20"	89°42'59"	16215	210			4000	SW	Cs	V
Mo_gl 138		78E/9	27°57'28"	89°43'4"	57412	380			4080	N	Cs	C
Mo_gl 139		78E/9	27°56'47"	89°41'43"	6207	110			4200	NW	Ds	E
Mo_gl 140		78E/9	27°56'30"	89°41'35"	9658	125			4100	N	Ds	V
Mo_gl 141		78E/9	27°56'26"	89°41'31"	6889	125			4090	NE	Ds	V
Mo_gl 142		78E/9	27°56'37"	89°41'30"	24860	265			4090	NW	Ds	V
Mo_gl 143		78E/9	27°56'52"	89°40'29"	27899	200			4200	NE	Ds	E
Mo_gl 144		78E/9	27°56'34"	89°40'34"	4984	85			4160	NE	Ds	E
Mo_gl 145		78E/9	27°57'4"	89°40'13"	42811	320			4320	E	Cs	E
Mo_gl 146		78E/9	27°57'8"	89°40'25"	21969	185			4320	SE	Ds	E
Mo_gl 147		78E/9	27°57'47"	89°39'22"	4302	120			4440	NE	Cs	E
Mo_gl 148		78E/9	27°57'44"	89°39'16"	2938	70			4480	NE	Cs	E
Mo_gl 149		78E/9	27°57'43"	89°39'18"	1864	65			4480	NE	Ds	E
Mo_gl 150		78E/9	27°57'39"	89°39'20"	16722	180			4440	NE	Cs	E
Mo_gl 151		78E/9	27°57'49"	89°39'26"	10394	175			4400	NE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 152		78E/9	27°57'1"	89°40'37"	88573	580			4400	NE	Cs	V
Mo_gl 153		78E/9	27°57'34"	89°39'25"	3897	75			4400	NE	Cs	V
Mo_gl 154		78E/9	27°57'14"	89°39'18"	8064	110			4480	NE	Ds	E
Mo_gl 155		78E/9	27°57'12"	89°39'29"	20673	185			4560	SE	Ds	E
Mo_gl 156		78E/9	27°57'31"	89°39'38"	78469	380			4440	E	Ds	E
Mo_gl 157		78E/9	27°58'50"	89°40'18"	6787	95			4360	NE	Cs	E
Mo_gl 158		78E/9	27°58'42"	89°40'39"	4599	190			4400	N	Ds	E
Mo_gl 159		78E/9	27°58'26"	89°40'45"	7996	145			4600	E	Ds	E
Mo_gl 160		78E/9	27°58'54"	89°39'27"	18235	215			4480	NE	Ds	E
Mo_gl 161		78E/9	27°58'16"	89°39'46"	5241	80			4360	N	Ds	E
Mo_gl 162		78E/9	27°58'13"	89°39'16"	7193	125			4520	NW	Cs	E
Mo_gl 163		78E/9	27°58'23"	89°39'15"	4836	90			4520	W	Ds	E
Mo_gl 164		78E/9	27°58'44"	89°38'16"	59573	385			4480	NE	Ds	E
Mo_gl 165		78E/9	27°58'1"	89°39'11"	15493	190			4600	W	Ds	E
Mo_gl 166		78E/9	27°58'41"	89°37'4"	78753	405			4600	NW	Ds	C
Mo_gl 167		78E/9	27°58'55"	89°36'15"	141534	605			4640	NE	Cs	E
Mo_gl 168		78E/9	27°58'19"	89°36'20"	14993	210			4840	SE	Ds	E
Mo_gl 169		78E/9	27°58'58"	89°35'20"	7611	115			4880	NE	Ds	E
Mo_gl 170		78E/9	27°59'14"	89°35'3"	5180	100			5040	NE	Ds	E
Mo_gl 171		78E/9	27°59'26"	89°35'12"	6071	120			4920	NE	Ds	E
Mo_gl 172		78E/9	27°59'40"	89°35'23"	19281	240			4880	S	Cs	V
Mo_gl 173		77H/12	28°0'39"	89°35'35"	9435	110	235	Mo_gr34	4960	SE	Cs	E
Mo_gl 174		78E/9	27°59'26"	89°37'28"	6862	130			4840	SW	Cs	E
Mo_gl 175		78E/9	27°59'40"	89°37'3"	8786	185			4640	S	Cs	V
Mo_gl 176		78E/9	27°59'35"	89°37'14"	5011	80			4760	SE	Cs	V
Mo_gl 177		78E/9	27°59'43"	89°38'16"	6456	130			4560	S	Ds	V
Mo_gl 178		77H/12	28°0'48"	89°41'8"	15067	165			4360	NW	Cs	E
Mo_gl 179		77H/12	28°0'5"	89°41'12"	8125	95			4360	NE	Ds	E
Mo_gl 180		77H/12	28°0'59"	89°40'7"	11630	110			4360	NE	Cs	E
Mo_gl 181		77H/12	28°0'49"	89°40'3"	4498	85			4680	NE	Cs	E
Mo_gl 182		77H/12	28°0'26"	89°40'5"	8854	130			4280	N	Cs	E
Mo_gl 183		78E/9	27°59'15"	89°39'47"	5903	90			4680	N	Cs	E
Mo_gl 184		77H/12	28°0'5"	89°37'45"	22010	195	252	Mo_gr37	4200	S	Cs	E
Mo_gl 185		77H/12	28°0'12"	89°37'55"	8206	150	200	Mo_gr37	4360	SE	Cs	E
Mo_gl 186		77H/12	28°1'7"	89°37'4"	7091	105	10	Mo_gr37	4480	SE	Cs	E
Mo_gl 187		77H/12	28°0'57"	89°37'29"	2580	65			4600	S	Cs	E
Mo_gl 188		77H/12	28°0'53"	89°37'37"	3262	80			4640	S	Ds	E
Mo_gl 189		77H/12	28°0'49"	89°37'40"	6301	100			4640	S	Cs	E
Mo_gl 190		77H/12	28°0'5"	89°38'34"	18532	160			4800	SE	Cs	E
Mo_gl 191		77H/12	28°0'28"	89°38'52"	25974	220			4880	SE	Cs	E
Mo_gl 192		77H/12	28°1'38"	89°39'6"	18984	245			4728	SE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 193		77H/12	28°1'9"	89°38'20"	86837	395	1058	Mo_gr38	4640	NE	Cs	E
Mo_gl 194		77H/12	28°1'2"	89°38'6"	12217	155	1050	Mo_gr38	4650	NE	Cs	E
Mo_gl 195	Mome Tso	77H/12	28°2'41"	89°37'31"	146039	565	600	Mo_gr39	4640	NW	Cs	C
Mo_gl 196		77H/12	28°2'11"	89°36'3"	27217	280	440	Mo_gr42	5000	NE	Cs	E
Mo_gl 197		77H/12	28°3'17"	89°35'14"	11414	155	1215	Mo_gr47	4482	NE	Cs	E
Mo_gl 198		77H/12	28°2'22"	89°33'39"	37111	240			4040	E	Cs	E
Mo_gl 199		77H/12	28°2'3"	89°33'50"	14088	220			5000	SE	Cs	E
Mo_gl 200	Kab Tso	77H/12	28°4'0"	89°35'5"	52090	285	0	Mo_gr47	4280	SE	Cs	M
Mo_gl 201		77H/12	28°6'16"	89°36'56"	30864	325	0	Mo_gr51	4080	S	Cs	M
Mo_gl 202		77H/12	28°7'44"	89°36'32"	34288	325	0	Mo_gr52	4380	S	Cs	L
Mo_gl 203		77H/12	28°8'48"	89°36'9"	9718	160	150	Mo_gr52	4530	SW	Cs	B
Mo_gl 204		77H/12	28°8'43"	89°36'29"	6551	95			4620	SE	Cs	E
Mo_gl 205		77H/12	28°8'12"	89°37'7"	8489	160	67	Mo_gr52	4440	SW	Cs	B
Mo_gl 206		77H/12	28°8'25"	89°37'1"	42473	465			4440	SW	Cs	E
Mo_gl 207		77H/12	28°7'56"	89°37'36"	11015	125	250	Mo_gr55	4680	NW	Cs	E
Mo_gl 208		77H/12	28°7'2"	89°38'34"	9029	125	100	Mo_gr55	4920	NW	Cs	E
Mo_gl 209		77H/12	28°6'59"	89°36'21"	52374	400			4480	W	Cs	E
Mo_gl 210	Oneme Tso	77H/12	28°4'15"	89°39'56"	31715	280			4370	SE	Cs	V
Mo_gl 211		77H/12	28°5'32"	89°38'39"	19119	210			4680	SW	Cs	V
Mo_gl 212		77H/12	28°6'10"	89°38'11"	3944	80			4880	SW	Ds	E
Mo_gl 213	Paro Tso	77H/12	28°5'55"	89°39'10"	9111	95			4920	W	Ds	E
Mo_gl 214	Kharkhil Tso	77H/12	28°5'41"	89°40'0"	46019	375			4580	NW	Cs	E
Mo_gl 215		77H/12	28°7'11"	89°39'4"	4248	105			4360	NE	Cs	V
Mo_gl 216		77H/12	28°6'2"	89°39'52"	62754	370			4406	NE	Cs	V
Mo_gl 217		77H/12	28°7'40"	89°38'4"	8064	110			4640	SE	Ds	C
Mo_gl 218		77H/12	28°7'0"	89°39'38"	54494	290			4600	E	Cs	C
Mo_gl 219		77H/12	28°8'35"	89°38'11"	92132	355			4720	SE	Cs	C
Mo_gl 220		77H/12	28°10'3"	89°41'20"	73958	520	150	Mo_gr62	4880	SE	Cs	E
Mo_gl 221		77H/12	28°8'29"	89°44'22"	99919	365			4860	NW	Cs	E
Mo_gl 222	Labsar Ting Tso	77H/12	28°6'17"	89°43'19"	8077	135			4560	SW	Cs	E
Mo_gl 223		77H/16	28°6'41"	89°43'9"	3627	80			4720	W	Cs	E
Mo_gl 224		77H/16	28°9'52"	89°46'17"	18194	165	600	Mo_gr71	5000	SE	Ds	E
Mo_gl 225		77H/16	28°12'22"	89°48'13"	12656	155	440	Mo_gr76	5000	NE	Cs	E
Mo_gl 226	Simdong Goi Ts	77H/16	28°13'55"	89°48'3"	24799	270	500	Mo_gr79	5240	SW	Ds	B
Mo_gl 227		77H/16	28°12'7"	89°50'53"	31735	265	250	Mo_gr80	5280	SE	Ds	E
Mo_gl 228		77H/16	28°12'11"	89°52'14"	20308	225	750	Mo_gr81	5080	W	Ds	E
Mo_gl 229		77H/16	28°11'2"	89°52'20"	18005	200	1200	Mo_gr82	5000	NW	Cs	E
Mo_gl 230		77H/16	28°11'16"	89°52'17"	37941	335	500	Mo_gr82	5020	NW	Cs	E
Mo_gl 231		77H/16	28°11'32"	89°52'25"	8381	115	500	Mo_gr82	5200	S	Cs	E
Mo_gl 232		77H/16	28°10'7"	89°52'55"	8010	120	650	Mo_gr82	5160	NW	Ds	V
Mo_gl 233		77H/16	28°10'18"	89°52'44"	12312	145	200	Mo_gr82	5640	NW	Cs	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 234	Setang Burgi Ts	77H/16	28°10'6"	89°51'21"	232775	795	50	Mo_gr84	4480	NW	Cs	V
Mo_gl 235		77H/16	28°8'35"	89°50'43"	150131	565	0	Mo_gr87	4960	SW	Cs	V
Mo_gl 236		77H/16	28°5'56"	89°47'58"	8381	115			5160	SE	Ds	E
Mo_gl 237		77H/16	28°5'22"	89°48'59"	13521	145	500	Mo_gr91	5160	SW	Cs	V
Mo_gl 238		77H/16	28°5'44"	89°46'16"	13028	160			4720	NW	Cs	E
Mo_gl 239		77H/16	28°5'5"	89°47'5"	28844	330			4760	W	Cs	E
Mo_gl 240		77H/16	28°4'16"	89°47'54"	21051	225			6440	NE	Ds	E
Mo_gl 241		77H/16	28°4'23"	89°46'18"	9712	135			4640	NW	Ds	E
Mo_gl 242		77H/16	28°4'40"	89°45'13"	24151	195			4640	NW	Ds	E
Mo_gl 243		77H/12	28°2'34"	89°44'51"	35625	320			4200	NW	Cs	V
Mo_gl 244		77H/16	28°3'6"	89°46'34"	13973	160			4840	SW	Ds	E
Mo_gl 245	Chhumne Tso	77H/16	28°3'19"	89°46'44"	80509	410			4860	SW	Cs	C
Mo_gl 246		77H/16	28°3'23"	89°46'18"	5970	100			4840	SW	Ds	V
Mo_gl 247		77H/16	28°3'25"	89°46'23"	23421	250			4860	SE	Ds	V
Mo_gl 248		77H/16	28°3'32"	89°46'13"	25380	210			4800	SW	Cs	C
Mo_gl 249		77H/16	28°3'40"	89°47'49"	6841	95			4840	SW	Ds	V
Mo_gl 250		77H/16	28°4'17"	89°48'3"	40535	285			4800	SE	Ds	E
Mo_gl 251		77H/16	28°4'42"	89°48'11"	13359	190			4920	NE	Ds	E
Mo_gl 252		77H/16	28°4'48"	89°48'17"	8368	125			4840	E	Ds	E
Mo_gl 253		77H/16	28°4'33"	89°48'60"	15020	150	35	Mo_gr92	4880	SE	Ds	C
Mo_gl 254		77H/16	28°3'35"	89°49'14"	13156	150	0	Mo_gr96	5000	SW	Ds	M
Mo_gl 255		77H/16	28°4'1"	89°51'4"	38009	270	150	Mo-gr99	4440	SW	Cs	B
Mo_gl 256		77H/16	28°1'57"	89°48'36"	13169	155			4820	W	Cs	V
Mo_gl 257		77H/16	28°1'12"	89°47'35"	22239	230			4601	NW	Cs	E
Mo_gl 258		77H/16	28°1'42"	89°46'17"	23651	225			4472	NW	Ds	E
Mo_gl 259		77H/16	28°0'29"	89°46'43"	11461	145			4520	W	Ds	V
Mo_gl 260		77H/16	28°0'46"	89°46'30"	23455	190			4400	SW	Ds	E
Mo_gl 261		77H/16	28°0'55"	89°46'28"	22125	190			4480	SW	Ds	E
Mo_gl 262		77H/16	28°0'17"	89°46'23"	9495	115			4520	W	Cs	V
Mo_gl 263		77H/16	28°0'35"	89°46'20"	7409	120			4540	SW	Ds	V
Mo_gl 264		77H/16	28°0'5"	89°47'44"	31222	230			4220	SE	Ds	E
Mo_gl 265		77H/16	28°0'35"	89°47'41"	13014	130			4200	S	Ds	E
Mo_gl 266		77H/16	28°0'50"	89°47'41"	15310	175			4400	SW	Ds	E
Mo_gl 267		77H/16	28°1'30"	89°48'3"	8908	100			4620	E	Ds	V
Mo_gl 268		77H/16	28°0'34"	89°48'44"	10644	140			4620	SW	Ds	E
Mo_gl 269		77H/16	28°1'13"	89°49'18"	24718	215			4620	SW	Cs	E
Mo_gl 270		77H/16	28°1'51"	89°49'40"	19592	235			4920	SE	Cs	V
Mo_gl 271		77H/16	28°1'14"	89°50'57"	8759	115			5000	S	Ds	V
Mo_gl 272		77H/16	28°2'19"	89°50'4"	7780	110			5160	SW	Ds	V
Mo_gl 273		77H/16	28°2'43"	89°50'11"	21193	180			4915	SE	Ds	E
Mo_gl 274		77H/16	28°2'19"	89°51'44"	11616	125			5000	SE		E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 275		77H/16	28°2'25"	89°51'50"	16087	185			5052	SE		E
Mo_gl 276		77H/16	28°2'44"	89°51'59"	9273	140			5080	S	Ds	E
Mo_gl 277		77H/16	28°3'49"	89°51'4"	10779	160			5040	S	Cs	E
Mo_gl 278		77H/16	28°2'8"	89°52'52"	10664	135			5040	SW	Ds	E
Mo_gl 279		78E/13	27°59'17"	89°48'4"	24515	220			4240	NW	Ds	C
Mo_gl 280		78E/13	27°58'20"	89°48'50"	8287	125			4320	N	Ds	V
Mo_gl 281		78E/13	27°59'41"	89°47'14"	24542	150			4300	NW	Cs	E
Mo_gl 282		78E/13	27°58'40"	89°48'36"	39846	300			4330	SE	Cs	E
Mo_gl 283		78E/13	27°59'18"	89°50'36"	36834	215			4650	SE	Ds	E
Mo_gl 284		77H/16	28°0'53"	89°51'21"	213642	665	1593	Mo_gr104	4800	SW	Ds	V
Mo_gl 285		77H/16	28°0'11"	89°52'40"	84237	410	921	Mo_gr104	4930	SW	Ds	E
Mo_gl 286		77H/16	28°0'8"	89°53'37"	210015	715	321	Mo_gr105	5080	SW	Ds	C
Mo_gl 287		77H/16	28°0'15"	89°53'27"	55487	360	472	Mo_gr105	5120	SW	Ds	E
Mo_gl 288		77H/16	28°0'13"	89°53'20"	14162	125	701	Mo_gr105	5120	SW	Ds	V
Mo_gl 289		78E/13	27°59'3"	89°52'27"	35922	365	860	Mo_gr107	4800	W	Ds	V
Mo_gl 290		78E/13	27°59'20"	89°52'27"	19936	225	460	Mo_gr107	4860	SW	Ds	V
Mo_gl 291		78E/13	27°59'27"	89°52'9"	20267	170			4980	SW	Cs	E
Mo_gl 292		78E/13	27°59'37"	89°52'32"	21253	180	203	Mo_gr107	4910	SW	Cs	V
Mo_gl 293		78E/13	27°59'1"	89°53'43"	3687	80	46	Mo_gr107	5120	SW	Ds	E
Mo_gl 294		78E/13	27°59'14"	89°53'34"	4174	100	0	Mo_gr107	5040	W	Ds	S
Mo_gl 295		78E/13	27°59'23"	89°53'39"	5849	100	0	Mo_gr107	5080	SW	Ds	S
Mo_gl 296		78E/13	27°59'47"	89°53'21"	148416	690	490	Mo_gr108	4960	SW	Ds	V
Mo_gl 297		78E/13	27°59'7"	89°54'28"	18890	155	246	Mo_gr108	5120	SW	Cs	V
Mo_gl 298		78E/13	27°59'10"	89°54'35"	14068	160	252	Mo_gr108	5130	SW	Cs	V
Mo_gl 299		78E/13	27°59'4"	89°54'41"	7071	120	616	Mo_gr108	5135	SE	Cs	E
Mo_gl 300		78E/13	27°58'1"	89°54'56"	291767	945	0	Mo_gr108	5140	W	Ds	E
Mo_gl 301		78E/13	27°58'23"	89°53'51"	38407	335	1180	Mo_gr108	5120	W	Cs	V
Mo_gl 302		78E/13	27°58'28"	89°53'34"	30891	245			5080	W	Cs	V
Mo_gl 303		78E/13	27°58'34"	89°53'35"	4464	95			5140	W	Cs	V
Mo_gl 304		78E/13	27°58'56"	89°53'28"	115668	560	0	Mo_gr109	5120	W	Cs	E
Mo_gl 305		78E/13	27°58'15"	89°53'9"	3019	80	0	Mo_gr110	5080	W	Ds	S
Mo_gl 306		78E/13	27°58'25"	89°53'13"	5950	100	0	Mo_gr110	5040	SW	Ds	S
Mo_gl 307		78E/13	27°58'15"	89°53'2"	7024	115	56	Mo_gr110	5050	NW	Ds	B
Mo_gl 308		78E/13	27°58'59"	89°53'6"	19977	140		Mo_gr111	5160	S	Cs	E
Mo_gl 309		78E/13	27°57'1"	89°54'56"	10671	125	129	Mo_gr111	5080	S	Cs	V
Mo_gl 310		78E/13	27°57'30"	89°52'40"	13777	155	0	Mo_gr112	5040	NW	Cs	V
Mo_gl 311		78E/13	27°57'38"	89°52'32"	10718	185	0	Mo_gr112	5060	NW	Cs	V
Mo_gl 312		78E/13	27°57'50"	89°52'18"	37570	310	0	Mo_gr112	5000	NW	Cs	V
Mo_gl 313		78E/13	27°57'11"	89°53'19"	19666	175	0	Mo_gr112	4920	W	Cs	V
Mo_gl 314		78E/13	27°57'10"	89°53'6"	88701	560	0	Mo_gr112	4920	NW	Ds	V
Mo_gl 315		78E/13	27°57'14"	89°52'25"	12048	190	102	Mo_gr112	4920	N	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 316		78E/13	27°57'59"	89°50'48"	72587	445			4580	W	Cs	C
Mo_gl 317		78E/13	27°56'25"	89°51'53"	9293	105			4860	W	Ds	V
Mo_gl 318		78E/13	27°56'49"	89°51'59"	15763	160			4960	SW	Cs	V
Mo_gl 319		78E/13	27°57'46"	89°51'9"	6423	115			5050	S	Cs	E
Mo_gl 320		78E/13	27°56'23"	89°53'39"	6767	120	300	Mo_gr116	4860	S	Ds	E
Mo_gl 321		78E/13	27°56'34"	89°53'38"	6423	125	140	Mo_gr116	4890	S	Ds	E
Mo_gl 322		78E/13	27°55'37"	89°52'41"	96582	600			4800	SW	Cs	V
Mo_gl 323		78E/13	27°56'13"	89°53'10"	79577	515	0	Mo_gr117	4900	SW	Cs	V
Mo_gl 324		78E/13	27°55'49"	89°50'12"	10698	165			4680	NW	Cs	V
Mo_gl 325		78E/13	27°55'5"	89°51'4"	38320	230			4720	NW	Ds	E
Mo_gl 326		78E/13	27°55'6"	89°50'35"	10326	140			4740	NE	Ds	V
Mo_gl 327		78E/13	27°56'27"	89°48'17"	4343	95			3950	NW	Ds	E
Mo_gl 328	Chumpasum	78E/13	27°55'47"	89°48'9"	136158	550			4280	W	Ds	C
Mo_gl 329		78E/13	27°54'20"	89°49'15"	13487	180			4555	NW	Cs	V
Mo_gl 330		78E/13	27°54'10"	89°50'41"	5727	95			4950	SW	Ds	E
Mo_gl 331		78E/13	27°54'2"	89°50'36"	4370	95			4480	SW	Ds	E
Mo_gl 332		78E/13	27°54'7"	89°50'25"	6294	105			4480	SW	Cs	E
Mo_gl 333		78E/13	27°54'7"	89°50'19"	3100	70			4480	SW	Cs	E
Mo_gl 334		78E/13	27°54'4"	89°50'22"	4964	105			4490	SW	Cs	E
Mo_gl 335		78E/13	27°54'55"	89°49'24"	5653	105			4490	SW	Cs	E
Mo_gl 336		78E/13	27°54'34"	89°49'5"	10198	150			4620	NW	Cs	E
Mo_gl 337		78E/13	27°53'4"	89°49'37"	32843	330			4450	NW	Cs	V
Mo_gl 338		78E/13	27°53'25"	89°49'34"	9435	125			4620	NW	Cs	V
Mo_gl 339		78E/13	27°53'15"	89°49'25"	3816	105			4600	NW	Ds	V
Mo_gl 340		78E/13	27°53'55"	89°48'27"	6207	120			4580	NW	Ds	E
Mo_gl 341		78E/13	27°52'41"	89°49'49"	5855	110			4480	W	Ds	V
Mo_gl 342		78E/13	27°53'59"	89°49'5"	20207	210			4580	SW	Ds	E
Mo_gl 343		78E/13	27°53'4"	89°50'21"	41831	450	775	Mo_gr118	4600	SW	Ds	V
Mo_gl 344		78E/13	27°53'11"	89°50'55"	13460	130	227	Mo_gr118	4850	SW	Ds	E
Mo_gl 345		78E/13	27°52'8"	89°50'37"	4282	100			4740	NW	Ds	E
Mo_gl 346		78E/13	27°52'8"	89°50'33"	6774	110			4760	NW	Ds	E
Mo_gl 347		78E/13	27°52'39"	89°48'11"	16479	185			4230	NW	Cs	V
Mo_gl 348		78E/13	27°52'58"	89°48'0"	33714	265			4320	NW	Cs	V
Mo_gl 349		78E/13	27°51'17"	89°49'59"	8293	110			4440	W	Ds	V
Mo_gl 350		78E/13	27°52'24"	89°49'4"	3654	75			4470	SW	Ds	V
Mo_gl 351		78E/13	27°52'31"	89°49'13"	17330	180			4540	SW	Ds	V
Mo_gl 352		78E/13	27°52'47"	89°49'10"	17289	235			4580	NW	Ds	V
Mo_gl 353		78E/13	27°51'46"	89°49'60"	5578	120			4630	N	Ds	V
Mo_gl 354		78E/13	27°51'58"	89°48'40"	8820	110			4380	N	Ds	V
Mo_gl 355		78E/13	27°51'2"	89°49'31"	8064	115			4390	NW	Ds	V
Mo_gl 356		78E/13	27°51'32"	89°49'39"	8705	110			4650	NW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mo_gl 357		78E/13	27°51'10"	89°49'19"	18518	190			4050	NW	Ds	V
Mo_gl 358		78E/13	27°52'4"	89°48'4"	35551	260			4300	NW	Ds	C
Mo_gl 359		78E/13	27°51'32"	89°48'41"	57054	375			4030	NW	Ds	V
Mo_gl 360		78E/13	27°51'4"	89°48'16"	5680	115			4050	NW	Ds	E
Mo_gl 361		78E/13	27°50'43"	89°47'59"	51340	265			4180	NW	Ds	V
Mo_gl 362		78E/13	27°49'24"	89°49'40"	8928	150			4280	SE	Ds	V
Mo_gl 363		78E/13	27°48'9"	89°50'39"	26136	290			4350	S	Ds	V
Mo_gl 364		78E/13	27°49'25"	89°50'55"	59269	345			4350	SW	Ds	V
Mo_gl 365		78E/13	27°49'5"	89°51'52"	7024	125			4500	S	Ds	E
Mo_gl 366		78E/13	27°50'56"	89°50'6"	6247	115			4530	SW	Ds	E
Mo_gl 367		78E/13	27°50'19"	89°51'17"	8280	155			4220	SW	Ds	V
Mo_gl 368		78E/13	27°48'49"	89°50'43"	51030	370			4250	SW	Cs	E
Mo_gl 369		78E/13	27°48'5"	89°51'45"	10022	120			4200	NW	Cs	V
Mo_gl 370	Chha Tso	78E/13	27°48'42"	89°50'10"	49848	270			4220	SW	Cs	E
Mo_gl 371		78E/13	27°48'55"	89°50'24"	12643	155			4200	NW	Ds	E
Mo_gl 372		78E/13	27°47'49"	89°50'53"	6490	95			4120	NE	Ds	E
Mo_gl 373		78E/13	27°48'35"	89°50'9"	4694	85			4230	SW	Ds	E
Mo_gl 374		78E/13	27°47'21"	89°50'54"	3971	100			4235	SW	Ds	E
Mo_gl 375		78E/13	27°47'25"	89°50'55"	37192	295			4180	SE	Cs	E
Mo_gl 376		78E/13	27°47'17"	89°50'44"	42777	325			4170	S	Cs	E
Mo_gl 377		78E/13	27°47'26"	89°50'35"	17363	180			4050	NW	Cs	V
Mo_gl 378		78E/13	27°47'9"	89°50'1"	36949	300			4160	SW	Cs	E
Mo_gl 379		78E/13	27°47'20"	89°50'18"	33822	310			4100	NW	Cs	E
Mo_gl 380		78E/13	27°46'59"	89°49'43"	23340	265			4020	W	Ds	E

Glacial Lake Inventory of Pho Chu Basin

Total Number :549 Total Area : 23.49 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Pho_gl 1		78E/13	27°46'11"	89°51'34"	26206	255			3900	SE	Ds	C
Pho_gl 2		78E/13	27°46'49"	89°50'24"	56137	310			3990	NE	Cs	V
Pho_gl 3		78E/13	27°46'57"	89°50'56"	88623	565			3990	SE	Ds	V
Pho_gl 4		78E/13	27°47'48"	89°50'33"	78300	415			4180	SE	Ds	E
Pho_gl 5		78E/13	27°48'45"	89°51'6"	8579	140			4270	S	Cs	E
Pho_gl 6		78E/13	27°47'35"	89°51'59"	23417	220			4230	SE	Cs	V
Pho_gl 7		78E/13	27°48'33"	89°51'16"	6078	120			4350	SE	Cs	E
Pho_gl 8		78E/13	27°47'15"	89°53'3"	14822	230			3920	SE	Ds	V
Pho_gl 9		78E/13	27°48'58"	89°52'10"	3335	65			4190	SE	Ds	E
Pho_gl 10		78E/13	27°47'52"	89°52'50"	12905	165			4280	E	Cs	E
Pho_gl 11		78E/13	27°46'21"	89°53'58"	3566	75			3910	W	Ds	V
Pho_gl 12		78E/13	27°47'23"	89°53'2"	14526	140			3910	W	Cs	V
Pho_gl 13		78E/13	27°46'41"	89°53'42"	7469	140			3900	W	Ds	V
Pho_gl 14		78E/13	27°47'24"	89°53'56"	5285	110			3900	NE	Ds	V
Pho_gl 15		78E/13	27°48'23"	89°52'21"	11071	135			4140	NE	Ds	V
Pho_gl 16		78E/13	27°48'21"	89°52'9"	9389	155			4190	NE	Cs	E
Pho_gl 17		78E/13	27°48'54"	89°51'22"	75680	515			4225	E	Ds	C
Pho_gl 18		78E/13	27°48'11"	89°52'47"	10232	175			4355	SE	Ds	E
Pho_gl 19		78E/13	27°48'47"	89°51'56"	5684	120			4435	SE	Cs	E
Pho_gl 20		78E/13	27°49'28"	89°52'1"	6120	120			4300	SE		E
Pho_gl 21		78E/13	27°49'40"	89°52'28"	41875	455			4175	NE	Ds	V
Pho_gl 22		78E/13	27°49'21"	89°52'21"	55899	365			4180	NE	Ds	V
Pho_gl 23		78E/13	27°49'48"	89°51'16"	32901	265			4350	NE	Ds	C
Pho_gl 24		78E/13	27°50'51"	89°51'11"	21649	155			4880	E	Ds	V
Pho_gl 25		78E/13	27°50'42"	89°50'57"	18708	190			4380	E	Ds	V
Pho_gl 26		78E/13	27°51'15"	89°51'21"	14053	195			4390	SE	Ds	V
Pho_gl 27		78E/13	27°51'52"	89°50'29"	22229	215			4470	SE	Ds	V
Pho_gl 28		78E/13	27°51'34"	89°51'41"	7037	130			4345	E	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 29	Tshojakoma	78E/13	27°52'44"	89°50'8"	189407	830			4520	E	Ds	V
Pho_gl 30		78E/13	27°51'18"	89°50'55"	35451	280			4580	NE	Ds	C
Pho_gl 31		78E/13	27°52'12"	89°50'24"	4409	95			4835	E	Cs	E
Pho_gl 32		78E/13	27°52'13"	89°51'27"	5009	110			4500	SE	Cs	E
Pho_gl 33		78E/13	27°52'57"	89°50'46"	82684	510			4580	SE	Ds	V
Pho_gl 34		78E/13	27°52'53"	89°50'35"	63310	340			4580	NE	Cs	C
Pho_gl 35		78E/13	27°52'42"	89°50'48"	4668	80			4590	SE	Cs	V
Pho_gl 36		78E/13	27°52'42"	89°50'55"	7649	110			4590	SE	Ds	V
Pho_gl 37		78E/13	27°53'39"	89°50'13"	27501	350			4660	S	Ds	V
Pho_gl 38		78E/13	27°53'44"	89°50'38"	53567	315			4800	SE	Cs	E
Pho_gl 39		78E/13	27°52'30"	89°51'57"	6510	120			4600	E	Cs	E
Pho_gl 40		78E/13	27°53'28"	89°51'9"	4117	90			4660	SE	Cs	E
Pho_gl 41		78E/13	27°53'7"	89°51'15"	6905	115			4750	NE	Cs	E
Pho_gl 42		78E/13	27°53'34"	89°51'48"	19366	220			4580	E	Cs	V
Pho_gl 43		78E/13	27°53'43"	89°51'49"	27382	280	590	Pho_gr1	4580	S	Ds	V
Pho_gl 44		78E/13	27°54'37"	89°51'8"	4096	110	866	Pho_gr1	4700	SW	Cs	E
Pho_gl 45		78E/13	27°52'27"	89°52'7"	18153	235			4560	NW	Cs	E
Pho_gl 46		78E/13	27°51'56"	89°52'53"	32325	210			4380	SE	Ds	V
Pho_gl 47		78E/13	27°52'40"	89°52'43"	15768	160			4540	SE	Cs	E
Pho_gl 48		78E/13	27°52'35"	89°52'33"	5034	115			4580	SE	Cs	E
Pho_gl 49		78E/13	27°53'55"	89°52'15"	58860	520			4400	S	Ds	V
Pho_gl 50		78E/13	27°54'14"	89°52'5"	48438	585			4580	SE	Ds	V
Pho_gl 51		78E/13	27°54'55"	89°51'28"	46662	415			4700	SE	Ds	E
Pho_gl 52		78E/13	27°54'8"	89°52'30"	14550	145			4700	SW	Cs	E
Pho_gl 53		78E/13	27°54'52"	89°51'50"	73279	510			4750	S	Cs	C
Pho_gl 54		78E/13	27°54'32"	89°52'32"	16627	205			4750	S	Cs	E
Pho_gl 55		78E/13	27°54'1"	89°53'51"	8472	150			4825	S	Ds	V
Pho_gl 56		78E/13	27°55'6"	89°53'13"	18819	225			4880	SW	Cs	E
Pho_gl 57		78E/13	27°55'8"	89°53'2"	7526	135			4855	SW	Cs	E
Pho_gl 58		78E/13	27°55'22"	89°53'5"	3578	90			4835	E	Cs	E
Pho_gl 59		78E/13	27°55'21"	89°53'18"	83663	470			4855	SE	Ds	V
Pho_gl 60		78E/13	27°55'29"	89°53'40"	19588	230			4860	S	Ds	E
Pho_gl 61		78E/13	27°55'14"	89°53'47"	19185	270			4940	SE	Ds	E
Pho_gl 62		78E/13	27°55'42"	89°53'27"	36635	305			4866	SW	Ds	E
Pho_gl 63		78E/13	27°54'33"	89°53'28"	7728	115			4785	SW	Cs	E
Pho_gl 64		78E/13	27°53'15"	89°53'45"	127162	545			4580	W	Ds	C
Pho_gl 65		78E/13	27°53'33"	89°53'10"	7991	85			4600	S	Cs	E
Pho_gl 66		78E/13	27°53'3"	89°54'3"	16191	235			4580	S	Cs	E
Pho_gl 67		78E/13	27°53'56"	89°53'14"	5992	110			4710	E	Cs	E
Pho_gl 68		78E/13	27°53'14"	89°54'17"	4758	95			4595	E	Cs	E
Pho_gl 69		78E/13	27°53'25"	89°54'43"	8003	95			4590	E	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 70		78E/13	27°54'2"	89°54'31"	57379	425			4850	SW	Cs	E
Pho_gl 71		78E/13	27°54'58"	89°53'20"	2982	65			4850	SW	Cs	E
Pho_gl 72		78E/13	27°54'5"	89°54'12"	104666	420			4790	SW	Cs	C
Pho_gl 73		78E/13	27°55'6"	89°54'13"	4647	75			4900	SE	Ds	E
Pho_gl 74		78E/13	27°55'13"	89°54'15"	21386	215			4900	SE	Ds	E
Pho_gl 75		78E/13	27°55'9"	89°54'19"	10500	145			4900	SE	Cs	E
Pho_gl 76		78E/13	27°55'8"	89°54'33"	55800	340	118	Pho_gr2	4950	SE	Cs	E
Pho_gl 77		78E/13	27°55'30"	89°54'22"	35278	285			4880	S	Ds	E
Pho_gl 78		78E/13	27°55'34"	89°54'28"	10820	115			4880	S	Cs	E
Pho_gl 79		78E/13	27°55'55"	89°54'59"	18161	160	450	Pho_gr3	4975	SE	Ds	V
Pho_gl 80		78E/13	27°56'47"	89°54'10"	18474	165	165	Pho_gr3	4985	S	Cs	E
Pho_gl 81		78E/13	27°56'52"	89°54'51"	24207	170	607	Pho_gr5	5100	S	Cs	E
Pho_gl 82		78E/13	27°56'6"	89°55'52"	15118	145	695	Pho_gr5	5080	S	Cs	V
Pho_gl 83		78E/13	27°55'34"	89°55'57"	29446	215			4995	SW	Ds	V
Pho_gl 84		78E/13	27°56'49"	89°55'14"	214078	660	0	Pho_gr8	5040	SW	Ds	V
Pho_gl 85		78E/13	27°56'40"	89°55'37"	18589	190			5050	SE	Ds	V
Pho_gl 86		78E/13	27°56'39"	89°55'50"	10487	135	179	Pho_gr7	5080	SE	Ds	V
Pho_gl 87		78E/13	27°56'27"	89°55'55"	10487	135	323	Pho_gr7	5120	SE	Cs	E
Pho_gl 88		78E/13	27°56'9"	89°56'13"	8476	100	27	Pho_gr8	5040	E	Ds	V
Pho_gl 89		78E/13	27°55'11"	89°56'44"	16500	155	251	Pho_gr9	4940	S	Cs	E
Pho_gl 90		78E/13	27°55'14"	89°55'5"	5248	75			4880	SW	Cs	E
Pho_gl 91		78E/13	27°55'26"	89°55'8"	7320	85			4900	W	Cs	E
Pho_gl 92		78E/13	27°55'30"	89°55'7"	5034	80			4900	W	Cs	E
Pho_gl 93		78E/13	27°55'33"	89°55'13"	8653	145			4880	W	Cs	E
Pho_gl 94		78E/13	27°55'59"	89°55'13"	29331	185	670	Pho_gr9	4800	SW	Ds	V
Pho_gl 95		78E/13	27°55'17"	89°56'26"	96268	600	299	Pho_gr9	4800	SW	Ds	V
Pho_gl 96		78E/13	27°54'22"	89°55'8"	12354	125			4640	SW	Ds	V
Pho_gl 97		78E/13	27°54'15"	89°56'27"	56203	310			4800	SW	Ds	E
Pho_gl 98		78E/13	27°54'16"	89°56'11"	14279	230			4800	W	Cs	E
Pho_gl 99		78E/13	27°54'21"	89°56'5"	11774	140			4760	SW	Ds	E
Pho_gl 100		78E/13	27°53'19"	89°56'49"	2945	80			4720	SW	Ds	V
Pho_gl 101		78E/13	27°54'27"	89°56'3"	9118	130			4760	S	Ds	E
Pho_gl 102		78E/13	27°53'11"	89°56'31"	13572	120			4680	NE	Cs	E
Pho_gl 103		78E/13	27°53'21"	89°56'26"	1571	50			4760	NE	Ds	V
Pho_gl 104		78E/13	27°53'60"	89°55'22"	6741	130			4720	NE	Cs	E
Pho_gl 105		78E/13	27°51'41"	89°55'41"	383279	1055			4520	E	Ds	V
Pho_gl 106		78E/13	27°52'49"	89°55'17"	21501	215			4600	S	Ds	V
Pho_gl 107		78E/13	27°52'4"	89°56'23"	15184	160			4640	SW	Ds	V
Pho_gl 108		78E/13	27°52'17"	89°56'30"	39201	325			4640	SW	Ds	V
Pho_gl 109		78E/13	27°52'10"	89°56'33"	7921	115			4640	SE	Cs	V
Pho_gl 110		78E/13	27°52'37"	89°56'37"	9336	135			4760	SW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 111		78E/13	27°51'32"	89°56'48"	51700	400			4560	SW	Cs	E
Pho_gl 112		78E/13	27°51'46"	89°53'11"	19288	230			4120	N	Ds	V
Pho_gl 113		78E/13	27°50'46"	89°53'50"	21809	195			4200	SW	Ds	V
Pho_gl 114		78E/13	27°50'47"	89°53'22"	7345	125			4240	SE	Cs	E
Pho_gl 115		78E/13	27°50'19"	89°54'27"	25235	210			4320	SE	Ds	V
Pho_gl 116		78E/13	27°50'49"	89°54'24"	157020	665			4280	SW	Ds	V
Pho_gl 117		78E/13	27°51'29"	89°54'4"	6041	100			4920	SE	Ds	E
Pho_gl 118		78E/13	27°51'19"	89°54'1"	9796	110			4960	E	Cs	E
Pho_gl 119		78E/13	27°49'50"	89°54'52"	145788	635			3840	SW	Ds	V
Pho_gl 120		78E/13	27°50'28"	89°55'6"	59460	340			4000	SW	Ds	V
Pho_gl 121		78E/13	27°48'14"	89°55'60"	16566	205			4120	S	Ds	V
Pho_gl 122		78E/13	27°49'37"	89°55'41"	14378	180			4240	SW	Ds	E
Pho_gl 123		78E/13	27°48'32"	89°55'30"	60690	325			3920	W	Ds	V
Pho_gl 124		78E/13	27°48'42"	89°55'34"	9262	140			3920	SW	Ds	V
Pho_gl 125		78E/13	27°47'48"	89°55'52"	7769	115			4000	E	Ds	E
Pho_gl 126		78E/13	27°47'50"	89°55'55"	8369	130			4000	SE	Cs	E
Pho_gl 127		78E/13	27°48'31"	89°56'46"	149119	500			4160	S	Ds	C
Pho_gl 128		78E/13	27°47'38"	89°57'51"	11890	170			4200	NE	Ds	V
Pho_gl 129		78E/13	27°47'37"	89°57'41"	9467	160			4200	N	Ds	E
Pho_gl 130		78E/13	27°49'46"	89°57'46"	160186	540			4080	NE	Ds	V
Pho_gl 131		78E/13	27°49'35"	89°57'20"	65362	395			4240	NE	Ds	C
Pho_gl 132		78E/13	27°49'44"	89°56'33"	290787	780			4440	E	Ds	E
Pho_gl 133		78E/13	27°50'59"	89°56'17"	15348	180			4400	NE	Ds	V
Pho_gl 134		78E/13	27°50'54"	89°56'7"	68302	335			4440	NE	Cs	E
Pho_gl 135		78E/13	27°50'40"	89°56'27"	13489	175			4600	SE	Cs	E
Pho_gl 136		78E/13	27°50'31"	89°56'25"	9447	160			4600	E	Cs	E
Pho_gl 137		78E/13	27°51'46"	89°56'27"	4935	115			4600	SW	Ds	V
Pho_gl 138		78E/13	27°51'18"	89°58'21"	160104	740			4320	S	Ds	V
Pho_gl 139		78E/13	27°50'9"	89°59'32"	43207	365			4080	SW	Ds	C
Pho_gl 140		78E/13	27°52'11"	89°57'33"	19741	245			4600	NE	Cs	V
Pho_gl 141		78E/13	27°52'8"	89°57'23"	9212	135			4600	N	Cs	E
Pho_gl 142		78E/13	27°52'46"	89°56'50"	8538	120			3920	E	Ds	E
Pho_gl 143		78E/13	27°53'7"	89°57'4"	75306	380	966	Pho_gr10	4560	SE	Ds	E
Pho_gl 144		78E/13	27°53'47"	89°56'24"	98579	410	580	Pho_gr10	4840	S	Ds	V
Pho_gl 145		78E/13	27°54'36"	89°57'30"	39851	270	210	Pho_gr11	4880	NE	Ds	V
Pho_gl 146		78E/13	27°56'43"	89°59'54"	18684	95			4233	SE	Ds	E
Pho_gl 147		78E/13	27°57'18"	89°56'45"	10537	160	362	Pho_gr20	4840	NE	Cs	E
Pho_gl 148		78E/13	27°58'9"	89°56'17"	454510	1285	0	Pho_gr21	4880	SE	Ds	V
Pho_gl 149		78E/13	27°57'6"	89°56'50"	22928	265	69	Pho_gr20	4920	NE	Cs	V
Pho_gl 150		78E/13	27°58'7"	89°56'43"	12934	160			5202	SE	Cs	E
Pho_gl 151		78E/13	27°58'35"	89°57'45"	15069	180			4680	SE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 152		77H/16	28°0'2"	89°58'49"	33263	315			4590	NW	Ds	C
Pho_gl 153		77H/16	28°0'26"	89°57'17"	167437	640	250	Pho_gr25	4650	NW	Ds	E
Pho_gl 154		77H/16	28°1'31"	89°56'13"	9336	130			4990	E	Cs	E
Pho_gl 155		77H/16	28°1'41"	89°55'34"	7140	105			4900	NW	Cs	E
Pho_gl 156		77H/16	28°1'9"	89°54'39"	13325	150			4940	NE	Cs	E
Pho_gl 157		77H/16	28°1'48"	89°53'47"	93727	445	295	Pho_gr31	5021	NE	Cs	E
Pho_gl 158		77H/16	28°1'3"	89°54'58"	10294	140			5120	SE	Cs	E
Pho_gl 159		77H/16	28°1'36"	89°54'58"	139475	495			5080	SW	Cs	E
Pho_gl 160		77H/16	28°3'40"	89°53'52"	27481	335	0	Pho_gr33	4880	NW	Cs	S
Pho_gl 161		77H/16	28°3'18"	89°53'38"	81360	485	0	Pho_gr33	4960	NE	Cs	S
Pho_gl 162		77H/16	28°3'22"	89°52'34"	49779	380			5140	E	Cs	E
Pho_gl 163		77H/16	28°6'6"	89°54'12"	369572	1200	603	Pho_gr41	4280	S	Ds	V
Pho_gl 164		77H/16	28°6'37"	89°54'38"	280550	1095	793	Pho_gr47/52	4320	SW	Ds	V
Pho_gl 165		77H/16	28°6'8"	89°55'56"	41250	330	716	Pho_gr52	4390	SW	Cs	V
Pho_gl 166		77H/16	28°7'32"	89°55'6"	5367	110	30	Pho_gr52	4600	SW	Cs	S
Pho_gl 167		77H/16	28°7'37"	89°55'8"	2978	105	0	Pho_gr52	4600	SW	Cs	S
Pho_gl 168		77H/16	28°7'43"	89°55'10"	3677	90	0	Pho_gr52	4610	SW	Cs	S
Pho_gl 169		77H/16	28°7'27"	89°56'23"	9804	125	0	Pho_gr52	4710	SW	Cs	S
Pho_gl 170		77H/16	28°8'19"	89°56'26"	14912	265	510	Pho-gr51	5100	SE	Cs	V
Pho_gl 171		77H/16	28°8'9"	89°56'22"	38642	255	204	Pho_gr51	5100	SE	Cs	V
Pho_gl 172		77H/16	28°7'50"	89°56'26"	33522	240	0	Pho_gr52	4310	SW	Cs	S
Pho_gl 173		77H/16	28°5'28"	89°55'45"	14921	155			5000	NW	Cs	E
Pho_gl 174		77H/16	28°4'55"	89°56'44"	19440	260	640	Pho_gr55	4720	S	Ds	C
Pho_gl 175		77H/16	28°5'20"	89°57'5"	12404	170			4800	SW	Ds	V
Pho_gl 176		77H/16	28°5'29"	89°57'27"	45362	500	720	Pho_gr57	4880	S	Ds	V
Pho_gl 177		77H/16	28°6'24"	89°57'12"	12383	130			5070	S	Ds	V
Pho_gl 178		77H/16	28°4'23"	89°57'14"	18408	185	1407	Pho_gr59	4960	W	Cs	V
Pho_gl 179		77H/16	28°3'54"	89°56'56"	11133	140			4720	SW	Cs	E
Pho_gl 180		77H/16	28°3'52"	89°58'24"	35467	270			4980	SE	Ds	E
Pho_gl 181		77H/16	28°4'31"	89°59'8"	14439	195	210	Pho_gr61	4980	E	Cs	E
Pho_gl 182		77H/16	28°4'40"	89°59'48"	11482	145	296	Pho_gr62	5000	E	Ds	V
Pho_gl 183		77H/16	28°5'30"	89°59'8"	28694	250	214	Pho_gr63	5020	E	Ds	V
Pho_gl 184		77H/16	28°5'16"	89°59'22"	7456	145			5145	E	Cs	V
Pho_gl 185		77H/16	28°5'4"	89°59'19"	5001	80			5200	E	Cs	V
Pho_gl 186		77H/16	28°5'25"	89°59'43"	8859	130	319	Pho-gr64	4990	NE	Ds	V
Pho_gl 187		77L/4	28°1'51"	90°0'10"	6428	110	616	Pho_gr71	4040	SW	Cs	V
Pho_gl 188		77L/4	28°2'14"	90°2'31"	34020	270	0	Pho_gr71	4280	SW	Cs	S
Pho_gl 189		77L/4	28°2'18"	90°2'43"	15850	200	0	Pho_gr71	4320	SW	Cs	S
Pho_gl 190		77L/4	28°3'38"	90°1'31"	10257	140			4400	S	Ds	B
Pho_gl 191		77L/4	28°3'18"	90°1'26"	17952	180			4600	E	Ds	E
Pho_gl 192		77L/4	28°3'39"	90°0'8"	6695	110			5120	SE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 193		77H/16	28°7'24"	89°59'3"	9681	155	97	Pho_gr66	4940	SW	Ds	V
Pho_gl 194		77H/16	28°7'28"	89°59'7"	4771	105	209	Pho_gr66	4940	SE	Ds	V
Pho_gl 195		77H/16	28°7'17"	89°59'23"	3529	85	225	Pho_gr66	5030	SW	Ds	E
Pho_gl 196		77L/4	28°6'23"	90°1'48"	46892	390	0	Pho_gr71	4740	W	Cs	S
Pho_gl 197		77L/4	28°0'56"	90°1'49"	34945	355			4440	W	Cs	V
Pho_gl 198		77L/4	28°0'22"	90°1'31"	7267	125			4560	W	Cs	E
Pho_gl 199		77L/4	28°2'36"	90°3'1"	80348	565			4410	NE	Cs	V
Pho_gl 200		77L/4	28°4'59"	90°2'17"	12996	165			4920	E	Cs	E
Pho_gl 201		77L/4	28°5'40"	90°2'29"	81335	460	410	Pho_gr74	5060	SE	Cs	E
Pho_gl 202		77L/4	28°5'40"	90°4'19"	21575	205			4740	SW	Ds	E
Pho_gl 203		77L/4	28°4'9"	90°5'35"	64186	325			4680	SW	Cs	C
Pho_gl 204		77L/4	28°4'10"	90°5'10"	83202	410			4640	SW	Cs	C
Pho_gl 205		77L/4	28°3'0"	90°5'21"	17433	170			4760	W	Ds	E
Pho_gl 206		77L/4	28°5'39"	90°13'36"	44194	260	0	Pho_gr82	4260	SW	Cs	S
Pho_gl 207		77L/4	28°5'47"	90°13'45"	15463	185	0	Pho_gr82	4320	SW	Cs	S
Pho_gl 208		77L/4	28°5'28"	90°14'47"	18799	215	213	Pho_gr83	4280	SW	Ds	V
Pho_gl 209		77L/4	28°6'44"	90°14'4"	145949	550	0	Pho_gr83	4360	SW	Cs	S
Pho_gl 210		77L/8	28°5'0"	90°18'29"	769800	1980	0	Pho_gr86	4600	NW		M
Pho_gl 211		77L/8	28°5'40"	90°19'12"	141976	650	0	Pho_gr87	4710	NW		M
Pho_gl 212		77L/8	28°3'48"	90°19'22"	12058	165	286	Pho_gr89	5185	NE		E
Pho_gl 213		77L/8	28°3'23"	90°19'28"	15846	175			5155	NW		E
Pho_gl 214		77L/8	28°3'16"	90°19'31"	8854	115			5160	NW		E
Pho_gl 215		77L/8	28°4'29"	90°18'24"	9270	125			5135	N		E
Pho_gl 216		77L/8	28°4'39"	90°18'16"	49298	245			5140	N		E
Pho_gl 217		77L/8	28°3'56"	90°18'30"	78674	380			5110	NW		E
Pho_gl 218		77L/8	28°2'24"	90°18'1"	7921	105	400	Pho_gr94	5315	NE		E
Pho_gl 219		77L/8	28°1'5"	90°18'50"	7012	115	90	Pho_gr94	5310	NE		E
Pho_gl 220		77L/8	28°1'50"	90°17'48"	86048	420	0	Pho_gr94	5355	NE		E
Pho_gl 221		77L/8	28°3'56"	90°16'2"	21986	180	120	Pho_gr95	5140	NW		E
Pho_gl 222		77L/8	28°3'52"	90°15'29"	59259	390			5120	NW		E
Pho_gl 223		77L/4	28°4'24"	90°14'7"	27830	210			4800	N	Ds	V
Pho_gl 224		77L/4	28°4'44"	90°13'18"	7469	110			4720	NW	Cs	E
Pho_gl 225		77L/8	28°3'2"	90°15'23"	92653	375			5140	SW		E
Pho_gl 226		77L/8	28°3'34"	90°15'12"	6942	105			5140	SW		E
Pho_gl 227		77L/8	28°3'42"	90°15'4"	6449	100			5160	SW		E
Pho_gl 228		77L/8	28°2'48"	90°15'58"	6819	110			5180	SW		E
Pho_gl 229		77L/8	28°1'13"	90°16'38"	24244	190			5180	SW		V
Pho_gl 230		77L/8	28°1'25"	90°16'51"	161877	555	130	Pho_gr97	5185	SW		V
Pho_gl 231		77L/8	28°1'24"	90°16'11"	11811	155			5250	SW		E
Pho_gl 232		77L/8	28°1'43"	90°16'0"	7666	115	638	Pho_gr99	5260	SW		E
Pho_gl 233		77L/8	28°0'58"	90°16'48"	159142	675	0	Pho_gr100	5300	SW		V

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 234		77L/8	28°0'50"	90°16'37"	114368	640	0	Pho_gr101	5320	SW		V
Pho_gl 235		78I/5	27°59'42"	90°16'47"	28254	330	880	Pho_gr104	5230	NW		V
Pho_gl 236		78I/5	27°59'28"	90°17'47"	468690	1535	250	Pho_gr104	5300	NW		V
Pho_gl 237		78I/5	27°59'15"	90°18'29"	114026	515	74	Pho_gr103	5350	NW		V
Pho_gl 238		78I/5	27°59'17"	90°17'28"	3019	70	440	Pho_gr104	5370	N		V
Pho_gl 239		78I/5	27°59'56"	90°15'56"	69322	435	260	Pho_gr105	5115	NW		V
Pho_gl 240		77L/4	28°1'50"	90°13'59"	11322	145			4920	NE	Ds	E
Pho_gl 241		77L/4	28°0'31"	90°6'30"	80743	535			4540	NW	Ds	V
Pho_gl 242		77L/4	28°0'50"	90°5'28"	24145	230			4680	NW	Ds	C
Pho_gl 243		78I/1	27°59'44"	90°5'43"	9924	180			4590	NW	Cs	E
Pho_gl 244		78I/1	27°58'7"	90°6'59"	2073	55	30	Pho_gr111	5040	NW	Ds	E
Pho_gl 245		78I/1	27°58'6"	90°6'38"	8768	125			5030	NW	Ds	E
Pho_gl 246		78I/1	27°58'49"	90°5'25"	11244	155			4990	NW	Cs	E
Pho_gl 247		78I/1	27°57'56"	90°4'16"	108935	425			4790	NW	Ds	V
Pho_gl 248		78I/1	27°56'33"	90°4'51"	10820	130			4680	NW	Ds	V
Pho_gl 249		78I/1	27°56'37"	90°3'33"	8451	115			4440	NW	Ds	C
Pho_gl 250		78I/1	27°56'42"	90°3'19"	18371	205			4480	NW	Ds	E
Pho_gl 251		78I/1	27°56'31"	90°3'47"	2714	70			4400	NW	Ds	V
Pho_gl 252		78I/1	27°56'6"	90°3'27"	11289	165			4460	NW	Ds	V
Pho_gl 253		78I/1	27°54'50"	90°2'35"	7205	115			4550	SE	Ds	E
Pho_gl 254		78I/1	27°54'33"	90°3'43"	9813	120			4400	E	Cs	M
Pho_gl 255		78I/1	27°55'29"	90°3'5"	6206	125			4420	SE	Cs	E
Pho_gl 256		78I/1	27°55'24"	90°3'6"	15591	195			4430	SE	Cs	C
Pho_gl 257		78I/1	27°54'15"	90°4'58"	70675	375			4300	SW	Ds	L
Pho_gl 258		78I/1	27°55'5"	90°4'9"	35640	390			4310	SW	Ds	L
Pho_gl 259		78I/1	27°55'3"	90°4'1"	3323	85			4340	SW	Cs	M
Pho_gl 260		78I/1	27°55'55"	90°3'30"	4203	90			4460	NE	Ds	L
Pho_gl 261		78I/1	27°54'48"	90°4'58"	45494	255			4230	S	Ds	C
Pho_gl 262		78I/1	27°55'41"	90°4'14"	88557	450			4300	SE	Cs	C
Pho_gl 263		78I/1	27°54'38"	90°5'59"	53859	385			4360	SW	Ds	V
Pho_gl 264		78I/1	27°55'51"	90°5'42"	6819	105			4460	NW	Ds	E
Pho_gl 265		78I/1	27°55'38"	90°5'52"	133792	445			4510	E	Ds	M
Pho_gl 266		78I/1	27°55'20"	90°5'42"	10405	160			4640	NE	Ds	E
Pho_gl 267		78I/1	27°55'17"	90°5'56"	21924	240			4550	SE	Ds	E
Pho_gl 268		78I/1	27°56'52"	90°5'28"	136699	775			4630	SW	Cs	V
Pho_gl 269		78I/1	27°56'38"	90°5'49"	15163	160			4830	SE	Ds	V
Pho_gl 270		78I/1	27°56'4"	90°6'8"	9323	140			4590	SW	Ds	E
Pho_gl 271		78I/1	27°55'10"	90°6'13"	3183	75			4320	SW	Ds	V
Pho_gl 272		78I/1	27°54'48"	90°5'15"	52053	425			4130	SW	Ds	V
Pho_gl 273		78I/1	27°54'12"	90°6'50"	4141	80			4300	S	Cs	V
Pho_gl 274		78I/1	27°54'30"	90°6'55"	10500	140			4380	SW	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 275		78I/1	27°54'14"	90°6'27"	21386	190			4300	NW	Ds	B
Pho_gl 276		78I/1	27°53'53"	90°5'53"	54603	265			4300	W	Ds	B
Pho_gl 277		78I/1	27°52'5"	90°6'37"	79962	450			4360	SW	Cs	C
Pho_gl 278		78I/1	27°52'50"	90°5'43"	5503	105			4380	SE	Cs	E
Pho_gl 279		78I/1	27°52'13"	90°6'21"	3233	75			4350	SE	Cs	E
Pho_gl 280		78I/1	27°52'55"	90°6'50"	49952	315			4225	SE	Ds	M
Pho_gl 281		78I/1	27°53'30"	90°6'12"	3076	65			4740	E	Cs	E
Pho_gl 282		78I/1	27°53'34"	90°6'19"	2690	55			4770	E	Cs	E
Pho_gl 283		78I/1	27°53'39"	90°6'25"	36002	270			4760	E	Cs	E
Pho_gl 284		78I/1	27°52'9"	90°7'58"	4869	95			4270	SE	Ds	B
Pho_gl 285		78I/1	27°54'12"	90°7'27"	18223	180			4660	SE	Cs	E
Pho_gl 286		78I/1	27°57'21"	90°6'41"	8916	125	71	Pho_gr112	5100	SE	Cs	E
Pho_gl 287		78I/1	27°57'7"	90°6'35"	10948	165	113	Pho_gr112	5040	SE	Cs	E
Pho_gl 288		78I/1	27°57'2"	90°7'19"	6185	140	1021	Pho_gr113	4710	NW	Ds	L
Pho_gl 289		78I/1	27°57'12"	90°7'21"	35817	210	1192	Pho_gr113	4735	W	Ds	L
Pho_gl 290		78I/1	27°56'24"	90°9'22"	99686	770			4510	E	Ds	V
Pho_gl 291		78I/1	27°56'37"	90°8'48"	28336	230			4710	SE	Ds	V
Pho_gl 292		78I/1	27°56'17"	90°8'57"	9027	135			4885	S	Ds	V
Pho_gl 293		78I/1	27°57'17"	90°8'2"	17873	215			4910	SW	Ds	V
Pho_gl 294		78I/1	27°57'12"	90°8'6"	4799	65			4910	S	Ds	V
Pho_gl 295		78I/1	27°57'26"	90°8'9"	4532	90			4980	NW	Ds	V
Pho_gl 296		78I/1	27°57'23"	90°8'11"	1637	55			4980	SE	Ds	V
Pho_gl 297		78I/1	27°57'22"	90°8'15"	5511	95			4980	SE	Ds	V
Pho_gl 298		78I/1	27°57'16"	90°8'17"	4248	100	437	Pho_gr115	4980	SE	Ds	V
Pho_gl 299		78I/1	27°57'53"	90°8'1"	43129	260			4950	S	Cs	M
Pho_gl 300		78I/1	27°56'7"	90°9'52"	5161	90			4945	S	Cs	M
Pho_gl 301		78I/1	27°57'11"	90°9'27"	64946	405			4780	SE	Cs	B
Pho_gl 302		78I/1	27°57'59"	90°8'47"	239910	855	946	Pho_gr116	4870	SE	Cs	M
Pho_gl 303		78I/1	27°58'46"	90°8'23"	6103	145	808	Pho_gr117	4940	SE	Cs	E
Pho_gl 304		78I/1	27°58'35"	90°8'22"	3660	175	548	Pho_gr117	4950	SE	Ds	E
Pho_gl 305		78I/1	27°58'26"	90°8'33"	28957	325	148	Pho_gr117	4990	SE	Ds	B
Pho_gl 306		78I/1	27°58'43"	90°9'1"	13255	200			4975	SE	Cs	B
Pho_gl 307		78I/1	27°58'23"	90°9'7"	5223	80			5040	SE	Cs	E
Pho_gl 308		78I/1	27°59'6"	90°9'10"	181338	110			4900	SE	Cs	E
Pho_gl 309		78I/1	27°59'39"	90°8'32"	93064	65			4940	SE	Cs	V
Pho_gl 310		78I/1	27°59'14"	90°8'2"	17071	140			5140	N	Cs	V
Pho_gl 311		78I/1	27°59'19"	90°8'2"	2147	810			5140	NW	Ds	E
Pho_gl 312		78I/1	27°59'6"	90°8'3"	19745	555			5120	NE	Ds	E
Pho_gl 313		78I/1	27°59'59"	90°7'19"	222135	205			5030	NE	Ds	E
Pho_gl 314		78I/1	27°59'54"	90°7'31"	22134	55			5070	SE	Cs	E
Pho_gl 315		78I/1	27°59'16"	90°9'29"	2961	190			5020	SE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 316		78I/1	27°59'12"	90°9'33"	7773	915			5025	SE	Cs	E
Pho_gl 317		78I/1	27°59'17"	90°9'32"	2147	180			5025	SE	Cs	E
Pho_gl 318		77L/4	27°59'60"	90°8'56"	9961	135	1775	Pho_gr120	5060	NE	Ds	E
Pho_gl 319		77L/4	28°0'4"	90°9'33"	55660	350	870	Pho_gr121	4990	S	Cs	E
Pho_gl 320		77L/4	28°0'48"	90°9'39"	76120	525			5035	SE	Ds	E
Pho_gl 321		78I/1	27°59'58"	90°10'8"	90190	465			4875	SE	Cs	E
Pho_gl 322		78I/1	27°59'47"	90°10'26"	117131	530			4880	NE	Ds	E
Pho_gl 323		78I/1	27°59'45"	90°10'45"	117670	595			4910	E	Cs	E
Pho_gl 324		78I/1	27°59'5"	90°11'45"	81269	410			4940	S	Ds	V
Pho_gl 325		78I/1	27°59'8"	90°11'55"	37458	240			4950	S	Ds	V
Pho_gl 326		78I/1	28°0'10"	90°11'3"	31856	245			4990	S	Ds	V
Pho_gl 327		77L/4	28°0'25"	90°11'40"	209628	930	417	Pho_gr124	5100	SE	Ds	V
Pho_gl 328		77L/4	28°1'57"	90°10'22"	186367	715			5052	S	Cs	V
Pho_gl 329		77L/4	28°1'51"	90°11'23"	51778	320	296	Pho_gr109	5020	S	Cs	E
Pho_gl 330		77L/4	28°1'47"	90°12'3"	543737	1320	456	Pho_gr125	5100	S	Ds	E
Pho_gl 331		77L/4	28°0'19"	90°13'25"	32671	215			5120	E	Cs	E
Pho_gl 332		77L/4	28°0'37"	90°13'33"	8011	110			5080	E	Cs	E
Pho_gl 333		78I/1	27°59'11"	90°13'33"	200190	875			4930	SW	Ds	V
Pho_gl 334		78I/1	27°59'37"	90°13'46"	242875	840			4910	SW	Cs	V
Pho_gl 335		78I/1	27°59'19"	90°14'55"	138151	465	305	Pho_gr127	4950	W	Cs	E
Pho_gl 336		78I/1	27°58'43"	90°13'33"	2961	75			5075	W	Cs	E
Pho_gl 337		78I/1	27°58'23"	90°14'52"	723673	1685	40	Pho_gr128	5080	SW	Cs	E
Pho_gl 338		78I/1	27°59'7"	90°14'7"	5445	140			5140	SW	Cs	E
Pho_gl 339		78I/1	27°59'38"	90°14'29"	6646	115	137	Pho_gr127	5180	SW	Cs	E
Pho_gl 340		78I/1	27°59'46"	90°14'2"	10940	130	0	Pho_gr128	5060	S		S
Pho_gl 341		78I/1	27°59'53"	90°14'10"	4211	80	374	Pho_gr107	5120	SW	Cs	E
Pho_gl 342		78I/1	27°59'55"	90°14'14"	3109	70	362	Pho_gr108	5120	SW	Cs	E
Pho_gl 343		78I/5	27°59'3"	90°15'8"	2575	60	190	Pho_gr108	5110	NW		E
Pho_gl 344		78I/1	27°58'17"	90°14'29"	10722	180			5080	SW	Cs	E
Pho_gl 345		78I/1	27°58'52"	90°12'14"	76548	560			4860	W	Ds	V
Pho_gl 346		78I/1	27°58'5"	90°14'1"	4183	95			5035	NW	Ds	B
Pho_gl 347		78I/1	27°57'52"	90°12'44"	4730	80			4980	S	Cs	E
Pho_gl 348		78I/1	27°57'1"	90°13'26"	5918	80			4980	S	Cs	E
Pho_gl 349		78I/1	27°57'20"	90°13'49"	2727	65			5110	S	Cs	E
Pho_gl 350		78I/1	27°57'15"	90°13'21"	3002	65			5000	SW	Cs	E
Pho_gl 351		78I/1	27°57'15"	90°13'28"	3771	70			5000	SW	Cs	E
Pho_gl 352		78I/1	27°57'25"	90°13'2"	3393	70			4990	SW	Cs	E
Pho_gl 353		78I/1	27°57'32"	90°13'6"	10002	155			4980	SW	Cs	V
Pho_gl 354		78I/1	27°57'34"	90°13'16"	9475	145			4980	SE	Ds	E
Pho_gl 355		78I/1	27°57'42"	90°13'25"	3150	70			5015	SW	Cs	E
Pho_gl 356		78I/1	27°57'51"	90°13'39"	48299	325			5035	SE	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 357		78I/1	27°57'35"	90°14'42"	16356	170	140	Pho_gr129	5180	SW	Ds	V
Pho_gl 358		78I/1	27°57'42"	90°14'45"	13230	200	0	Pho_gr129	5180	NW	Ds	V
Pho_gl 359		78I/1	27°57'11"	90°14'1"	23212	205			5050	SW	Ds	V
Pho_gl 360		78I/1	27°57'42"	90°14'10"	86205	420			5110	W	Ds	V
Pho_gl 361		78I/1	27°57'58"	90°14'20"	215941	615	440	Pho_gr129	5110	SW	Cs	V
Pho_gl 362		78I/5	27°58'14"	90°15'7"	23524	230			5300	SE	Cs	C
Pho_gl 363		78I/5	27°57'22"	90°15'33"	20333	220	0	Pho_gr130	5150	SW	Ds	V
Pho_gl 364		78I/5	27°57'26"	90°15'21"	26839	290	164	Pho_gr130	5150	W	Ds	V
Pho_gl 365		78I/5	27°57'30"	90°15'7"	73089	395	0	Pho_gr130	5150	SW	Ds	V
Pho_gl 366		78I/1	27°56'54"	90°14'50"	7497	120			5160	NE	Cs	E
Pho_gl 367		78I/1	27°56'23"	90°14'47"	4384	80			5080	N	Cs	E
Pho_gl 368		78I/1	27°56'56"	90°14'25"	25560	240			5080	W	Cs	E
Pho_gl 369		78I/5	27°56'1"	90°15'20"	6556	110			5090	SW	Ds	E
Pho_gl 370		78I/5	27°56'7"	90°15'27"	5947	125			5005	SW	Cs	E
Pho_gl 371		78I/5	27°56'15"	90°15'25"	12280	180	312	Pho_gr131	5110	SW	Cs	E
Pho_gl 372		78I/5	27°56'13"	90°15'17"	29171	300	327	Pho_gr131	5110	SW	Cs	E
Pho_gl 373		78I/5	27°55'55"	90°15'27"	157583	770	0	Pho_gr132	5110	NW	Ds	V
Pho_gl 374		78I/5	27°55'42"	90°15'5"	19132	225	175	Pho_gr132	5170	NW	Cs	V
Pho_gl 375		78I/5	27°54'32"	90°15'56"	17804	165			5225	NW	Cs	E
Pho_gl 376		78I/5	27°54'38"	90°16'58"	4442	95	104	Pho_gr132	5280	NW	Cs	E
Pho_gl 377		78I/5	27°54'16"	90°15'59"	7732	130	153	Pho_gr133	5180	N	Cs	E
Pho_gl 378		78I/5	27°55'6"	90°15'31"	5523	105	461	Pho_gr134	5110	NE	Cs	E
Pho_gl 379		78I/1	27°55'57"	90°14'28"	56906	645	68	Pho_gr134	5160	NE	Ds	V
Pho_gl 380		78I/1	27°55'31"	90°14'28"	6584	100	73	Pho_gr135	5230	E	Cs	E
Pho_gl 381		78I/1	27°56'35"	90°11'26"	190274	705			4630	NW	Ds	V
Pho_gl 382		78I/1	27°56'16"	90°12'11"	10824	170			4830	SW	Cs	E
Pho_gl 383		78I/1	27°55'24"	90°12'59"	7896	115			4910	NW	Cs	E
Pho_gl 384		78I/1	27°55'46"	90°12'54"	125254	520	300	Pho_gr137	4990	NW	Cs	C
Pho_gl 385		78I/1	27°55'55"	90°12'39"	8451	125	215	Pho_gr137	5020	NW	Ds	V
Pho_gl 386		78I/1	27°56'32"	90°11'2"	5737	120			4870	SW	Cs	E
Pho_gl 387		78I/1	27°55'31"	90°12'35"	5359	90			5070	SW	Ds	E
Pho_gl 388		78I/1	27°55'51"	90°12'17"	6576	115	252	Pho_gr138	5180	NW	Cs	E
Pho_gl 389		78I/1	27°54'44"	90°12'20"	5568	110			5100	NW	Cs	E
Pho_gl 390		78I/1	27°52'21"	90°12'56"	11565	125			4870	NE	Ds	E
Pho_gl 391		78I/1	27°52'37"	90°12'43"	455024	1155	302	Pho_gr143	4900	NW	Ds	C
Pho_gl 392		78I/1	27°55'22"	90°10'32"	5634	95			4550	E	Cs	E
Pho_gl 393		78I/1	27°54'41"	90°9'54"	48702	295			4100	NW	Ds	V
Pho_gl 394		78I/1	27°55'16"	90°10'16"	5536	95			4675	SE	Ds	E
Pho_gl 395		78I/1	27°54'36"	90°10'46"	68763	665			4590	SW	Ds	C
Pho_gl 396		78I/1	27°54'45"	90°9'8"	12613	180			4360	SW	Ds	V
Pho_gl 397		78I/1	27°54'30"	90°10'12"	436916	1125			4680	NW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 398		78I/1	27°53'34"	90°10'39"	3167	75			4880	NW	Ds	V
Pho_gl 399		78I/1	27°53'47"	90°8'11"	35985	220			4150	NW	Ds	C
Pho_gl 400		78I/1	27°52'35"	90°9'45"	36689	380			4460	NE	Cs	V
Pho_gl 401		78I/1	27°53'3"	90°10'10"	4713	95			4870	S	Cs	E
Pho_gl 402		78I/1	27°53'3"	90°11'42"	166409	520			4830	SW	Cs	C
Pho_gl 403		78I/1	27°52'34"	90°10'0"	4865	125			4930	SE	Cs	E
Pho_gl 404		78I/1	27°52'42"	90°10'8"	7279	115			4930	SE	Cs	E
Pho_gl 405		78I/1	27°52'38"	90°10'11"	4598	80			4950	SE	Cs	E
Pho_gl 406		78I/1	27°51'49"	90°10'53"	8941	120			4780	S	Cs	E
Pho_gl 407		78I/1	27°52'53"	90°10'36"	102380	445			4870	SE	Ds	E
Pho_gl 408		78I/1	27°52'2"	90°11'46"	2640	85			4875	SE	Cs	E
Pho_gl 409		78I/1	27°52'17"	90°11'41"	136596	515			4840	SW	Ds	E
Pho_gl 410		78I/1	27°53'20"	90°11'6"	3418	90			5040	SW	Ds	E
Pho_gl 411		78I/1	27°51'11"	90°11'4"	36557	345			4592	SW	Cs	E
Pho_gl 412		78I/1	27°51'37"	90°11'24"	160174	485			4730	SW	Cs	V
Pho_gl 413		78I/1	27°51'53"	90°11'53"	2990	75			4975	S	Cs	E
Pho_gl 414		78I/1	27°51'49"	90°11'59"	11474	195			4980	SW	Cs	E
Pho_gl 415		78I/1	27°52'8"	90°12'4"	32449	300	278	Pho_gr145	4980	SW	Ds	E
Pho_gl 416		78I/1	27°51'38"	90°11'2"	240543	565			4785	W	Cs	C
Pho_gl 417		78I/1	27°50'51"	90°10'29"	4754	100			4605	NE	Cs	E
Pho_gl 418		78I/1	27°50'21"	90°8'56"	17178	170			4430	NW	Ds	E
Pho_gl 419		78I/1	27°50'24"	90°8'46"	35566	240			4480	NW	Ds	E
Pho_gl 420		78I/1	27°50'58"	90°7'43"	70104	325			4320	NW	Ds	C
Pho_gl 421		78I/1	27°50'28"	90°8'31"	4339	105			4500	NW	Ds	E
Pho_gl 422		78I/1	27°50'33"	90°8'27"	5614	105			4515	NW	Cs	E
Pho_gl 423		78I/1	27°50'13"	90°7'24"	12289	195			4145	NE	Cs	E
Pho_gl 424		78I/1	27°50'20"	90°7'19"	11437	175			4160	NW	Cs	E
Pho_gl 425		78I/1	27°50'26"	90°7'13"	22681	230			4175	NW	Cs	E
Pho_gl 426		78I/1	27°49'0"	90°8'43"	4252	85			4625	NW	Cs	E
Pho_gl 427		78I/1	27°48'2"	90°7'14"	5976	125			4000	NE	Cs	E
Pho_gl 428		78I/1	27°49'31"	90°9'9"	11482	160			4340	SE	Cs	E
Pho_gl 429		78I/1	27°49'37"	90°9'40"	281348	905			4440	E	Ds	C
Pho_gl 430		78I/1	27°50'8"	90°9'4"	15040	210			4580	NE	Cs	E
Pho_gl 431		78I/1	27°49'7"	90°10'50"	2904	80			4435	SE	Ds	V
Pho_gl 432		78I/1	27°50'46"	90°9'22"	27386	190			4660	SW	Ds	C
Pho_gl 433		78I/1	27°49'11"	90°10'57"	54015	380			4510	SE	Cs	E
Pho_gl 434		78I/1	27°49'54"	90°10'42"	5223	90			4400	SE	Ds	V
Pho_gl 435		78I/1	27°49'50"	90°10'53"	5470	100			4510	SE	Ds	V
Pho_gl 436		78I/1	27°50'48"	90°10'9"	2106	55			4750	S	Cs	E
Pho_gl 437		78I/1	27°49'13"	90°11'50"	6794	110			4470	SE	Cs	E
Pho_gl 438		78I/1	27°50'20"	90°11'10"	98370	470			4580	SW	Cs	C

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 439		78I/1	27°50'22"	90°12'19"	30952	230			4740	SE	Cs	E
Pho_gl 440		78I/1	27°50'32"	90°12'13"	14567	205			4700	SE	Cs	E
Pho_gl 441		78I/1	27°50'44"	90°12'26"	14686	240			4785	SE	Cs	E
Pho_gl 442		78I/1	27°50'38"	90°12'32"	2994	75			4830	SE	Cs	E
Pho_gl 443		78I/1	27°50'42"	90°12'33"	4322	110			4860	SW	Cs	E
Pho_gl 444		78I/1	27°50'9"	90°13'40"	73353	375			4815	SE	Ds	V
Pho_gl 445		78I/1	27°50'57"	90°12'57"	110403	500			4865	SW	Cs	E
Pho_gl 446		78I/1	27°51'43"	90°12'18"	38930	235			5030	SE	Cs	E
Pho_gl 447		78I/1	27°51'11"	90°13'18"	7115	115			4990	S	Cs	E
Pho_gl 448		78I/1	27°51'0"	90°13'25"	11227	165			5020	SE	Cs	E
Pho_gl 449		78I/1	27°51'59"	90°12'29"	4363	90			5025	?	Cs	E
Pho_gl 450		78I/1	27°50'35"	90°13'50"	3196	80			4910	SE	Cs	E
Pho_gl 451		78I/1	27°50'33"	90°13'54"	2139	60			4930	SE	Cs	E
Pho_gl 452		78I/1	27°50'47"	90°13'57"	3191	75			4910	SE	Ds	E
Pho_gl 453		78I/1	27°51'0"	90°14'13"	31926	220			4910	SE	Ds	V
Pho_gl 454		78I/1	27°51'50"	90°13'22"	23606	235			4940	SE	Ds	V
Pho_gl 455		78I/1	27°51'28"	90°13'31"	9936	145			4990	SE	Ds	E
Pho_gl 456		78I/1	27°51'27"	90°13'43"	2920	75			5000	NE	Ds	E
Pho_gl 457		78I/1	27°51'31"	90°13'55"	22730	255			5045	SE	Ds	E
Pho_gl 458		78I/1	27°52'21"	90°13'5"	7983	140	338	Pho_gr144	5100	SE	Cs	E
Pho_gl 459		78I/1	27°52'6"	90°14'3"	4314	100			4980	SE	Ds	V
Pho_gl 460		78I/1	27°52'3"	90°14'7"	15780	180			4985	SE	Ds	V
Pho_gl 461		78I/1	27°52'48"	90°13'23"	10088	145			5100	SE	Cs	E
Pho_gl 462		78I/1	27°52'10"	90°14'23"	42191	245	134	Pho_gr146	5060	SE	Cs	E
Pho_gl 463		78I/1	27°53'42"	90°14'1"	30808	285			4940	SE	Ds	V
Pho_gl 464		78I/1	27°53'28"	90°14'2"	11260	170	174	Pho_gr147	4995	NE	Ds	E
Pho_gl 465		78I/1	27°53'26"	90°14'26"	42224	455	555	Pho_gr149	5015	S	Ds	V
Pho_gl 466		78I/1	27°53'6"	90°14'29"	30355	205	297	Pho_gr149	5175	SE	Cs	E
Pho_gl 467		78I/5	27°53'11"	90°15'6"	4836	100			5090	SW	Ds	V
Pho_gl 468		78I/5	27°53'5"	90°15'12"	4174	105			5100	SW	Cs	E
Pho_gl 469		78I/5	27°53'7"	90°15'20"	3315	100	340	Pho_gr150	5110	SE	Ds	E
Pho_gl 470		78I/5	27°53'5"	90°15'24"	1731	65	278	Pho_gr150	5110	S	Ds	V
Pho_gl 471		78I/5	27°53'9"	90°15'30"	9364	140	42	Pho_gr150	5115	S	Ds	E
Pho_gl 472		78I/5	27°53'13"	90°15'27"	2106	55	114	Pho_gr150	5115	W	Cs	E
Pho_gl 473		78I/5	27°53'30"	90°15'17"	3841	80	197	Pho_gr150	5140	SW	Cs	E
Pho_gl 474		78I/5	27°52'18"	90°15'52"	18087	175			5070	SW	Ds	E
Pho_gl 475		78I/5	27°52'27"	90°15'42"	3854	85			5130	SW	Cs	E
Pho_gl 476		78I/5	27°52'51"	90°15'25"	3722	85			5070	SW	Ds	V
Pho_gl 477		78I/5	27°51'23"	90°15'42"	76861	380			5065	W	Ds	E
Pho_gl 478		78I/5	27°52'3"	90°16'23"	12305	185			5110	SW	Ds	E
Pho_gl 479		78I/5	27°52'5"	90°16'45"	17030	205			5110	SW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 480		78I/5	27°52'19"	90°16'10"	10804	135			5095	S	Cs	E
Pho_gl 481		78I/5	27°51'1"	90°16'49"	30285	235			5015	NW	Ds	E
Pho_gl 482		78I/5	27°51'45"	90°15'33"	17725	245			5065	SW	Cs	E
Pho_gl 483		78I/1	27°51'34"	90°14'2"	7333	120			4790	SW	Cs	E
Pho_gl 484		78I/1	27°50'36"	90°14'55"	5914	100			4790	SW	Cs	E
Pho_gl 485		78I/1	27°50'30"	90°14'49"	34509	300			4780	W	Ds	E
Pho_gl 486		78I/1	27°50'53"	90°14'48"	142868	580			4800	SW	Cs	E
Pho_gl 487		78I/5	27°51'41"	90°15'18"	9862	125			5020	NW	Ds	E
Pho_gl 488		78I/5	27°50'44"	90°15'59"	9278	140			4985	NW	Ds	E
Pho_gl 489		78I/5	27°50'30"	90°15'43"	50133	500	135	Pho_gr151	4870	NW	Ds	V
Pho_gl 490		78I/1	27°50'55"	90°14'24"	4195	80	122	Pho_gr152	4985	NW	Ds	E
Pho_gl 491		78I/1	27°49'29"	90°13'39"	315672	840			4660	NW	Ds	V
Pho_gl 492		78I/1	27°50'5"	90°14'5"	17199	220			4740	SW	Ds	V
Pho_gl 493		78I/1	27°50'11"	90°14'20"	5914	105			4780	SW	Cs	E
Pho_gl 494		78I/1	27°50'24"	90°14'9"	78687	535			4798	SW	Cs	V
Pho_gl 495		78I/1	27°49'2"	90°14'52"	41685	290			4740	W	Cs	V
Pho_gl 496		78I/1	27°49'59"	90°13'4"	4606	85	170	Pho_gr156	4820	NW	Ds	V
Pho_gl 497		78I/1	27°49'8"	90°14'7"	2213	80			4905	N	Cs	V
Pho_gl 498		78I/1	27°49'29"	90°14'7"	2755	75			5075	N	Cs	E
Pho_gl 499		78I/1	27°49'31"	90°13'14"	9414	145			4740	NW	Cs	E
Pho_gl 500		78I/1	27°49'48"	90°12'9"	137855	720			4670	NW	Cs	V
Pho_gl 501		78I/1	27°48'19"	90°11'44"	11281	155			4630	NW	Cs	E
Pho_gl 502		78I/1	27°48'19"	90°11'37"	16401	200			4635	NW	Cs	E
Pho_gl 503		78I/1	27°48'6"	90°11'37"	20777	215			4580	NE	Cs	E
Pho_gl 504		78I/1	27°48'10"	90°11'28"	12519	175			4585	NE	Cs	E
Pho_gl 505		78I/1	27°48'11"	90°10'24"	3142	75			4310	NW	Cs	E
Pho_gl 506		78I/1	27°48'1"	90°10'6"	61179	455			4270	NW	Ds	V
Pho_gl 507		78I/1	27°47'30"	90°9'45"	7575	165			4280	SW	Cs	E
Pho_gl 508		78I/1	27°47'46"	90°9'15"	2155	65			4585	SW	Cs	E
Pho_gl 509		78I/1	27°47'52"	90°9'18"	2237	70			4585	SW	Cs	E
Pho_gl 510		78I/1	27°47'55"	90°9'21"	1563	60			4585	SW	Cs	E
Pho_gl 511		78I/1	27°47'5"	90°10'28"	3849	90			4570	SW	Cs	E
Pho_gl 512		78I/1	27°46'4"	90°10'59"	11705	185			4345	S	Ds	V
Pho_gl 513		78I/1	27°47'15"	90°10'3"	3261	80			4375	SW	Ds	E
Pho_gl 514		78I/1	27°47'43"	90°10'22"	2632	85			4500	SW	Cs	E
Pho_gl 515		78I/1	27°47'46"	90°10'24"	1065	50			4520	SW	Cs	E
Pho_gl 516		78I/1	27°47'49"	90°10'25"	1518	50			4530	SW	Cs	E
Pho_gl 517		78I/1	27°47'52"	90°10'28"	4602	85			4540	SW	Cs	E
Pho_gl 518		78I/1	27°47'55"	90°10'34"	5363	120			4540	W	Cs	E
Pho_gl 519		78I/1	27°48'32"	90°11'17"	13160	240			4620	SW	Ds	V
Pho_gl 520		78I/1	27°47'37"	90°11'13"	9813	185			4620	S	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Pho_gl 521		78I/1	27°47'9"	90°12'33"	173133	755			4554	SW	Ds	V
Pho_gl 522		78I/1	27°47'52"	90°11'40"	2303	65			4710	S	Cs	E
Pho_gl 523		78I/1	27°47'6"	90°12'56"	10298	145			4620	SE	Ds	V
Pho_gl 524		78I/1	27°48'4"	90°12'1"	2591	80			4625	SE	Ds	V
Pho_gl 525		78I/1	27°48'8"	90°12'12"	4795	115			4740	S	Cs	E
Pho_gl 526		78I/1	27°48'35"	90°12'18"	61743	425			4790	SW	Cs	E
Pho_gl 527		78I/1	27°47'21"	90°12'46"	28686	330			4560	SW	Ds	V
Pho_gl 528		78I/1	27°46'55"	90°10'25"	32280	385			4220	NW	Ds	V
Pho_gl 529		78I/1	27°46'43"	90°12'22"	96766	785			4500	SW	Ds	V
Pho_gl 530		78I/1	27°46'49"	90°12'47"	80295	510			4520	SE	Ds	V
Pho_gl 531		78I/1	27°47'42"	90°12'1"	45975	305			4500	SE	Ds	V
Pho_gl 532		78I/1	27°46'27"	90°10'11"	14970	155			4430	NW	Ds	E
Pho_gl 533		78I/1	27°45'28"	90°10'38"	150320	635			4360	NW	Ds	C
Pho_gl 534		78I/1	27°45'6"	90°11'43"	27962	250			4500	W	Cs	E
Pho_gl 535		78I/1	27°45'3"	90°10'11"	155260	500			4225	NW	Ds	C
Pho_gl 536		78I/2	27°44'49"	90°10'51"	38371	235			4380	NW	Ds	E
Pho_gl 537		78I/2	27°44'30"	90°10'50"	30972	280			4355	NW	Cs	E
Pho_gl 538		78I/2	27°44'45"	90°9'14"	115277	470			4420	NW	Ds	V
Pho_gl 539		78I/2	27°44'24"	90°9'17"	2365	60			4460	W	Ds	V
Pho_gl 540		78I/2	27°44'35"	90°9'4"	22097	345			4430	SW	Ds	V
Pho_gl 541		78I/2	27°43'46"	90°9'59"	10434	155			4500	W	Ds	E
Pho_gl 542		78I/2	27°43'46"	90°9'53"	12465	185			4510	NW	Ds	E
Pho_gl 543		78I/2	27°43'9"	90°9'38"	10894	135			4495	NW	Ds	E
Pho_gl 544		78I/2	27°41'4"	90°9'55"	15077	205			4160	NW	Ds	V
Pho_gl 545		78I/2	27°41'9"	90°9'39"	5511	120			4270	NE	Ds	V
Pho_gl 546		78I/2	27°44'36"	90°6'1"	14295	135			4080	W	Ds	V
Pho_gl 547		78I/2	27°41'51"	90°5'30"	5897	95			4100	NE	Ds	V
Pho_gl 548		78I/2	27°42'7"	90°5'26"	4030	100			4380	NW	Cs	E
Pho_gl 549		78I/2	27°41'25"	90°4'60"	2969	80			4355	NW	Ds	E

Glacial Lake Inventory of Tang (Dang) Chu Basin

Total Number :51 Total Area : 1.81 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Tang_gl 1		78I/2	27°41'18"	90°9'48"	8357	80			4280	S	Cs	E
Tang_gl 2		78I/2	27°41'31"	90°9'29"	6017	80			4260	E	Ds	V
Tang_gl 3		78I/2	27°43'12"	90°10'31"	46991	345			4260	SE	Ds	C
Tang_gl 4		78I/2	27°43'42"	90°10'28"	3449	75			4600	S	Ds	E
Tang_gl 5		78I/2	27°43'46"	90°10'28"	5193	85			4580	S	Cs	E
Tang_gl 6		78I/2	27°43'46"	90°10'21"	11436	135			4600	E	Cs	E
Tang_gl 7		78I/2	27°43'50"	90°10'27"	16948	220			4580	SE	Ds	E
Tang_gl 8		78I/2	27°44'22"	90°11'23"	100492	515			4300	E	Ds	C
Tang_gl 9		78I/1	27°45'22"	90°11'51"	137698	700			4404	SW	Ds	V
Tang_gl 10		78I/1	27°45'9"	90°12'42"	4287	95			4420	SW	Ds	E
Tang_gl 11		78I/1	27°45'23"	90°12'50"	14799	210			4580	SW	Cs	E
Tang_gl 12		78I/1	27°45'52"	90°12'44"	21331	205			4680	S	Ds	E
Tang_gl 13		78I/2	27°45'11"	90°12'51"	3649	80			4700	SW	Cs	E
Tang_gl 14		78I/2	27°44'3"	90°12'21"	13567	160			4180	SW	Ds	V
Tang_gl 15		78I/2	27°44'11"	90°12'36"	32776	260			4220	SW	Ds	V
Tang_gl 16		78I/2	27°44'29"	90°12'36"	3467	85			4400	S	Ds	E
Tang_gl 17		78I/2	27°43'52"	90°12'35"	27114	250			4220	SW	Ds	E
Tang_gl 18		78I/1	27°44'20"	90°13'46"	12217	195			4230	SE	Ds	V
Tang_gl 19		78I/1	27°45'27"	90°13'3"	6126	135			4460	SE	Ds	E
Tang_gl 20		78I/1	27°45'53"	90°12'55"	57519	400			4700	S	Cs	E
Tang_gl 21		78I/1	27°45'37"	90°13'46"	3632	65			4320	S	Cs	E
Tang_gl 22		78I/1	27°47'34"	90°13'29"	4072	105			4650	SE	Ds	V
Tang_gl 23		78I/1	27°47'37"	90°13'12"	2516	65			4790	NE	Cs	E
Tang_gl 24		78I/1	27°48'13"	90°13'16"	3082	65			4940	SE	Cs	E
Tang_gl 25		78I/1	27°48'22"	90°13'13"	2988	85			5050	SE	Cs	E
Tang_gl 26		78I/1	27°48'18"	90°13'21"	7918	125			4940	SW	Cs	E
Tang_gl 27		78I/1	27°48'2"	90°13'36"	4592	85			4780	SE	Cs	E
Tang_gl 28		78I/1	27°47'53"	90°13'36"	1826	50			4760	SE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Tang_gl 29		78I/1	27°47'44"	90°13'46"	5591	135			4706	SE	Cs	E
Tang_gl 30		78I/1	27°47'30"	90°14'10"	5140	120			4720	SW	Ds	V
Tang_gl 31		78I/1	27°47'60"	90°14'2"	789374	1560			4730	SE	Ds	V
Tang_gl 32		78I/1	27°48'9"	90°14'15"	3657	85			4740	W	Cs	E
Tang_gl 33		78I/1	27°48'9"	90°14'27"	113838	505			4750	SW	Cs	V
Tang_gl 34		78I/1	27°47'13"	90°14'20"	5988	90			4720	SW	Cs	E
Tang_gl 35		78I/1	27°47'2"	90°14'36"	4352	125			4660	SW	Cs	E
Tang_gl 36		78I/1	27°46'43"	90°14'59"	15577	175			4580	SE	Cs	E
Tang_gl 37		78I/5	27°47'24"	90°14'46"	5496	145			4740	SE	Cs	E
Tang_gl 38		78I/5	27°46'29"	90°16'4"	6899	135			4320		Ds	V
Tang_gl 39		78I/5	27°46'51"	90°16'16"	5037	85			4500		Cs	E
Tang_gl 40		78I/5	27°46'59"	90°16'7"	35605	235			4540		Cs	E
Tang_gl 41		78I/5	27°46'14"	90°16'43"	1733	50			4620		Cs	E
Tang_gl 42		78I/5	27°46'19"	90°16'40"	3825	85			4660	SE	Cs	E
Tang_gl 43		78I/5	27°46'25"	90°16'44"	1658	50			4720	SW	Cs	E
Tang_gl 44		78I/5	27°46'20"	90°17'13"	3034	75			4700	S	Ds	V
Tang_gl 45		78I/5	27°46'2"	90°17'22"	9467	135			4600	NW	Ds	V
Tang_gl 46		78I/5	27°45'55"	90°17'37"	15686	170			4740	W	Ds	V
Tang_gl 47		78I/5	27°45'48"	90°17'16"	57856	385			4550	NW	Ds	E
Tang_gl 48		78I/5	27°45'47"	90°16'44"	65655	440			4400	SW	Ds	E
Tang_gl 49		78I/5	27°45'1"	90°17'0"	65585	450			4362	W	Ds	V
Tang_gl 50		78I/6	27°44'36"	90°16'37"	20352	265			4440	N	Ds	C
Tang_gl 51		78I/6	27°42'46"	90°16'29"	9025	120			4280	SW	Ds	E

Glacial Lake Inventory of Mangde Chu Basin

Total Number :521   Total Area : 17.59 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Mangd_gl 1		78I/7	27°18'34"	90°22'29"	52525	305			4160	NE	Ds	E
Mangd_gl 2		78I/7	27°19'31"	90°21'47"	7954	120			4120	NE	Ds	E
Mangd_gl 3		78I/7	27°20'10"	90°20'47"	10877	170			4125	N	Ds	E
Mangd_gl 4		78I/7	27°19'56"	90°20'50"	5862	95			4140	N	Ds	E
Mangd_gl 5		78I/7	27°19'52"	90°20'50"	5277	70			4320	N	Ds	E
Mangd_gl 6		78I/7	27°20'32"	90°20'14"	11170	150			4200	NE	Css	E
Mangd_gl 7		78I/7	27°20'54"	90°20'6"	18370	215			4040	NE	Ds	E
Mangd_gl 8		78I/7	27°21'4"	90°20'10"	8216	110			4040	SE	Cs	E
Mangd_gl 9		78I/7	27°21'10"	90°19'23"	11339	150			4160	NE	Ds	E
Mangd_gl 10		78I/7	27°22'15"	90°19'35"	9785	115			4200	SE	Ds	E
Mangd_gl 11		78I/7	27°22'47"	90°19'31"	36140	260			4240	SE	Ds	C
Mangd_gl 12		78I/7	27°23'22"	90°19'52"	21232	205			4280	SE	Ds	E
Mangd_gl 13		78I/7	27°21'60"	90°20'12"	6969	115			4160	W	Cs	E
Mangd_gl 14		78I/7	27°22'49"	90°21'44"	7800	100			4280	SW	Ds	E
Mangd_gl 15		78I/7	27°22'26"	90°22'56"	13000	120			4240	SE	Ds	E
Mangd_gl 16		78I/7	27°22'29"	90°22'51"	11108	170			4280	SE	Ds	E
Mangd_gl 17		78I/7	27°22'40"	90°23'36"	9831	120			4240	SE	Ds	E
Mangd_gl 18		78I/7	27°22'47"	90°23'31"	11416	145			4240	SE	Ds	E
Mangd_gl 19		78I/7	27°22'47"	90°23'20"	18401	200			4320	SE	Ds	E
Mangd_gl 20		78I/7	27°22'58"	90°22'58"	36601	270			4240	NE	Ds	V
Mangd_gl 21		78I/6	27°23'6"	90°18'54"	10616	140			4200	NE	Ds	E
Mangd_gl 22		78I/6	27°42'43"	90°17'25"	33709	250			4200	SE	Ds	V
Mangd_gl 23		78I/6	27°42'60"	90°17'37"	145005	755			4280	SW	Cs	V
Mangd_gl 24		78I/6	27°42'39"	90°18'9"	29216	340			4360	SW	Cs	V
Mangd_gl 25		78I/6	27°41'34"	90°18'54"	5000	100			4200	SW	Ds	E
Mangd_gl 26		78I/6	27°39'23"	90°20'1"	82880	450			4160	NW	Ds	C
Mangd_gl 27		78I/6	27°37'58"	90°18'49"	41694	380			4400	SW	Ds	C
Mangd_gl 28		78I/6	27°38'31"	90°20'38"	14231	175			4240	SE	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 29		78I/6	27°37'56"	90°21'28"	2754	70			4120	S	Cs	E
Mangd_gl 30		78I/6	27°38'1"	90°21'33"	4816	90			4120	SW	Cs	E
Mangd_gl 31		78I/6	27°37'51"	90°21'56"	7970	165			4000	S	Ds	E
Mangd_gl 32		78I/6	27°38'42"	90°22'37"	18401	225			4140	NE	Ds	E
Mangd_gl 33		78I/6	27°38'35"	90°22'10"	12477	100			4200	N	Ds	E
Mangd_gl 34		78I/6	27°38'31"	90°21'47"	13324	130			4155	N	Ds	E
Mangd_gl 35		78I/6	27°39'51"	90°22'33"	19293	280			4190	NE	Ds	E
Mangd_gl 36		78I/6	27°41'12"	90°23'50"	10508	205			4400	SW	Ds	E
Mangd_gl 37		78I/6	27°40'57"	90°24'42"	15016	165			4280	SW	Ds	E
Mangd_gl 38		78I/6	27°40'15"	90°24'9"	9508	160			4200	SW	Ds	E
Mangd_gl 39		78I/6	27°39'60"	90°24'42"	22047	240			4120	S	Ds	V
Mangd_gl 40		78I/6	27°40'8"	90°24'33"	10262	200			4240	NE	Ds	E
Mangd_gl 41		78I/6	27°40'34"	90°24'33"	7246	85			4280	SE	Ds	E
Mangd_gl 42		78I/6	27°40'17"	90°26'9"	4016	85			4120	SW	Cs	E
Mangd_gl 43		78I/6	27°40'1"	90°26'19"	1923	70			4040	SW	Ds	E
Mangd_gl 44		78I/6	27°41'11"	90°25'26"	19847	135			4200	NW	Cs	E
Mangd_gl 45		78I/6	27°41'13"	90°24'55"	19585	205			4240	NE	Ds	E
Mangd_gl 46		78I/6	27°41'21"	90°24'48"	3000	80			4320	NE	Cs	E
Mangd_gl 47		78I/6	27°41'51"	90°23'54"	38832	315			4200	NW	Ds	V
Mangd_gl 48		78I/6	27°41'50"	90°23'14"	6385	115			4240	NW	Ds	V
Mangd_gl 49		78I/6	27°41'33"	90°23'21"	26909	255			4400	N	Ds	V
Mangd_gl 50		78I/6	27°43'11"	90°19'44"	283949	885			4200	NE	Ds	M
Mangd_gl 51		78I/6	27°42'43"	90°19'49"	58279	495			4320	NW	Ds	E
Mangd_gl 52		78I/6	27°42'54"	90°19'1"	5216	115			4480	NE	Ds	E
Mangd_gl 53		78I/6	27°42'40"	90°19'1"	2323	65			4560	NW	Ds	E
Mangd_gl 54		78I/6	27°43'54"	90°19'30"	55510	335			4280	NE	Ds	V
Mangd_gl 55		78I/6	27°44'16"	90°17'59"	109927	450			4360	NE	Ds	C
Mangd_gl 56		78I/5	27°44'51"	90°17'50"	192392	545			4520	SE	Ds	C
Mangd_gl 57		78I/5	27°45'6"	90°18'19"	76649	520			4600	SE	Ds	V
Mangd_gl 58		78I/5	27°45'20"	90°18'4"	104589	450			4560	SE	Ds	C
Mangd_gl 59		78I/5	27°45'27"	90°18'48"	9416	140			4520	NE	Ds	E
Mangd_gl 60		78I/5	27°45'21"	90°18'33"	4569	65			4640	SE	Cs	E
Mangd_gl 61		78I/5	27°45'29"	90°18'28"	4431	70			4680	SE	Ds	E
Mangd_gl 62		78I/5	27°45'57"	90°18'34"	4585	95			4560	NE	Ds	V
Mangd_gl 63		78I/5	27°46'9"	90°18'23"	5077	105			4680	SE	Cs	E
Mangd_gl 64		78I/5	27°47'23"	90°17'58"	3139	70			4560	NE	Ds	E
Mangd_gl 65		78I/5	27°47'25"	90°17'56"	2339	60			4560	NE	Cs	V
Mangd_gl 66		78I/5	27°47'21"	90°17'20"	42417	350			4640	NE	Cs	C
Mangd_gl 67		78I/5	27°49'32"	90°15'36"	31293	355	145	Mangd_gr1	4960	SW	Ds	V
Mangd_gl 68		78I/5	27°48'44"	90°15'29"	120897	530			4800	SW	Ds	V
Mangd_gl 69		78I/5	27°49'6"	90°15'48"	5154	85			4920	SW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 70		78I/5	27°49'9"	90°15'51"	9508	170			4920	SW	Cs	E
Mangd_gl 71		78I/5	27°48'49"	90°15'50"	12370	205			4880	SW	Ds	V
Mangd_gl 72		78I/5	27°48'53"	90°15'47"	16724	140			4880	SE	Cs	E
Mangd_gl 73		78I/5	27°48'42"	90°16'3"	3139	90			4960	NW	Ds	E
Mangd_gl 74		78I/5	27°48'39"	90°15'60"	12447	170			4960	NW	Ds	E
Mangd_gl 75		78I/5	27°48'1"	90°15'40"	7123	120			4720	SE	Cs	E
Mangd_gl 76		78I/5	27°48'11"	90°15'43"	29940	305			4720	SE	Ds	V
Mangd_gl 77		78I/5	27°48'45"	90°16'32"	6985	155			4880	SE	Ds	V
Mangd_gl 78		78I/5	27°48'54"	90°16'32"	3031	75			4880	SE	Cs	E
Mangd_gl 79		78I/5	27°48'58"	90°16'27"	1154	45			4880	SE	Cs	E
Mangd_gl 80		78I/5	27°49'6"	90°16'33"	217085	700	680	Mangd_gr2	4890	S	Ds	C
Mangd_gl 81		78I/5	27°49'21"	90°16'5"	5077	105	110	Mangd_gr2	5040	SE	Cs	E
Mangd_gl 82		78I/5	27°48'35"	90°17'17"	5231	100			4800	SE	Cs	E
Mangd_gl 83		78I/5	27°48'40"	90°17'16"	1400	40			4800	SE	Cs	E
Mangd_gl 84		78I/5	27°49'22"	90°17'2"	11262	140	415	Mangd_gr3	4960	NE	Cs	C
Mangd_gl 85		78I/5	27°50'48"	90°16'50"	36863	265			4880	SE	Ds	V
Mangd_gl 86		78I/5	27°50'43"	90°16'42"	4908	80	480	Mangd_gr4	4920	SE	Cs	E
Mangd_gl 87		78I/5	27°50'57"	90°16'15"	8123	135	295	Mangd_gr5	5080	SE	Ds	V
Mangd_gl 88		78I/5	27°51'7"	90°16'9"	6877	135			5120	NE	Cs	V
Mangd_gl 89		78I/5	27°51'6"	90°16'24"	3369	45			5080	SE	Ds	E
Mangd_gl 90		78I/5	27°51'26"	90°16'36"	52710	265			5000	SE	Ds	V
Mangd_gl 91		78I/5	27°53'13"	90°16'12"	50387	355			5080	SE	Ds	C
Mangd_gl 92		78I/5	27°53'17"	90°16'2"	3600	70			5120	NE	Ds	E
Mangd_gl 93		78I/5	27°53'36"	90°16'6"	6293	145			5120	SE	Ds	V
Mangd_gl 94		78I/5	27°53'37"	90°15'58"	13693	145			5160	SE	Ds	V
Mangd_gl 95		78I/5	27°54'29"	90°16'20"	88357	460	520	Mangd_gr6	5160	S	Ds	V
Mangd_gl 96		78I/5	27°54'13"	90°16'15"	10800	170	520	Mangd_gr6	5100	NE	Cs	C
Mangd_gl 97		78I/5	27°54'39"	90°16'12"	5877	140	520	Mangd_gr6	5200	SE	Cs	E
Mangd_gl 98		78I/5	27°54'10"	90°16'33"	7200	125	655	Mangd_gr8	5120	S	Cs	V
Mangd_gl 99		78I/5	27°54'22"	90°16'46"	192607	605	0	Mangd_gr8	4960	SW	Ds	M
Mangd_gl 100		78I/5	27°54'42"	90°16'45"	59787	290	105	Mangd_gr7	5160	SW	Cs	C
Mangd_gl 101		78I/5	27°54'4"	90°16'32"	11647	160			5120	W	Ds	B
Mangd_gl 102		78I/5	27°53'32"	90°16'47"	6231	125			5080	SE	Cs	V
Mangd_gl 103		78I/5	27°52'55"	90°16'49"	21585	235			5000	S	Cs	E
Mangd_gl 104		78I/5	27°52'36"	90°17'1"	521081	1165		Mangd_gr9	5000	SW	Ds	V
Mangd_gl 105		78I/5	27°52'59"	90°17'14"	8446	190	1450	Mangd_gr10	5040	SW	Ds	V
Mangd_gl 106		78I/5	27°53'19"	90°17'34"	868294	1480	0	Mangd_gr10	5040	SW	Ds	V
Mangd_gl 107		78I/5	27°53'1"	90°17'47"	51402	275	378	Mangd_gr11	5080	SW	Cs	V
Mangd_gl 108		78I/5	27°53'1"	90°18'3"	34355	220	0	Mangd_gr11	5080	W	Ds	V
Mangd_gl 109		78I/5	27°52'18"	90°16'60"	38217	260			5040	SW	Cs	V
Mangd_gl 110		78I/5	27°52'9"	90°17'1"	6139	115			5040	SW	Cs	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 111		78I/5	27°52'26"	90°17'45"	141713	570			5160	S	Ds	V
Mangd_gl 112		78I/5	27°52'40"	90°17'59"	34909	245			5200	SW	Cs	E
Mangd_gl 113		78I/5	27°51'49"	90°17'17"	3585	75			5040	W	Ds	V
Mangd_gl 114		78I/5	27°51'39"	90°17'55"	203700	740	215	Mangd_gr12	4960	SW	Ds	V
Mangd_gl 115		78I/5	27°50'43"	90°18'23"	236901	650		Mangd_gr13	4880	SE	Ds	B
Mangd_gl 116		78I/5	27°51'32"	90°18'55"	114927	765	600	Mangd_gr13	4920	SW	Cs	C
Mangd_gl 117		78I/5	27°51'41"	90°19'10"	3969	130	360	Mangd_gr14	4960	SW	Ds	V
Mangd_gl 118		78I/5	27°50'58"	90°18'58"	18078	225	185	Mangd_gr15	5040	SW	Ds	V
Mangd_gl 119		78I/5	27°50'43"	90°18'46"	19770	150	500	Mangd_gr16	4920	W	Cs	E
Mangd_gl 120		78I/5	27°50'13"	90°18'8"	6985	100			4880	W	Cs	E
Mangd_gl 121		78I/5	27°49'50"	90°18'46"	4954	115			4880	SW	Ds	V
Mangd_gl 122		78I/5	27°48'53"	90°18'44"	6231	110	325	Mangd_gr20	4880	SW	Ds	V
Mangd_gl 123		78I/5	27°48'29"	90°19'0"	5831	100			4960	SW	Cs	E
Mangd_gl 124		78I/5	27°47'40"	90°18'60"	3169	60			4640	SW	Ds	V
Mangd_gl 125		78I/5	27°47'44"	90°19'3"	8031	115			4680	SW	Ds	V
Mangd_gl 126		78I/5	27°47'57"	90°19'45"	7662	125			5000	SW	Ds	E
Mangd_gl 127		78I/5	27°46'53"	90°19'48"	7216	80			4880	NW	Ds	C
Mangd_gl 128		78I/5	27°45'44"	90°20'49"	2277	70			4560	SW	Ds	E
Mangd_gl 129		78I/5	27°45'24"	90°21'24"	27109	290			4400	NE	Ds	C
Mangd_gl 130		78I/5	27°47'42"	90°20'9"	7200	120			4920	S	Ds	V
Mangd_gl 131		78I/5	27°48'14"	90°20'17"	4446	70			4640	E	Ds	V
Mangd_gl 132		78I/5	27°49'21"	90°20'16"	29909	235	558	Mangd_gr22	4800	SE	Ds	V
Mangd_gl 133		78I/5	27°50'8"	90°19'36"	3939	90			5040	SE	Ds	E
Mangd_gl 134		78I/5	27°50'16"	90°20'3"	15031	105			4960	SE	Ds	E
Mangd_gl 135		78I/5	27°50'18"	90°19'44"	29493	175			4960	SE	Cs	V
Mangd_gl 136		78I/5	27°50'6"	90°20'25"	10816	95			4960	W	Cs	B
Mangd_gl 137		78I/5	27°49'52"	90°20'19"	8354	100			4920	SW	Cs	C
Mangd_gl 138		78I/5	27°49'5"	90°21'6"	4123	90			4800	SE	Cs	E
Mangd_gl 139		78I/5	27°49'16"	90°21'10"	22216	280			4800	S	Ds	V
Mangd_gl 140		78I/5	27°49'54"	90°20'57"	6077	95			4920	S	Ds	V
Mangd_gl 141		78I/5	27°50'9"	90°20'57"	68741	305			4960	SE	Ds	V
Mangd_gl 142		78I/5	27°50'23"	90°20'41"	3200	40			4960	SE	Ds	V
Mangd_gl 143		78I/5	27°50'28"	90°20'54"	70495	415			4960	SW	Ds	V
Mangd_gl 144		78I/5	27°50'37"	90°20'41"	30847	325	643	Mangd_gr23	5000	SE	Ds	V
Mangd_gl 145		78I/5	27°50'42"	90°21'4"	5000	135			5040	SW	Ds	V
Mangd_gl 146		78I/5	27°50'29"	90°21'14"	2662	55			5000	W	Ds	V
Mangd_gl 147		78I/5	27°50'24"	90°21'19"	6062	125			5000	SW	Ds	V
Mangd_gl 148		78I/5	27°50'43"	90°21'35"	7462	190			5040	SW	Ds	V
Mangd_gl 149		78I/5	27°50'7"	90°21'30"	12770	154			4960	SW	Ds	V
Mangd_gl 150		78I/5	27°49'19"	90°21'39"	65079	358			4840	SW	Ds	V
Mangd_gl 151		78I/5	27°49'32"	90°21'48"	39125	280			4896	SW	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 152		78I/5	27°49'38"	90°21'38"	6108	95			4880	S	Cs	V
Mangd_gl 153		78I/5	27°49'50"	90°21'58"	32940	200			4960	W	Ds	V
Mangd_gl 154		78I/5	27°48'41"	90°21'37"	28032	115			4680	SW	Ds	V
Mangd_gl 155		78I/5	27°48'48"	90°21'56"	115743	350			4760	SW	Ds	V
Mangd_gl 156		78I/5	27°49'30"	90°22'27"	4246	90			5120	SW	Cs	E
Mangd_gl 157		78I/5	27°48'49"	90°22'19"	1985	50			4800	W	Cs	V
Mangd_gl 158		78I/5	27°47'53"	90°21'27"	6554	125			4600	SW	Ds	V
Mangd_gl 159		78I/5	27°47'59"	90°21'37"	5585	110			4640	SW	Ds	V
Mangd_gl 160		78I/5	27°48'21"	90°21'57"	9708	190			4800	SW	Ds	V
Mangd_gl 161		78I/5	27°48'3"	90°21'51"	8816	155			4680	SW	Cs	E
Mangd_gl 162		78I/5	27°47'36"	90°22'52"	14831	210			4800	SW	Ds	V
Mangd_gl 163		78I/5	27°47'37"	90°22'45"	32247	350			4560	SW	Ds	V
Mangd_gl 164		78I/5	27°47'52"	90°22'33"	3308	55			4760	E	Cs	E
Mangd_gl 165		78I/5	27°47'54"	90°22'55"	35817	310			4600	SW	Ds	V
Mangd_gl 166		78I/5	27°48'32"	90°22'33"	10647	130			4920	SW	Cs	E
Mangd_gl 167		78I/5	27°46'51"	90°22'51"	76295	610			4520	SW	Ds	V
Mangd_gl 168		78I/5	27°47'18"	90°23'27"	24539	210			4680	SW	Ds	V
Mangd_gl 169		78I/5	27°47'31"	90°23'35"	8493	120			4680	SW	Ds	V
Mangd_gl 170		78I/5	27°47'30"	90°23'25"	3877	90			4720	E	Ds	V
Mangd_gl 171		78I/5	27°47'26"	90°23'16"	36094	210			4680	SE	Cs	C
Mangd_gl 172		78I/5	27°47'39"	90°23'24"	2985	55			4720	SE	Cs	E
Mangd_gl 173		78I/5	27°46'39"	90°23'25"	3816	95			4760	SE	Cs	E
Mangd_gl 174		78I/5	27°46'45"	90°24'13"	136190	615			4507	SE	Ds	V
Mangd_gl 175		78I/5	27°47'28"	90°24'5"	114174	405			4800	S	Cs	C
Mangd_gl 176		78I/5	27°46'12"	90°25'9"	232809	870			4640	SW	Ds	V
Mangd_gl 177		78I/5	27°46'7"	90°24'56"	6708	75			4680	E	Cs	C
Mangd_gl 178		78I/5	27°46'20"	90°24'53"	2123	50			4800	SE	Cs	E
Mangd_gl 179		78I/5	27°46'22"	90°24'54"	1108	45			4800	SE	Cs	E
Mangd_gl 180		78I/5	27°46'26"	90°25'39"	89034	490			4687	SW	Ds	V
Mangd_gl 181		78I/5	27°46'50"	90°25'41"	8831	95			4880	S	Cs	E
Mangd_gl 182		78I/5	27°45'1"	90°24'52"	15693	135			4540	S	Cs	E
Mangd_gl 183		78I/5	27°45'38"	90°25'26"	21355	200			4480	SE	Ds	C
Mangd_gl 184		78I/5	27°45'40"	90°25'38"	5185	110			4480	SE	Ds	V
Mangd_gl 185		78I/5	27°45'58"	90°25'44"	58310	325			4560	SW	Ds	V
Mangd_gl 186		78I/5	27°45'52"	90°25'34"	4492	65			4560	S	Cs	E
Mangd_gl 187		78I/5	27°46'10"	90°27'23"	98942	335			4560	SE	Ds	C
Mangd_gl 188		78I/5	27°47'43"	90°29'51"	9170	155			3160	E	Ds	V
Mangd_gl 189		78I/5	27°47'42"	90°29'45"	2677	90			3160	E	Ds	V
Mangd_gl 190		78I/5	27°46'59"	90°29'12"	4769	60			3880	NE	Cs	C
Mangd_gl 191		78I/5	27°46'51"	90°28'17"	30817	280			4200	NW	Ds	C
Mangd_gl 192		78I/5	27°46'36"	90°28'2"	37771	245			4520	NE	Ds	C

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 193		78I/5	27°47'16"	90°27'19"	9539	115			4280	E	Ds	V
Mangd_gl 194		78I/5	27°46'58"	90°27'20"	14816	190			4520	N	Ds	V
Mangd_gl 195		78I/5	27°46'51"	90°27'24"	20293	275			4560	N	Cs	V
Mangd_gl 196		78I/5	27°46'54"	90°26'58"	27370	215			4440	N	Ds	V
Mangd_gl 197		78I/5	27°46'46"	90°26'47"	211316	845			4520	N	Ds	V
Mangd_gl 198		78I/5	27°46'15"	90°26'47"	30632	250			4560	N	Ds	V
Mangd_gl 199		78I/5	27°46'27"	90°26'25"	17416	130			4680	E	Ds	V
Mangd_gl 200		78I/5	27°46'39"	90°26'25"	10308	160			4760	NE	Ds	V
Mangd_gl 201		78I/5	27°47'2"	90°26'33"	8462	95			4560	SE	Ds	C
Mangd_gl 202		78I/5	27°47'28"	90°25'31"	286842	1110			4480	NE	Ds	V
Mangd_gl 203		78I/5	27°47'13"	90°25'29"	7400	125			4960	NE	Cs	E
Mangd_gl 204		78I/5	27°46'54"	90°25'13"	28355	225			4720	NE	Ds	V
Mangd_gl 205		78I/5	27°47'26"	90°25'11"	2246	55			4640	S	Ds	V
Mangd_gl 206		78I/5	27°47'33"	90°25'12"	4185	65			4640	SE	Ds	V
Mangd_gl 207		78I/5	27°47'30"	90°24'45"	157191	505			4720	E	Ds	C
Mangd_gl 208		78I/5	27°48'31"	90°24'35"	345875	1085			4705	NE	Ds	V
Mangd_gl 209		78I/5	27°48'17"	90°24'12"	6585	110			4800	N	Cs	E
Mangd_gl 210		78I/5	27°48'8"	90°24'6"	116312	470			4800	NE	Cs	V
Mangd_gl 211		78I/5	27°48'25"	90°24'6"	21524	210			4760	NE	Ds	V
Mangd_gl 212		78I/5	27°49'17"	90°24'17"	7554	100			4680	SE	Ds	V
Mangd_gl 213		78I/5	27°49'7"	90°23'53"	135128	605			4720	N	Ds	C
Mangd_gl 214		78I/5	27°49'13"	90°23'36"	8908	160			4800	E	Ds	V
Mangd_gl 215		78I/5	27°49'12"	90°23'21"	40602	340			4800	E	Ds	V
Mangd_gl 216		78I/5	27°49'9"	90°23'9"	2262	70			4840	NE	Cs	E
Mangd_gl 217		78I/5	27°49'4"	90°22'37"	10154	140			4760	NW	Cs	E
Mangd_gl 218		78I/5	27°50'14"	90°23'22"	15185	200	220	Mangd_gr24	4840	NW	Ds	V
Mangd_gl 219		78I/5	27°50'3"	90°23'27"	60110	380	845	Mangd_gr24	4840	NW	Cs	V
Mangd_gl 220		78I/5	27°49'46"	90°23'20"	11677	190	415	Mangd_gr24	4960	NE	Cs	E
Mangd_gl 221		78I/5	27°49'47"	90°23'10"	7354	120	205	Mangd_gr24	4960	NE	Cs	E
Mangd_gl 222		78I/5	27°50'5"	90°23'3"	18893	160	555	Mangd_gr24	4960	N	Cs	V
Mangd_gl 223		78I/5	27°50'26"	90°23'14"	14354	181	1265	Mangd_gr24	4840	NE	Ds	V
Mangd_gl 224		78I/5	27°50'17"	90°22'51"	36463	365	615	Mangd_gr24/2	4875	NE	Ds	V
Mangd_gl 225		78I/5	27°50'1"	90°22'30"	5800	130	500	Mangd_gr25	4760	NE	Cs	E
Mangd_gl 226		78I/5	27°50'16"	90°22'38"	11231	215			4920	NE	Ds	V
Mangd_gl 227		78I/5	27°50'30"	90°22'28"	4046	120			5000	SE	Cs	E
Mangd_gl 228		78I/5	27°50'42"	90°22'46"	2646	95			4960	N	Cs	E
Mangd_gl 229		78I/5	27°50'56"	90°22'34"	10031	155			4960	SE	Ds	V
Mangd_gl 230		78I/5	27°51'3"	90°22'12"	2985	60	210	Mangd_gr26	5040	E	Cs	E
Mangd_gl 231		78I/5	27°51'18"	90°22'9"	4046	80			5160	E	Ds	V
Mangd_gl 232		78I/5	27°51'27"	90°21'30"	2369	60	340	Mangd_gr27	4800	N	Cs	E
Mangd_gl 233		78I/5	27°51'30"	90°21'6"	5523	110	305	Mangd_gr28	4840	NE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 234		78I/5	27°52'6"	90°21'8"	70803	495	0	Mangd_gr30	5120	SE	Cs	E
Mangd_gl 235		78I/5	27°52'22"	90°20'38"	10047	75	0	Mangd_gr30	5160	SE	Cs	E
Mangd_gl 236		78I/5	27°52'40"	90°20'11"	2308	60	130	Mangd_gr30	5200	SE	Cs	E
Mangd_gl 237		78I/5	27°52'47"	90°21'42"	1862	55			4920	N	Cs	E
Mangd_gl 238		78I/5	27°53'39"	90°20'38"	5262	110	975	Mangd_gr34	5040	NW	Cs	E
Mangd_gl 239		78I/5	27°53'10"	90°20'25"	2554	60	265	Mangd_gr35	5160	NW	Cs	E
Mangd_gl 240		78I/5	27°53'16"	90°20'1"	2154	50	420	Mangd_gr36	5120	N	Cs	E
Mangd_gl 241		78I/5	27°53'4"	90°19'57"	1939	55	75	Mangd_gr36	5160	NE	Cs	E
Mangd_gl 242		78I/5	27°53'30"	90°19'37"	82434	380	305	Mangd_gr37	5080	SE	Ds	EV
Mangd_gl 243		78I/5	27°54'25"	90°20'41"	10370	175	1180	Mangd_gr38	5080	E	Ds	V
Mangd_gl 244		78I/5	27°54'10"	90°20'17"	4646	80	560	Mangd_gr38	5200	NE	Cs	V
Mangd_gl 245		78I/5	27°54'16"	90°20'16"	6816	110	530	Mangd_gr38	5160	N	Ds	V
Mangd_gl 246		78I/5	27°54'51"	90°20'31"	4262	70			5280	SE	Cs	E
Mangd_gl 247		78I/5	27°54'55"	90°20'19"	18801	225			5280	SE	Cs	E
Mangd_gl 248		78I/5	27°55'29"	90°19'45"	3892	85			5140	E	Cs	E
Mangd_gl 249		78I/5	27°55'23"	90°19'40"	11677	110			5150	NE	Cs	E
Mangd_gl 250		78I/5	27°55'13"	90°19'38"	7708	140	525	Mangd_gr39/	5160	NE	Cs	E
Mangd_gl 251		78I/5	27°55'15"	90°19'33"	1846	45	515	Mangd_gr40	5160	NE	Cs	E
Mangd_gl 252		78I/5	27°55'22"	90°19'28"	24124	295	545	Mangd_gr40	5160	NE	Ds	V
Mangd_gl 253		78I/5	27°55'10"	90°18'49"	3831	75	170	Mangd_gr40	5640	N	Cs	E
Mangd_gl 254		78I/5	27°55'13"	90°18'43"	3262	55	280	Mangd_gr40	5640	N	Ds	V
Mangd_gl 255		78I/5	27°55'28"	90°18'44"	20816	255			5050	SE	Cs	B
Mangd_gl 256		78I/5	27°55'52"	90°17'56"	93142	425	45	Mangd_gr42	5160	N	Cs	E
Mangd_gl 257		78I/5	27°56'34"	90°17'11"	2954	60			5200	E	Cs	E
Mangd_gl 258		78I/5	27°56'45"	90°17'4"	10508	155			5200	SE	Cs	V
Mangd_gl 259		78I/5	27°56'57"	90°17'13"	12077	140	975	Mangd_gr44	5200	SE	Cs	V
Mangd_gl 260		78I/5	27°57'17"	90°17'10"	40786	400	230	Mangd_gr44	5200	SE	Ds	V
Mangd_gl 261		78I/5	27°57'20"	90°17'22"	19508	225	322	Mangd_gr44	5200	NW	Ds	V
Mangd_gl 262		78I/5	27°57'24"	90°17'17"	4816	75	335	Mangd_gr44	5200	SW	Ds	V
Mangd_gl 263		78I/5	27°56'25"	90°18'22"	7908	125	410	Mangd_gr45	5200	S	Cs	V
Mangd_gl 264		78I/5	27°56'24"	90°19'13"	17431	240	975	Mangd_gr46	5200	S	Ds	V
Mangd_gl 265		78I/5	27°56'29"	90°19'7"	7216	135	855	Mangd_gr46	5200	SE	Ds	V
Mangd_gl 266		78I/5	27°56'31"	90°19'24"	38309	315	870	Mangd_gr46	5200	SE	Ds	V
Mangd_gl 267		78I/5	27°56'56"	90°20'11"	10077	200			5240	SE	Cs	E
Mangd_gl 268		78I/5	27°57'23"	90°20'16"	6231	91	285	Mangd_gr49	5240	SE	Cs	E
Mangd_gl 269		78I/5	27°57'49"	90°19'58"	14616	140	220	Mangd_gr51	5360	SE	Cs	E
Mangd_gl 270		78I/5	27°58'9"	90°20'7"	239778	850	200	Mangd_gr51	5280	E	Ds	V
Mangd_gl 271		78I/5	27°58'14"	90°19'39"	35509	250	0	Mangd_gr51	5320	E	Ds	V
Mangd_gl 272		78I/5	27°59'2"	90°20'22"	26893	220	930	Mangd_gr54	5240	SE	Ds	V
Mangd_gl 273		78I/5	27°59'2"	90°20'7"	9123	160	550	Mangd_gr54	5240	NE	Ds	V
Mangd_gl 274		78I/5	27°59'17"	90°19'2"	21370	165	240	Mangd_gr54	5400	E	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 275		78I/5	27°59'14"	90°18'56"	19078	100	170	Mangd_gr54	5400	E	Cs	C
Mangd_gl 276		77L/8	27°59'43"	90°18'54"	16216	175	0	Mangd_gr55	5480	NE	Cs	S
Mangd_gl 277		77L/8	28°0'10"	90°18'54"	108035	425	55	Mangd_gr55	5400	NE	Cs	E
Mangd_gl 278		77L/8	28°0'12"	90°18'42"	5185	90	335	Mangd_gr55	5400	NE	Cs	E
Mangd_gl 279		77L/8	28°0'12"	90°18'34"	15431	190	405	Mangd_gr56	5400	NE	Cs	E
Mangd_gl 280		77L/8	28°0'17"	90°19'0"	12385	145	310	Mangd_gr55	5420	NE	Cs	E
Mangd_gl 281		77L/8	28°0'10"	90°19'8"	6939	100	40	Mangd_gr55	5930	NE	Cs	V
Mangd_gl 282		77L/8	28°0'18"	90°19'18"	62002	360	200	Mangd_gr55	5420	SE	Cs	E
Mangd_gl 283		78I/5	28°0'34"	90°19'29"	12247	150	215	Mangd_gr57	5475	S	Cs	E
Mangd_gl 284		77L/8	27°59'43"	90°20'6"	4646	115	1030	Mangd_gr55	5360	SE	Ds	V
Mangd_gl 285		78I/5	28°0'21"	90°19'51"	341413	795	255	Mangd_gr58	5390	S	Ds	V
Mangd_gl 286		78I/5	27°59'55"	90°20'9"	4308	55			5320	SE	Cs	E
Mangd_gl 287		78I/5	27°59'48"	90°20'15"	1892	50			5320	SE	Cs	E
Mangd_gl 288		78I/5	27°59'45"	90°20'21"	2415	50			5360	SE	Cs	E
Mangd_gl 289		78I/5	27°59'54"	90°20'33"	1477	50			5400	SW	Cs	E
Mangd_gl 290		77L/8	27°59'58"	90°20'30"	1046	40			5400	SW	Cs	E
Mangd_gl 291		77L/8	28°0'26"	90°20'6"	5139	75	375	Mangd_gr58	5390	SE	Cs	E
Mangd_gl 292		77L/8	28°0'28"	90°20'13"	5831	100	375	Mangd_gr58	5425	SE	Cs	E
Mangd_gl 293		77L/8	28°0'34"	90°20'8"	4892	95	150	Mangd_gr58	5468	SE	Ds	E
Mangd_gl 294		77L/8	28°0'13"	90°20'29"	6077	105			5460	SE	Cs	E
Mangd_gl 295		77L/8	28°0'30"	90°20'58"	22016	145	635	Mangd_gr60	5220	SE	Ds	E
Mangd_gl 296		77L/8	28°0'51"	90°21'19"	144759	890	270	Mangd_gr61	5360	SE	Ds	V
Mangd_gl 297		77L/8	28°1'30"	90°21'33"	60187	460	172	Mangd_gr62	5320	SE	Cs	E
Mangd_gl 298		77L/8	28°1'28"	90°21'42"	16801	195	495	Mangd_gr62	5320	SE	Cs	E
Mangd_gl 299		77L/8	28°1'59"	90°21'29"	6954	105	330	Mangd_gr62		SE	Cs	E
Mangd_gl 300		77L/8	28°2'4"	90°21'26"	5154	90	280	Mangd_gr62		SE	Cs	E
Mangd_gl 301		77L/8	28°2'1"	90°21'21"	5093	90	130	Mangd_gr62		SE	Cs	E
Mangd_gl 302		77L/8	28°2'8"	90°21'27"	6031	90	325	Mangd_gr62		SE	Ds	E
Mangd_gl 303		77L/8	28°2'48"	90°21'28"	411431	1405	110	Mangd_gr63/64		SE	Cs	M
Mangd_gl 304		77L/8	28°1'45"	90°21'35"	8785	120				SE	Cs	E
Mangd_gl 305		77L/8	28°1'42"	90°21'41"	6985	120				SE	Cs	E
Mangd_gl 306		77L/8	28°1'41"	90°21'45"	5739	110				SE	Cs	E
Mangd_gl 307		77L/8	28°2'21"	90°21'59"	767429	1800	0	Mangd_gr65	5240	SW	Cs	V
Mangd_gl 308		78I/5	28°0'46"	90°22'31"	710227	1170	30	Mangd_gr70	4193	W	Cs	M
Mangd_gl 309		78I/5	27°58'59"	90°21'41"	18970	235	0	Mangd_gr72	5280	NW	Ds	V
Mangd_gl 310		78I/5	27°58'50"	90°23'6"	200746	575	0	Mangd_gr76	5200	W	Ds	V
Mangd_gl 311		78I/5	27°59'1"	90°22'58"	1292	40	520	Mangd_gr75/	5240	SE	Ds	V
Mangd_gl 312		78I/5	27°59'3"	90°23'1"	4723	70	430	Mangd_gr75/	5240	SE	Cs	E
Mangd_gl 313		78I/5	27°59'13"	90°23'0"	140975	545	180	Mangd_gr75	5240	S	Cs	V
Mangd_gl 314		78I/5	27°59'4"	90°22'49"	4892	105	890	Mangd_gr73	5240	S	Cs	V
Mangd_gl 315		78I/5	27°59'8"	90°22'44"	10508	145	670	Mangd_gr73	5240	SE	Cs	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 316		78I/5	27°59'30"	90°22'32"	5077	105	95	Mangd_gr74	5400	E	Cs	E
Mangd_gl 317		78I/5	27°59'33"	90°22'47"	1492	60	295	Mangd_gr74	5320	SE	Ds	V
Mangd_gl 318		78I/5	27°58'25"	90°22'57"	2754	45	385	Mangd_gr79	5240	W	Cs	E
Mangd_gl 319		78I/5	27°57'20"	90°22'10"	71972	490	195	Mangd_gr81	5240	SW	Cs	V
Mangd_gl 320		78I/5	27°57'29"	90°22'21"	18693	195	20	Mangd_gr81	5240	SW	Cs	V
Mangd_gl 321		78I/5	27°56'36"	90°22'42"	7031	115			5240	NW	Ds	V
Mangd_gl 322		78I/5	27°56'43"	90°22'53"	138374	700	0	Mangd_gr85	5240	NW	Cs	V
Mangd_gl 323		78I/5	27°56'35"	90°23'5"	4877	105	0	Mangd_gr85	5240	NW	Cs	V
Mangd_gl 324		78I/5	27°56'23"	90°22'23"	12016	170	665	Mangd_gr86	5160	W	Cs	V
Mangd_gl 325		78I/5	27°56'23"	90°22'34"	11677	145	400	Mangd_gr86	5200	W	Cs	V
Mangd_gl 326		78I/5	27°55'42"	90°23'24"	2062	60	233	Mangd_gr88	5240	S	Cs	V
Mangd_gl 327		78I/5	27°55'36"	90°23'22"	8616	138	280	Mangd_gr89	5240	SW	Cs	V
Mangd_gl 328		78I/5	27°55'42"	90°22'58"	16185	225			5240	SE	Cs	C
Mangd_gl 329		78I/5	27°55'12"	90°22'50"	6908	120	1305	Mangd_gr90	5145	NW	Ds	V
Mangd_gl 330		78I/5	27°55'22"	90°23'10"	5077	105	685	Mangd_gr90	5200	SW	Ds	V
Mangd_gl 331		78I/5	27°55'6"	90°23'5"	9954	155	1065	Mangd_gr90	5120	NW	Ds	V
Mangd_gl 332		78I/5	27°55'27"	90°23'30"	4292	110	140	Mangd_gr90	5200	SW	Ds	V
Mangd_gl 333		78I/5	27°54'59"	90°23'1"	22601	255			5160	NW	Cs	E
Mangd_gl 334		78I/5	27°54'38"	90°23'38"	42786	280	500	Mangd_gr91	5137	S	Ds	V
Mangd_gl 335		78I/5	27°54'45"	90°23'47"	3431	70	275	Mangd_gr91	5160	SW	Cs	E
Mangd_gl 336		78I/5	27°54'11"	90°24'6"	2800	60	105	Mangd_gr92	5120	S	Cs	E
Mangd_gl 337		78I/5	27°53'31"	90°24'5"	3446	65	760	Mangd_gr93	5000	SW	Ds	V
Mangd_gl 338		78I/5	27°53'35"	90°24'9"	10139	170	560	Mangd_gr93	5000	SW	Ds	V
Mangd_gl 339		78I/5	27°53'18"	90°24'14"	5908	125	710	Mangd_gr93/9	4960	SW	Ds	V
Mangd_gl 340		78I/5	27°53'22"	90°24'24"	8170	140	530	Mangd_gr93/9	5000	SW	Ds	V
Mangd_gl 341		78I/5	27°53'36"	90°24'39"	34617	230	15	Mangd_gr94	5080	SW	Cs	C
Mangd_gl 342		78I/5	27°52'40"	90°24'37"	17385	175			4960	S	Cs	E
Mangd_gl 343		78I/5	27°51'25"	90°25'49"	28247	210			4800	NW	Cs	V
Mangd_gl 344		78I/5	27°51'43"	90°25'60"	4077	60			4880	SW	Cs	V
Mangd_gl 345		78I/5	27°51'49"	90°26'2"	2569	65			4880	SW	Cs	V
Mangd_gl 346		78I/5	27°50'41"	90°26'15"	23170	250			4720	NW	Ds	V
Mangd_gl 347		78I/5	27°50'45"	90°26'25"	19124	155			4720	W	Ds	V
Mangd_gl 348		78I/5	27°50'12"	90°26'49"	5031	100			4640	SE	Ds	V
Mangd_gl 349		78I/5	27°50'17"	90°26'57"	4216	80			4680	SE	Cs	E
Mangd_gl 350		78I/5	27°50'19"	90°27'33"	4492	100			4560	SW	Ds	V
Mangd_gl 351		78I/5	27°49'23"	90°28'9"	3446	65			4360	E	Cs	E
Mangd_gl 352		78I/5	27°49'38"	90°28'3"	5446	90			4520	N	Cs	E
Mangd_gl 353		78I/5	27°50'20"	90°28'7"	6893	115			4440	SE	Cs	E
Mangd_gl 354		78I/5	27°51'23"	90°26'31"	3816	70			4880	N	Cs	E
Mangd_gl 355		78I/5	27°53'27"	90°26'20"	31124	240	1400	Mangd_gr98	4696	E	Ds	V
Mangd_gl 356		78I/5	27°53'33"	90°25'44"	16770	170	445	Mangd_gr98	5280	SE	Ds	C

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 357		78I/5	27°54'5"	90°27'4"	11862	165		Mangd_gr98	4400	NE	Ds	V
Mangd_gl 358		78I/5	27°54'3"	90°25'58"	24216	250	600	Mangd_gr98	4840	NE	Ds	V
Mangd_gl 359		78I/5	27°54'22"	90°26'45"	7631	105			4680	SE	Cs	E
Mangd_gl 360		78I/5	27°54'9"	90°25'19"	42140	145	237	Mangd_gr98	5120	SE	Cs	C
Mangd_gl 361		78I/5	27°54'33"	90°24'60"	17785	125	120	Mangd_gr99	5040	E	Ds	V
Mangd_gl 362		78I/5	27°54'31"	90°24'53"	2662	70	60	Mangd_gr99	5040	NE	Cs	E
Mangd_gl 363		78I/5	27°54'37"	90°24'50"	1662	45	275	Mangd_gr99/	5080	NE	Cs	E
Mangd_gl 364		78I/5	27°54'42"	90°24'40"	3216	85	425	Mangd_gr101	5110	SE	Ds	V
Mangd_gl 365		78I/5	27°54'49"	90°24'38"	2585	85	300	Mangd_gr101	5115	SE	Cs	E
Mangd_gl 366		78I/5	27°55'4"	90°24'47"	150806	786	0	Mangd_gr101	5160	E	Ds	V
Mangd_gl 367		78I/5	27°54'57"	90°24'43"	1477	45	385	Mangd_gr101	5160	E	Cs	E
Mangd_gl 368		78I/5	27°55'2"	90°25'2"	11231	130	706	Mangd_gr101	5135	E	Ds	V
Mangd_gl 369		78I/5	27°55'31"	90°25'16"	8908	130	410	Mangd_gr103	5000	NE	Cs	V
Mangd_gl 370		78I/5	27°55'35"	90°25'14"	10447	145	500	Mangd_gr103	5000	NE	Cs	V
Mangd_gl 371		78I/5	27°55'36"	90°25'4"	72664	430	455	Mangd_gr100	5000	NE	Cs	V
Mangd_gl 372		78I/5	27°56'25"	90°24'11"	49356	265	0	Mangd_gr105	5219	SE	Cs	E
Mangd_gl 373		78I/5	27°56'29"	90°24'34"	5739	75	135	Mangd_gr106	5240	S	Cs	E
Mangd_gl 374		78I/5	27°56'10"	90°25'18"	114497	640	75	Mangd_gr108	5160	S	Ds	V
Mangd_gl 375		78I/5	27°56'12"	90°25'41"	6446	85			5200	SW	Cs	E
Mangd_gl 376		78I/5	27°55'53"	90°25'40"	4508	100			5080	SW	Cs	E
Mangd_gl 377		78I/5	27°55'35"	90°27'11"	6646	105			4720	S	Ds	V
Mangd_gl 378		78I/5	27°56'1"	90°26'45"	6677	120			4760	SE	Ds	V
Mangd_gl 379		78I/5	27°56'17"	90°26'20"	11662	140	1695	Mangd_gr110	4960	SE	Ds	V
Mangd_gl 380		78I/5	27°57'38"	90°25'30"	26832	200	315	Mangd_gr112	5240	SE	Cs	V
Mangd_gl 381		78I/5	27°57'30"	90°25'41"	16093	395	520	Mangd_gr113	4960	SE	Ds	V
Mangd_gl 382		78I/5	27°57'39"	90°26'50"	4954	95			5040	SE	Cs	V
Mangd_gl 383		78I/5	27°58'8"	90°26'55"	31001	290	705	Mangd_gr113	5080	E	Ds	V
Mangd_gl 384		78I/5	27°58'8"	90°26'43"	5169	90	470	Mangd_gr113	5120	E	Cs	V
Mangd_gl 385		78I/5	27°58'59"	90°26'22"	466125	535	510	Mangd_gr114	5086	N	Ds	B
Mangd_gl 386		78I/5	27°58'52"	90°25'56"	14693	160	1691	Mangd_gr116	5120	SE	Ds	V
Mangd_gl 387		78I/5	27°58'9"	90°25'1"	87711	410	0	Mangd_gr115	5200	NE	Ds	V
Mangd_gl 388		78I/5	27°57'45"	90°24'34"	9370	115	0	Mangd_gr115	5440	NE	Cs	S
Mangd_gl 389		78I/5	27°57'38"	90°24'28"	2000	75	0	Mangd_gr115	5400	SW	Cs	S
Mangd_gl 390		78I/5	27°57'41"	90°24'27"	26063	405	0	Mangd_gr115	5400	SW	Cs	S
Mangd_gl 391		78I/5	27°57'57"	90°24'3"	3262	80	0	Mangd_gr115	5400	SW	Cs	S
Mangd_gl 392		78I/5	27°58'9"	90°24'24"	2908	45	0	Mangd_gr115	5440	NE	Cs	S
Mangd_gl 393		78I/5	27°58'6"	90°23'59"	6093	70	0	Mangd_gr115	5440	NE	Cs	S
Mangd_gl 394		78I/5	27°58'12"	90°23'53"	5908	75	110	Mangd_gr115	5360	NE	Ds	V
Mangd_gl 395		78I/5	27°58'19"	90°23'44"	2708	70			5360	SE	Ds	E
Mangd_gl 396		78I/5	27°58'32"	90°24'59"	5446	95	335	Mangd_gr116	5240	SE	Ds	V
Mangd_gl 397		78I/5	27°58'30"	90°24'46"	37709	240	80	Mangd_gr116	5280	E	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 398		78I/5	27°59'23"	90°25'21"	288134	755	20	Mangd_gr117	5182	E	Ds	E
Mangd_gl 399		78I/5	27°59'20"	90°24'56"	9108	100	345	Mangd_gr118	5200	E	Cs	S
Mangd_gl 400		78I/5	27°59'26"	90°24'27"	27063	365	0	Mangd_gr118	5280	SE	Cs	S
Mangd_gl 401		78I/5	27°59'35"	90°24'17"	5754	105	0	Mangd_gr118	5280	E	Ds	S
Mangd_gl 402		78I/5	27°59'27"	90°24'21"	1492	40	0	Mangd_gr118	5320	NE	Cs	S
Mangd_gl 403		78I/5	27°59'23"	90°24'20"	2954	65	0	Mangd_gr118	5280	NE	Cs	S
Mangd_gl 404		77L/8	27°59'26"	90°24'14"	2631	55	0	Mangd_gr118	5320	E	Cs	S
Mangd_gl 405		77L/8	28°0'11"	90°25'12"	7123	115	690	Mangd_gr119	5080	SE	Cs	E
Mangd_gl 406		77L/8	28°0'21"	90°25'3"	5708	120	535	Mangd_gr119	5100	SE	Cs	E
Mangd_gl 407		77L/8	28°0'17"	90°24'60"	7062	110	420	Mangd_gr119	5100	SE	Cs	E
Mangd_gl 408		77L/8	28°0'41"	90°24'34"	71495	385	81	Mangd_gr120	5271	SE	Cs	V
Mangd_gl 409		78I/5	28°0'58"	90°24'23"	29417	235	0	Mangd_gr120	5240	SE	Cs	E
Mangd_gl 410		78I/5	27°58'52"	90°28'32"	4416	105	0	Mangd_gr117	4880	S		S
Mangd_gl 411		78I/5	27°59'17"	90°28'3"	6031	75	0	Mangd_gr117	4880	SE	Ds	S
Mangd_gl 412		78I/5	27°59'25"	90°27'52"	4892	75	0	Mangd_gr117	4920	SE	Ds	S
Mangd_gl 413		78I/5	27°59'16"	90°27'40"	15324	165	0	Mangd_gr117	4980	SE	Cs	S
Mangd_gl 414		78I/5	27°59'26"	90°27'29"	24570	109	0	Mangd_gr117	5000	SE	Ds	S
Mangd_gl 415		78I/5	27°59'46"	90°26'32"	5031	75	0	Mangd_gr117	5120	SE	Cs	S
Mangd_gl 416		78I/5	27°59'36"	90°25'31"	5862	140	0	Mangd_gr117	5200	SE	Cs	S
Mangd_gl 417		77L/8	27°59'40"	90°25'29"	4816	55	0	Mangd_gr117	5200	SE	Cs	S
Mangd_gl 418		77L/8	28°0'4"	90°26'17"	5908	105	0	Mangd_gr17	5140	SE	Cs	S
Mangd_gl 419		77L/8	28°0'15"	90°25'31"	13708	155	0	Mangd_gr17	5280	SE	Cs	S
Mangd_gl 420		78I/5	28°0'19"	90°25'25"	10354	130	0	Mangd_gr17	5290	SE	Cs	S
Mangd_gl 421		78I/5	27°59'54"	90°27'1"	5139	105	136	Mangd_gr117	5120	SE	Ds	E
Mangd_gl 422		77L/8	27°59'50"	90°27'24"	146452	385	0	Mangd_gr117	5000	SE	Cs	S
Mangd_gl 423		77L/8	28°0'25"	90°29'18"	35417	220	765	Mangd_gr127	5350	SW	Cs	E
Mangd_gl 424		78I/5	28°0'17"	90°29'30"	24601	220	835	Mangd_gr127	5320	SW	Cs	E
Mangd_gl 425		78I/5	27°59'7"	90°29'23"	9600	145			5160	NW	Cs	V
Mangd_gl 426		78I/5	27°57'42"	90°29'22"	10262	160	5	Mangd_gr129	5160	SW	Cs	E
Mangd_gl 427		78I/5	27°56'22"	90°29'38"	3816	80			5080	SW	Cs	E
Mangd_gl 428		78I/5	27°56'14"	90°29'12"	3677	55			4840	NW	Cs	E
Mangd_gl 429		78I/5	27°55'40"	90°28'4"	14539	60			4570	W	Cs	V
Mangd_gl 430		78I/5	27°55'0"	90°28'58"	18816	175			4720	NW	Ds	V
Mangd_gl 431		78I/5	27°55'25"	90°29'38"	3216	65			4960	S	Cs	E
Mangd_gl 432		78I/9	27°55'44"	90°30'0"	101419	530			5000	SW	Ds	V
Mangd_gl 433		78I/9	27°55'55"	90°30'4"	9216	140			5040	SW	Ds	V
Mangd_gl 434		78I/9	27°56'15"	90°30'7"	4569	95			5120	SW	Ds	V
Mangd_gl 435		78I/9	27°56'14"	90°30'29"	14601	140			5120	SW	Ds	V
Mangd_gl 436		78I/9	27°56'34"	90°30'14"	3031	80			5240	SE	Ds	V
Mangd_gl 437		78I/9	27°55'55"	90°30'19"	98358	425	370	Mangd_gr130	5080	W	Cs	E
Mangd_gl 438		78I/9	27°55'30"	90°30'44"	11600	195	470	Mangd_gr130	5120	SW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 439		78I/9	27°55'25"	90°30'45"	6123	130	366	Mangd_gr130	5120	SW	Cs	E
Mangd_gl 440		78I/9	27°55'21"	90°30'50"	13585	150			5120	SW	Ds	V
Mangd_gl 441		78I/9	27°55'17"	90°30'21"	146144	780			5120	SW	Ds	V
Mangd_gl 442		78I/5	27°54'56"	90°30'40"	9631	100	10	Mangd_gr132	5120	NW	Cs	E
Mangd_gl 443		78I/5	27°54'56"	90°30'9"	5216	95	40	Mangd_gr132	4840	W	Cs	E
Mangd_gl 444		78I/5	27°54'52"	90°30'7"	5216	115			4920	NW	Cs	E
Mangd_gl 445		78I/5	27°54'43"	90°29'16"	21262	115			4840	NW	Ds	V
Mangd_gl 446		78I/5	27°54'24"	90°29'28"	47033	90	1158	Mangd_gr132	4760	SW	Cs	V
Mangd_gl 447		78I/5	27°54'37"	90°28'44"	2046	270	924	Mangd_gr132	4920	NW	Cs	E
Mangd_gl 448		78I/5	27°53'24"	90°28'58"	33355	400			4560	W	Ds	V
Mangd_gl 449		78I/5	27°53'35"	90°29'19"	3739	50	625	Mangd_gr134	4880	W	Cs	E
Mangd_gl 450		78I/9	27°52'59"	90°28'40"	3246	185			4892	W	Ds	V
Mangd_gl 451		78I/9	27°52'51"	90°30'51"	12400	75			4780	W	Cs	V
Mangd_gl 452		78I/9	27°52'45"	90°30'56"	12200	65	780	Mangd_gr136	4480	SE	Cs	E
Mangd_gl 453		78I/9	27°52'17"	90°30'15"	3969	95			4720	SE	Ds	V
Mangd_gl 454		78I/9	27°51'28"	90°31'14"	7293	140			4800	S	Cs	E
Mangd_gl 455		78I/9	27°52'0"	90°31'31"	8539	60			5000	E	Ds	V
Mangd_gl 456		78I/9	27°52'15"	90°31'37"	4369	100			4920	NE	Ds	V
Mangd_gl 457		78I/9	27°53'31"	90°31'26"	7616	95			4870	E	Cs	E
Mangd_gl 458		78I/9	27°53'51"	90°31'31"	3092	80			4760	NE	Cs	E
Mangd_gl 459		78I/9	27°54'35"	90°30'59"	5693	90			5080	SE	Ds	V
Mangd_gl 460		78I/9	27°54'25"	90°31'52"	23770	85			4680	SE	Ds	V
Mangd_gl 461		78I/9	27°54'53"	90°31'10"	13201	105			5080	SE	Ds	V
Mangd_gl 462		78I/9	27°52'56"	90°33'7"	8262	145			4680	SE	Ds	V
Mangd_gl 463		78I/9	27°53'27"	90°34'12"	29663	180	946	Mangd_gr137	4920	SW	Ds	V
Mangd_gl 464		78I/9	27°51'58"	90°33'51"	54141	60	638	Mangd_gr137	4680	W	Cs	E
Mangd_gl 465		78I/9	27°51'46"	90°33'3"	5031	280			4560	NE	Ds	V
Mangd_gl 466		78I/9	27°51'35"	90°33'1"	3754	340			4600	W	Ds	V
Mangd_gl 467		78I/9	27°51'35"	90°33'9"	5831	65			4600	W	Ds	V
Mangd_gl 468		78I/9	27°51'30"	90°33'9"	3816	75			4600	SW	Cs	E
Mangd_gl 469		78I/9	27°51'39"	90°33'32"	3662	110			4680	SW	Ds	V
Mangd_gl 470		78I/9	27°51'44"	90°33'35"	3416	60			4680	SW	Cs	E
Mangd_gl 471		78I/9	27°51'41"	90°33'39"	3462	55			4680	SW	Cs	E
Mangd_gl 472		78I/9	27°51'17"	90°33'7"	8985	85			4620	SW	Ds	V
Mangd_gl 473		78I/9	27°51'19"	90°33'23"	32001	65			4680	W	Ds	V
Mangd_gl 474		78I/9	27°51'8"	90°33'4"	12262	175			4630	W	Cs	C
Mangd_gl 475		78I/9	27°50'47"	90°33'52"	8785	200			4870	N	Cs	E
Mangd_gl 476		78I/9	27°50'36"	90°33'15"	15554	140			4640	NW	Ds	V
Mangd_gl 477		78I/9	27°50'10"	90°33'27"	88465	115			4760	SW	Cs	V
Mangd_gl 478		78I/9	27°49'11"	90°33'14"	8831	170			4600	SW	Cs	E
Mangd_gl 479		78I/9	27°49'23"	90°33'38"	14370	465			4800	SW	Cs	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 480		78I/9	27°49'41"	90°33'51"	6000	180			4920	SW	Cs	E
Mangd_gl 481		78I/9	27°48'54"	90°33'48"	6800	245			4840	W	Ds	E
Mangd_gl 482		78I/9	27°48'50"	90°33'49"	4246	125			4800	SW	Ds	V
Mangd_gl 483		78I/9	27°48'49"	90°33'56"	3985	160			4800	W	Cs	E
Mangd_gl 484		78I/9	27°48'31"	90°33'23"	35524	90	1562	Mangd_gr140	4560	NW	Ds	V
Mangd_gl 485		78I/9	27°48'16"	90°33'23"	7154	105			4600	NE	Ds	E
Mangd_gl 486		78I/9	27°48'4"	90°33'10"	1631	335			4800	NE	Ds	V
Mangd_gl 487		78I/9	27°48'35"	90°33'19"	2631	125			4560	NE	Cs	E
Mangd_gl 488		78I/9	27°48'17"	90°32'7"	46556	60			4520	NW	Ds	V
Mangd_gl 489		78I/9	27°47'36"	90°32'22"	98804	65			4280	SW	Ds	V
Mangd_gl 490		78I/9	27°46'60"	90°32'9"	7077	440			4320	W	Cs	E
Mangd_gl 491		78I/9	27°46'48"	90°32'20"	32232	735			4331	NW	Cs	C
Mangd_gl 492		78I/9	27°46'10"	90°32'39"	51633	105			4320	W	Cs	C
Mangd_gl 493		78I/9	27°46'20"	90°32'53"	3000	305			4480	SW	Ds	V
Mangd_gl 494		78I/9	27°45'31"	90°32'47"	6831	430			4120	SW	Ds	V
Mangd_gl 495		78I/10	27°45'9"	90°33'4"	70741	65			4232	NW	Ds	V
Mangd_gl 496		78I/10	27°44'43"	90°33'19"	16001	135			4240	NW	Ds	V
Mangd_gl 497		78I/10	27°44'51"	90°32'59"	18616	435			4200	W	Cs	E
Mangd_gl 498		78I/10	27°44'40"	90°32'47"	4739	160			4360	N	Ds	E
Mangd_gl 499		78I/10	27°44'13"	90°33'25"	10339	205			4160	SW	Ds	V
Mangd_gl 500		78I/10	27°43'25"	90°32'45"	21093	75			4120	SW	Ds	V
Mangd_gl 501		78I/10	27°43'39"	90°32'55"	8693	155			4320	SW	Ds	V
Mangd_gl 502		78I/10	27°43'33"	90°33'5"	6123	175			4385	SW	Ds	V
Mangd_gl 503		78I/10	27°43'17"	90°32'41"	6739	125			3920	SW	Ds	V
Mangd_gl 504		78I/10	27°43'6"	90°33'42"	43694	100			4120	SW	Ds	V
Mangd_gl 505		78I/10	27°42'34"	90°33'60"	13585	130			4280	W	Ds	V
Mangd_gl 506		78I/10	27°42'11"	90°33'36"	18001	270			4280	NW	Ds	V
Mangd_gl 507		78I/10	27°42'19"	90°31'44"	11770	155			4080	NW	Ds	V
Mangd_gl 508		78I/10	27°42'17"	90°31'19"	21293	175			3840	SW	Ds	V
Mangd_gl 509		78I/10	27°41'27"	90°33'39"	41417	160			4120	NW	Ds	V
Mangd_gl 510		78I/10	27°41'7"	90°32'24"	17555	200			3880	NW	Ds	V
Mangd_gl 512		78I/11	27°41'11"	90°32'41"	4616	65			3900	SW	Ds	V
Mangd_gl 511		78I/11	27°26'14"	90°38'32"	18785	240			4040	NW	Ds	V
Mangd_gl 513		78I/15	27°22'29"	90°44'21"	5231	105			4380	NW	Ds	V
Mangd_gl 514		78I/15	27°22'27"	90°46'44"	19124	175			4240	NW	Ds	V
Mangd_gl 515		78I/15	27°22'35"	90°46'36"	10016	195			4240	N	Ds	V
Mangd_gl 516		78I/15	27°22'45"	90°46'22"	3677	90			4280	E	Ds	V
Mangd_gl 517		78I/15	27°22'44"	90°46'8"	17462	210			4280	E	Ds	V
Mangd_gl 518		78I/15	27°22'43"	90°45'44"	7585	125			4360	E	Ds	V
Mangd_gl 519		78I/15	27°22'45"	90°45'28"	5831	90			4400	SE	Ds	V
Mangd_gl 520		78I/15	27°22'33"	90°45'24"	51356	475			4400	NE	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Mangd_gl 521		78I/15	27°22'59"	90°45'33"	1754	60			4360	S	Ds	E

Glacial Lake Inventory of Chamkhar Chu Basin

Total Number :557   Total Area : 21.03 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Cham_gl 1		78I/15	27°20'46"	90°50'55"	4816	85			4120	N	Ds	E
Cham_gl 2		78I/15	27°20'27"	90°50'17"	61479	390			4040	N	Ds	C
Cham_gl 3		78I/15	27°20'37"	90°50'11"	47556	340			4120	NW	Cs	V
Cham_gl 4		78I/15	27°21'9"	90°49'54"	8200	160			4040	NW	Ds	V
Cham_gl 5		78I/15	27°21'2"	90°49'50"	4769	65			4080	NE	Ds	V
Cham_gl 6		78I/15	27°21'1"	90°49'43"	14016	115			4080	N	Ds	V
Cham_gl 7		78I/15	27°21'35"	90°49'16"	4923	125			4080	NE	Ds	V
Cham_gl 8		78I/15	27°21'23"	90°49'19"	3708	55			4160	NW	Ds	V
Cham_gl 9		78I/15	27°22'31"	90°48'35"	9108	100			4120	NE	Ds	V
Cham_gl 10		78I11	27°22'34"	90°44'25"	17139	130			4240	NE	Ds	V
Cham_gl 11		78I/11	27°22'47"	90°44'21"	8785	175			4160	SE	Ds	V
Cham_gl 12		78I/11	27°23'26"	90°43'37"	3477	105			4120	NW	Ds	E
Cham_gl 13		78I11	27°23'22"	90°43'33"	5031	60			4120	NE	Cs	V
Cham_gl 14		78I/11	27°24'21"	90°42'30"	6462	145			4240	SE	Ds	V
Cham_gl 15		78I/11	27°24'26"	90°42'47"	3985	65			4200	S	Cs	E
Cham_gl 16		78I11	27°24'44"	90°42'5"	4000	65			4240	NE	Ds	V
Cham_gl 17		78I/11	27°25'35"	90°41'37"	8893	105			4120	NW	Cs	E
Cham_gl 18		78I/11	27°25'39"	90°41'36"	3308	105			4120	NW	Cs	E
Cham_gl 19		78I11	27°25'54"	90°40'51"	15662	140			3920	NE	Ds	V
Cham_gl 20		78I/11	27°26'15"	90°39'31"	6677	85			3880	NE	Ds	V
Cham_gl 21		78I/11	27°26'13"	90°39'14"	9631	160			3920	NE	Ds	V
Cham_gl 22		78I/11	27°26'29"	90°39'7"	6769	160			3840	NW	Ds	V
Cham_gl 23		78I/11	27°26'31"	90°39'4"	4754	100			3840	NE	Ds	V
Cham_gl 24		78I/10	27°35'28"	90°34'51"	21124	125			4120	S	Ds	V
Cham_gl 25		78I/10	27°36'23"	90°39'37"	9185	154			2760	NE	Ds	V
Cham_gl 26		78I/10	27°37'40"	90°33'48"	6293	75			3760	E	Ds	V
Cham_gl 27		78I/10	27°38'54"	90°34'0"	21355	140			3960	N	Ds	V
Cham_gl 28		78I/10	27°38'47"	90°33'28"	8354	155			3920	NE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 29		78I/10	27°38'39"	90°33'11"	85080	345			3920	NE	Ds	V
Cham_gl 30		78I/10	27°38'20"	90°33'3"	15616	150			4000	NE	Ds	V
Cham_gl 31		78I/10	27°40'53"	90°34'12"	115727	280			4160	W	Ds	C
Cham_gl 32		78I/10	27°40'45"	90°34'24"	19401	175			4280	NW	Ds	V
Cham_gl 33		78I/10	27°40'35"	90°34'35"	30278	240			4320	NW	Ds	V
Cham_gl 34		78I/10	27°39'35"	90°36'12"	16493	245			3840	SE	Ds	V
Cham_gl 35		78I/10	27°40'4"	90°35'12"	52925	445			4080	SE	Ds	V
Cham_gl 36		78I/10	27°40'38"	90°36'13"	11754	145			4080	NE	Ds	V
Cham_gl 37		78I/10	27°40'33"	90°35'30"	45617	405			4120	NE	Ds	V
Cham_gl 38		78I/10	27°41'41"	90°35'19"	11447	115			4040	NE	Ds	V
Cham_gl 39		78I/10	27°41'15"	90°34'27"	7200	120			4120	NE	Ds	V
Cham_gl 40		78I/10	27°41'51"	90°34'7"	36186	315			4160	SE	Ds	V
Cham_gl 41		78I/10	27°42'50"	90°34'36"	39878	345			4280	E	Ds	V
Cham_gl 42		78I/10	27°42'40"	90°34'25"	88819	400			4320	NE	Cs	C
Cham_gl 43		78I/10	27°43'45"	90°35'4"	37186	240			4160	N	Cs	V
Cham_gl 44		78I/10	27°43'33"	90°34'44"	105912	475			4160	NE	Ds	C
Cham_gl 45		78I/10	27°43'54"	90°34'30"	16893	145			4360	E	Ds	V
Cham_gl 46		78I/10	27°43'49"	90°34'19"	17831	195			4360	SE/NE	Ds	V
Cham_gl 47		78I/10	27°43'59"	90°33'59"	5677	55			4480	SE	Ds	V
Cham_gl 48		78I/10	27°44'1"	90°34'10"	12524	110			4440	S	Cs	E
Cham_gl 49		78I/10	27°44'34"	90°34'33"	42925	295			4280	NE	Ds	V
Cham_gl 50		78I/10	27°44'35"	90°34'18"	25970	155			4160	E	Ds	V
Cham_gl 51		78I/9	27°45'9"	90°34'8"	33894	240			4280	NE	Ds	V
Cham_gl 52		78I/9	27°45'58"	90°33'20"	11954	155			4440	NE	Ds	V
Cham_gl 53		78I/9	27°46'47"	90°33'18"	19078	245			4480	E	Ds	V
Cham_gl 54		78I/9	27°46'38"	90°33'16"	3969	85			4560	NW	Cs	E
Cham_gl 55		78I/9	27°46'38"	90°32'54"	4385	90			4750	NE	Cs	E
Cham_gl 56		78I/9	27°46'53"	90°33'50"	87957	570			4520	SE	Cs	E
Cham_gl 57		78I/9	27°46'55"	90°34'51"	40602	300			4480	SE	Ds	V
Cham_gl 58		78I/9	27°47'0"	90°34'23"	87449	390			4560	E	Cs	C
Cham_gl 59		78I/9	27°47'22"	90°34'48"	11954	175			4760	SW	Ds	V
Cham_gl 60		78I/9	27°47'32"	90°35'31"	59710	380			4880	E	Cs	C
Cham_gl 61		78I/9	27°47'47"	90°35'21"	10862	175			4640	NE	Ds	V
Cham_gl 62		78I/9	27°47'52"	90°35'4"	7739	145			4840	SE	Cs	C
Cham_gl 63		78I/9	27°48'10"	90°35'19"	112589	195			4600	SE	Ds	V
Cham_gl 64		78I/9	27°48'17"	90°34'49"	125328	275			4680	SE	Ds	V
Cham_gl 65		78I/9	27°48'31"	90°34'47"	8508	160			4760	SE	Ds	V
Cham_gl 66		78I/9	27°48'3"	90°36'30"	12400	190			4640	W	Ds	V
Cham_gl 67		78I/9	27°47'38"	90°36'56"	6108	135			4750	SW	Ds	E
Cham_gl 68		78I/9	27°47'40"	90°36'54"	2354	65			4750	SW	Cs	V
Cham_gl 69		78I/9	27°47'46"	90°37'1"	4185	65			4750	SW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 70		78I/9	27°46'23"	90°36'50"	8416	155			4240	SW	Ds	V
Cham_gl 71		78I/9	27°46'41"	90°37'6"	45432	425			4245	SW	Ds	V
Cham_gl 72		78I/9	27°47'11"	90°37'10"	13570	180			4520	SE	DsDs	V
Cham_gl 73		78I/9	27°45'53"	90°37'42"	90511	640			4280	W	Ds	V
Cham_gl 74		78I/9	27°46'31"	90°37'57"	60033	290			4640	SE	Ds	C
Cham_gl 75		78I/9	27°46'32"	90°38'11"	12047	155			4720	SW	Ds	V
Cham_gl 76		78I/9	27°46'6"	90°38'17"	19616	220			4520	NW	Ds	V
Cham_gl 77		78I/9	27°45'50"	90°38'24"	116374	635			4600	W	Ds	V
Cham_gl 78		78I/9	27°45'26"	90°37'39"	132559	785			4400	NW	Ds	V
Cham_gl 79		78I/9	27°45'40"	90°36'47"	29324	250			4400	NW	Ds	V
Cham_gl 80		78I/9	27°45'1"	90°36'47"	45186	355			4340	NW	Ds	V
Cham_gl 81		78I/9	27°45'12"	90°37'6"	30155	225			4540	SW	Ds	V
Cham_gl 82		78I/10	27°44'47"	90°37'4"	5846	120			4520	NW	Ds	E
Cham_gl 83		78I/10	27°44'32"	90°37'10"	14831	125			4400	NW	Ds	C
Cham_gl 84		78I/10	27°44'27"	90°37'21"	11062	165			4440	SW	Cs	V
Cham_gl 85		78I/10	27°44'1"	90°37'23"	47586	360			4120	W	Ds	V
Cham_gl 86		78I/10	27°44'26"	90°37'46"	7477	100			4360	S	Ds	V
Cham_gl 87		78I/10	27°44'26"	90°37'51"	3816	100			4400	SW	Cs	V
Cham_gl 88		78I/10	27°44'5"	90°38'4"	7139	145			4320	W	Ds	V
Cham_gl 89		78I/10	27°43'27"	90°37'5"	4677	65			4120	W	Ds	V
Cham_gl 90		78I/10	27°43'27"	90°37'18"	21801	300			4280	NW	Ds	V
Cham_gl 91		78I/10	27°43'14"	90°37'46"	6169	115			4180	SE	Ds	V
Cham_gl 92		78I/10	27°43'25"	90°38'4"	21139	255			4150	S	Ds	V
Cham_gl 93		78I/10	27°43'31"	90°37'43"	5062	60			4340	SE	Ds	E
Cham_gl 94		78I/10	27°43'9"	90°38'22"	8616	90			4200	NW	Ds	V
Cham_gl 95		78I/10	27°43'11"	90°38'29"	5123	105			4240	SW	Ds	E
Cham_gl 96		78I/10	27°43'48"	90°39'3"	17416	205			4100	NE	Ds	V
Cham_gl 97		78I/9	27°45'21"	90°39'45"	67295	400			4280	SW	Ds	V
Cham_gl 98		78I/9	27°45'29"	90°39'25"	11200	175			4440	SE	Ds	V
Cham_gl 99		78I/9	27°45'24"	90°39'18"	4277	125			4520	NE	Cs	E
Cham_gl 100		78I/9	27°45'37"	90°40'6"	29478	220			4360	NW	Ds	V
Cham_gl 101		78I/9	27°45'46"	90°39'54"	54802	435			4370	NW	Ds	V
Cham_gl 102		78I/9	27°45'52"	90°39'34"	9154	75			4480	NE	Cs	E
Cham_gl 103		78I/9	27°46'1"	90°39'19"	16047	220			4720	WE	Ds	V
Cham_gl 104		78I/9	27°45'55"	90°39'6"	3123	45			4760	NE	Cs	E
Cham_gl 105		78I/9	27°45'10"	90°40'21"	4385	125			4560	S	Ds	E
Cham_gl 106		78I/10	27°43'32"	90°40'24"	36401	325			4120	NE	Ds	V
Cham_gl 107		78I/10	27°42'40"	90°41'54"	15447	150			4160	SE	Ds	V
Cham_gl 108		78I/10	27°43'8"	90°42'20"	7077	120			4040	SE	Ds	V
Cham_gl 109		78I/10	27°43'11"	90°42'17"	6985	150			4060	NE	Ds	V
Cham_gl 110		78I/10	27°42'54"	90°42'8"	54448	335			4080	NE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 111		78I/10	27°42'50"	90°41'51"	7323	100			4120	E	Ds	V
Cham_gl 112		78I/10	27°43'20"	90°42'8"	8462	170			4100	SE	Ds	V
Cham_gl 113		78I/10	27°43'48"	90°42'0"	16231	230			4100	NE	Ds	V
Cham_gl 114		78I/10	27°43'37"	90°41'49"	10154	165			4160	NE	Ds	V
Cham_gl 115		78I/10	27°43'44"	90°41'39"	13954	205			4180	NE	Ds	V
Cham_gl 116		78I/10	27°43'55"	90°41'32"	13016	105			4270	NE	Ds	V
Cham_gl 117		78I/10	27°44'9"	90°41'12"	13108	175			4120	NE	Ds	V
Cham_gl 118		78I/9	27°45'26"	90°41'39"	40109	350			4320	NW	Ds	V
Cham_gl 119		78I/9	27°45'12"	90°41'24"	25293	210			4480	NE	Cs	C
Cham_gl 120		78I/9	27°45'5"	90°41'6"	50325	455			4520	NE	Ds	C
Cham_gl 121		78I/9	27°45'27"	90°41'20"	5816	105			4440	NE	Ds	V
Cham_gl 122		78I/9	27°45'37"	90°41'7"	55787	345			4320	NE	Ds	V
Cham_gl 123		78I/9	27°45'29"	90°40'56"	19601	215			4360	NE	Ds	V
Cham_gl 124		78I/9	27°45'20"	90°40'38"	14324	240			4400	NE	Ds	V
Cham_gl 125		78I/9	27°46'38"	90°40'38"	7708	150			4240	NE	Ds	V
Cham_gl 126		78I/9	27°46'27"	90°40'39"	39632	235			4340	NW	Ds	V
Cham_gl 127		78I/9	27°46'11"	90°40'36"	17924	245			4460	NE	Ds	V
Cham_gl 128		78I/9	27°46'4"	90°40'17"	2477	45			4700	NE	Ds	E
Cham_gl 129		78I/9	27°46'21"	90°40'12"	59648	515			4510	NE	Ds	V
Cham_gl 130		78I/9	27°46'30"	90°39'39"	26309	205			4920	SW	Cs	C
Cham_gl 131		78I/9	27°46'25"	90°39'37"	5354	75			4920	NE	Ds	E
Cham_gl 132		78I/9	27°47'30"	90°40'9"	24139	295			4600	NE	Ds	V
Cham_gl 133		78I/9	27°47'16"	90°39'30"	35109	265			4600	NE	Ds	V
Cham_gl 134		78I/9	27°47'3"	90°39'36"	16770	170			4620	NW	Ds	V
Cham_gl 135		78I/9	27°47'4"	90°39'20"	7108	155			4720	N	Cs	E
Cham_gl 136		78I/9	27°47'14"	90°38'57"	237978	1270			4520	NE	Cs	V
Cham_gl 137		78I/9	27°47'45"	90°38'15"	373691	1350			4440	NE	Ds	E
Cham_gl 138		78I/9	27°47'11"	90°37'47"	12308	175			4680	E	Cs	V
Cham_gl 139		78I/9	27°47'53"	90°37'26"	180330	385			4560	SE	Ds	V
Cham_gl 140		78I/9	27°48'9"	90°37'5"	11462	170			4760	SE	Cs	E
Cham_gl 141		78I/9	27°48'17"	90°37'41"	38525	205			4760	SW	Ds	C
Cham_gl 142		78I/9	27°48'35"	90°37'21"	7846	135			4880	SE	Cs	E
Cham_gl 143		78I/9	27°48'45"	90°37'48"	25232	215			4880	SE	Ds	V
Cham_gl 144		78I/9	27°49'1"	90°38'51"	43802	315			4640	NE	Cs	V
Cham_gl 145		78I/9	27°48'46"	90°38'49"	9785	80			4720	SE	Cs	E
Cham_gl 146		78I/9	27°48'48"	90°38'36"	17370	226			4760	NE	Ds	V
Cham_gl 147		78I/9	27°49'3"	90°37'47"	3062	90			4880	NW	Cs	E
Cham_gl 148		78I/9	27°49'11"	90°37'34"	18416	325			4760	N	Ds	V
Cham_gl 149		78I/9	27°49'29"	90°36'44"	15816	165			4440	NE	Ds	V
Cham_gl 150		78I/9	27°48'31"	90°36'47"	45371	330			4640	NW	Ds	V
Cham_gl 151		78I/9	27°48'59"	90°35'31"	6416	165			4720	SE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 152		78I/9	27°49'1"	90°35'1"	111712	155			4840	SE	Ds	C
Cham_gl 153		78I/9	27°49'18"	90°34'54"	4677	55			5000	SE	Cs	E
Cham_gl 154		78I/9	27°49'23"	90°34'57"	5508	95			5020	SE	Cs	E
Cham_gl 155		78I/9	27°49'10"	90°35'23"	2215	60			4840	SE	Cs	E
Cham_gl 156		78I/9	27°50'8"	90°35'48"	27232	295			5040	NE	Cs	E
Cham_gl 157		78I/9	27°50'18"	90°36'9"	15185	105			4960	S	Cs	E
Cham_gl 158		78I/9	27°50'10"	90°36'47"	5862	105			4840	S	Cs	E
Cham_gl 159		78I/9	27°50'57"	90°37'57"	5169	105			4680	NW	Ds	V
Cham_gl 160		78I/9	27°50'37"	90°37'16"	126682	310			4760	SE	Cs	V
Cham_gl 161		78I/9	27°50'44"	90°36'15"	22093	225			4920	E	Ds	V
Cham_gl 162		78I/9	27°51'25"	90°36'29"	8139	140			4920	NE	Ds	V
Cham_gl 163		78I/9	27°51'37"	90°35'35"	802938	1535	425	Chamkr_gr2	4766	NE	Ds	C
Cham_gl 164		78I/9	27°51'16"	90°35'57"	41617	275	565	Chamkr_gr2	4920	N	Cs	E
Cham_gl 165		78I/9	27°50'59"	90°35'34"	3908	50	0	Chamkr_gr2	4990	NE	Cs	S
Cham_gl 166		78I/9	27°51'9"	90°35'35"	9262	165	0	Chamkr_gr2	4920	N	Cs	S
Cham_gl 167		78I/9	27°51'4"	90°35'14"	2523	65	170	Chamkr_gr2	5080	E	Cs	E
Cham_gl 168		78I/9	27°51'9"	90°34'58"	18508	250			4840	NE	Ds	V
Cham_gl 169		78I/9	27°51'0"	90°34'49"	2462	50	645	Chamkr_gr2	4920	SE	Cs	E
Cham_gl 170		78I/9	27°50'53"	90°34'48"	3016	60	455	Chamkr_gr2	4920	N	Cs	E
Cham_gl 171		78I/9	27°50'49"	90°34'51"	5016	90	300	Chamkr_gr3	4960	NW	Cs	E
Cham_gl 172		78I/9	27°50'46"	90°34'38"	3785	90	205	Chamkr_gr3	4960	NE	Cs	E
Cham_gl 173		78I/9	27°50'54"	90°34'34"	2815	65	480	Chamkr_gr3	5000	NE	Ds	V
Cham_gl 174		78I/9	27°51'17"	90°34'53"	20585	105			4800	N	Cs	V
Cham_gl 175		78I/9	27°52'30"	90°35'3"	174314	690			4596	E	Ds	V
Cham_gl 176		78I/9	27°52'17"	90°34'38"	17693	190			4720	NW	Cs	E
Cham_gl 177		78I/9	27°52'41"	90°34'25"	229347	460			4640	SE	Cs	V
Cham_gl 178		78I/9	27°52'51"	90°34'11"	171406	315			4640	SE	Cs	V
Cham_gl 179		78I/9	27°53'3"	90°33'49"	5277	75			4790	SE	DsS	E
Cham_gl 180		78I/9	27°53'1"	90°34'38"	12970	190			4800	SE	Ds	V
Cham_gl 181		78I/9	27°53'25"	90°34'47"	2569	65			4960	SE	Ds	V
Cham_gl 182		78I/9	27°53'37"	90°36'4"	108620	655			4622	E	Ds	V
Cham_gl 183		78I/9	27°53'17"	90°36'22"	3985	105			4520	NE	Cs	E
Cham_gl 184		78I/9	27°54'15"	90°35'57"	71433	565			4562	NE	Ds	V
Cham_gl 185		78I/9	27°54'8"	90°35'19"	67972	375			4720	NE	Ds	V
Cham_gl 186		78I/9	27°54'52"	90°34'59"	2262	100			4760	NE	Ds	V
Cham_gl 187		78I/9	27°55'11"	90°34'39"	18324	215			4760	NE	Cs	V
Cham_gl 188		78I/9	27°54'53"	90°33'45"	105804	645	70	Chamkr_gr6	4720	NE	Ds	E
Cham_gl 189		78I/9	27°56'8"	90°33'33"	18816	250			4751	NE	Ds	V
Cham_gl 190		78I/9	27°55'57"	90°33'29"	16385	205			4760	NE	Ds	V
Cham_gl 191		78I/9	27°55'26"	90°33'26"	297688	205			4770	NE	Ds	V
Cham_gl 192		78I/9	27°55'24"	90°32'48"	18478	295			4849	SE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 193		78I/9	27°55'8"	90°32'21"	357814	840	360	Chamkr_gr8	4920	NE	Ds	V
Cham_gl 194		78I/9	27°56'52"	90°33'19"	42971	355			4600	NE	Ds	V
Cham_gl 195		78I/9	27°56'25"	90°32'43"	3369	70			5240	NE	Cs	E
Cham_gl 196		78I/9	27°56'36"	90°32'35"	10923	125			5000	NE	Cs	E
Cham_gl 197		78I/9	27°56'45"	90°32'29"	5200	65			5040	NE	Cs	E
Cham_gl 198		78I/9	27°56'22"	90°32'16"	624670	1495	0	Chamkr_gr9	5046	NE	Cs	E
Cham_gl 199		78I/9	27°56'35"	90°31'38"	5062	95	310	Chamkr_gr11	4180	NW	Cs	E
Cham_gl 200		78I/9	27°57'24"	90°30'56"	79911	320			4260	E	Cs	V
Cham_gl 201		78I/9	27°57'1"	90°30'45"	25755	165			5000	N	Cs	E
Cham_gl 202		78I/9	27°57'11"	90°30'33"	23970	245			5000	NE	Cs	E
Cham_gl 203		78I/9	27°57'3"	90°30'31"	9170	115			5030	W	Ds	E
Cham_gl 204		78I/9	27°57'2"	90°30'14"	2800	60			4140	W	Ds	V
Cham_gl 205		78I/9	27°56'52"	90°30'15"	2185	55			4040	S	Cs	E
Cham_gl 206		78I/9	27°56'51"	90°30'6"	11908	185			4080	SW	Cs	C
Cham_gl 207		78I/9	27°57'14"	90°29'59"	19339	115			5160	SW	Ds	V
Cham_gl 208		78I/5	27°57'24"	90°29'58"	9616	90			5160	NE	Cs	V
Cham_gl 209		78I/9	27°57'7"	90°30'13"	2277	50			5080	NE	Cs	E
Cham_gl 210		78I/9	27°57'53"	90°30'37"	22401	135			5000	NE	Cs	V
Cham_gl 211		78I/9	27°57'52"	90°30'22"	12493	175			5040	NE	Ds	V
Cham_gl 212		78I/9	27°57'54"	90°30'10"	14016	115			5040	NE	Ds	E
Cham_gl 213		78I/5	27°57'52"	90°29'60"	6046	85			5120	E	Cs	V
Cham_gl 214		78I/5	27°58'6"	90°29'59"	30555	300			5120	SE	Ds	E
Cham_gl 215		78I/5	27°58'4"	90°29'50"	1892	45			5120	E	Cs	E
Cham_gl 216		78I/5	27°58'17"	90°29'47"	8662	120			5160	SE	Ds	E
Cham_gl 217		78I/5	27°58'23"	90°29'48"	6400	105			5160	SE	Cs	E
Cham_gl 218		78I/5	27°58'41"	90°29'54"	1815	50	240	Chamkr_gr13	5200	S	Cs	E
Cham_gl 219		78I/5	27°58'44"	90°29'53"	1446	50	190	Chamkr_gr13	5200	S	Cs	E
Cham_gl 220		78I/5	27°58'20"	90°29'54"	5246	120			5160	NE	Cs	E
Cham_gl 221		78I/9	27°58'11"	90°30'6"	5385	95			5120	SE	Cs	E
Cham_gl 222		78I/9	27°58'10"	90°30'10"	2769	55			5120	SE	Cs	E
Cham_gl 223		78I/9	27°58'2"	90°30'20"	11739	110			5120	SE	Cs	V
Cham_gl 224		78I/9	27°58'4"	90°30'29"	20001	270			5080	SE	Ds	V
Cham_gl 225		78I/9	27°57'53"	90°30'49"	23878	135			5060	S	Cs	V
Cham_gl 226		78I/9	27°57'60"	90°30'44"	14477	150			5080	SE	Ds	V
Cham_gl 227		78I/9	27°58'18"	90°30'42"	288734	950	460	Chamkr_gr18	5102	SE	Cs	V
Cham_gl 228		78I/9	27°58'21"	90°30'14"	3292	50			5120	SE	Cs	E
Cham_gl 229		78I/9	27°58'27"	90°30'14"	3400	55			5160	SE	Cs	E
Cham_gl 230		78I/9	27°58'32"	90°30'21"	2585	45			5160	SE	Cs	E
Cham_gl 231		78I/9	27°58'42"	90°30'29"	37355	240			5120	SE	Cs	E
Cham_gl 232		78I/9	27°59'11"	90°30'31"	205146	565	0	Chamkr_gr15	5200	S	Ds	S
Cham_gl 233		78I/9	27°59'22"	90°30'5"	9293	115	0	Chamkr_gr14	5267	SE	Cs	M

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 234		77L/12	28°0'9"	90°31'18"	28478	130	165	Chamkr_gr23	5240	SE	Ds	E
Cham_gl 235		78I/9	27°59'15"	90°30'51"	6185	55	55	Chamkr_gr15	5240	S	Cs	E
Cham_gl 236		78I/9	27°59'11"	90°30'47"	6385	60	0	Chamkr_gr15	5240	S	Cs	S
Cham_gl 237		78I/9	27°58'56"	90°30'48"	3000	60	205	Chamkr_gr17	5160	SE	Cs	V
Cham_gl 238		78I/9	27°59'1"	90°30'59"	8031	105			5200	SW	Cs	E
Cham_gl 239		78I/9	27°59'14"	90°31'10"	37971	185	0	Chamkr_gr17	5240	SW	Cs	M
Cham_gl 240		78I/9	27°58'52"	90°31'4"	47248	200	0	Chamkr_gr17	5160	SW	Cs	M
Cham_gl 241		78I/9	27°58'36"	90°30'60"	4846	115	80	Chamkr_gr18	5160	SW	Ds	V
Cham_gl 242		77L/12	28°0'1"	90°32'35"	86788	605	0	Chamkr_gr25	4680	SE	Cs	S
Cham_gl 243		77L/12	28°0'14"	90°32'28"	8539	135	0	Chamkr_gr25	4680	SE	Cs	S
Cham_gl 244		77L/12	28°0'18"	90°32'31"	9431	150	0	Chamkr_gr25	4680	SE	Cs	S
Cham_gl 245		77L/12	28°0'36"	90°32'27"	12739	165	0	Chamkr_gr25	4760	SE	Cs	S
Cham_gl 246		77L/12	28°0'37"	90°32'12"	7108	75	0	Chamkr_gr25	4800	SE	Cs	S
Cham_gl 247		77L/12	28°0'41"	90°32'16"	6877	95	0	Chamkr_gr25	4800	SE	Cs	S
Cham_gl 248		77L/12	28°0'43"	90°32'12"	7462	100	0	Chamkr_gr25	4800	SE	Cs	S
Cham_gl 249		77L/12	28°0'42"	90°32'5"	9539	115	0	Chamkr_gr25	4800	SE	Cs	S
Cham_gl 250		77L/12	28°0'40"	90°32'2"	6477	105	0	Chamkr_gr25	4800	SE	Cs	S
Cham_gl 251		77L/12	28°0'47"	90°32'7"	7554	105	0	Chamkr_gr25	4800	SE	Cs	S
Cham_gl 252		77L/12	28°1'1"	90°32'8"	24339	85	0	Chamkr_gr25	4840	SE	Cs	S
Cham_gl 253		77L/12	28°1'1"	90°31'59"	7923	110	0	Chamkr_gr25	4840	SE	Cs	S
Cham_gl 254		77L/12	28°0'55"	90°30'47"	20770	245	495	Chamkr_gr25	5240	SE	Cs	V
Cham_gl 255		77L/12	28°1'15"	90°32'2"	7631	100	0	Chamkr_gr25	4880	SE	Cs	S
Cham_gl 256		77L/12	28°1'18"	90°31'51"	4816	85	0	Chamkr_gr25	4880	SE	Cs	S
Cham_gl 257		77L/12	28°1'22"	90°32'2"	10693	130	0	Chamkr_gr25	4880	SE	Cs	S
Cham_gl 258		77L/12	28°1'13"	90°31'46"	7662	105	0	Chamkr_gr25	4880	SE	Cs	S
Cham_gl 259		77L/12	28°1'16"	90°31'49"	6446	105	0	Chamkr_gr25	4880	SE	Cs	S
Cham_gl 260		77L/12	28°1'20"	90°31'41"	6693	130	0	Chamkr_gr25	4920	SE	Cs	S
Cham_gl 261		77L/12	28°1'23"	90°31'43"	12108	160	0	Chamkr_gr25	4880	SE	Cs	S
Cham_gl 262		77L/12	28°1'35"	90°31'40"	14954	130	0	Chamkr_gr25	4920	SE	Cs	S
Cham_gl 263		77L/12	28°1'38"	90°31'34"	10062	110	0	Chamkr_gr25	4920	SE	Cs	S
Cham_gl 264		77L/12	28°1'40"	90°31'27"	9400	115	0	Chamkr_gr25	4920	SE	Cs	S
Cham_gl 265		77L/12	28°1'45"	90°31'49"	7708	95	0	Chamkr_gr25	4920	SE	Cs	S
Cham_gl 266		77L/12	28°1'49"	90°31'20"	9723	135	0	Chamkr_gr25	4920	SE	Cs	S
Cham_gl 267		77L/12	28°1'53"	90°31'14"	10662	130	0	Chamkr_gr25	4940	SE	Cs	S
Cham_gl 268		77L/12	28°2'2"	90°31'17"	8016	105	0	Chamkr_gr25	4940	SE	Cs	S
Cham_gl 269		77L/12	28°2'6"	90°31'16"	12539	135	0	Chamkr_gr25	4940	SE	Cs	S
Cham_gl 270		77L/12	28°2'8"	90°31'10"	7416	90	0	Chamkr_gr25	4940	SE	Cs	S
Cham_gl 271		77L/12	28°2'3"	90°31'7"	7831	115	0	Chamkr_gr25	4940	SE	Cs	S
Cham_gl 272		77L/12	28°2'13"	90°31'0"	7154	120	0	Chamkr_gr25	4960	SE	Cs	S
Cham_gl 273		77L/12	28°2'18"	90°30'60"	9847	120	0	Chamkr_gr25	4960	SE	Cs	S
Cham_gl 274		77L/12	28°2'31"	90°30'51"	10016	130	0	Chamkr_gr25	4960	SE	Cs	S

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 275		77L/12	28°2'14"	90°31'11"	7600	100	0	Chamkr_gr25	4960	SE	Cs	S
Cham_gl 276		77L/12	28°2'16"	90°31'16"	10262	125	0	Chamkr_gr25	4960	SE	Cs	S
Cham_gl 277		77L/12	28°2'21"	90°31'18"	8723	130	0	Chamkr_gr25	4960	SE	Cs	S
Cham_gl 278		77L/12	28°2'12"	90°31'20"	9262	130	0	Chamkr_gr25	4960	SE	Cs	S
Cham_gl 279		77L/12	28°2'2"	90°32'36"	13662	175	0	Chamkr_gr25	5000	SW	Cs	S
Cham_gl 280		77L/12	28°2'25"	90°32'22"	160714	560	0	Chamkr_gr25	5120	SE	Cs	S
Cham_gl 281		77L/12	28°2'15"	90°32'54"	161545	485	0	Chamkr_gr25	5140	SW	Cs	S
Cham_gl 282		77L/12	28°2'5"	90°32'43"	8416	60			5140	SW	Cs	S
Cham_gl 283		77L/12	28°1'15"	90°32'42"	28586	115	0	Chamkr_gr25	4760	SE	Cs	V
Cham_gl 284		77L/12	28°1'53"	90°33'14"	29186	285	355	Chamkr_gr25	5160	SE	Cs	V
Cham_gl 285		77L/12	28°1'34"	90°33'38"	80665	160	720	Chamkr_gr26	5120	SW	Cs	E
Cham_gl 286		77L/12	28°0'29"	90°33'58"	6154	455	280	Chamkr_gr27	5160	SW	Cs	V
Cham_gl 287		77L/12	28°0'45"	90°34'13"	47186	95			5160	SW	Cs	V
Cham_gl 288		77L/12	28°0'57"	90°34'23"	67710	345	560	Chamkr_gr28	5200	SW	Cs	V
Cham_gl 289		77L/12	28°1'3"	90°34'32"	6446	415	65	Chamkr_gr28	5240	SW	Cs	E
Cham_gl 290		77L/12	28°0'54"	90°34'32"	9308	90	90	Chamkr_gr28	5200	SW	Cs	V
Cham_gl 291		77L/12	28°0'42"	90°34'28"	24878	105	330	Chamkr_gr28	5160	SW	Cs	E
Cham_gl 292		77L/12	28°0'36"	90°34'14"	13539	170	305	Chamkr_gr28	5160	SW	Cs	E
Cham_gl 293		77L/12	28°0'21"	90°34'32"	107281	100	725	Chamkr_gr29	5160	W	Ds	V
Cham_gl 294		78I/9	27°59'60"	90°34'36"	20847	220	0	Chamkr_gr30	5185	NW	Ds	M
Cham_gl 295		78I/9	27°58'23"	90°35'15"	75418	555			4960	SW	Ds	V
Cham_gl 296		78I/9	27°58'52"	90°35'48"	112158	605	835	Chamkr_gr38	5040	SW	Ds	V
Cham_gl 297		78I/9	27°59'49"	90°35'45"	115066	555	580	Chamkr_gr34	5120	SE	Cs	V
Cham_gl 298		77L/12	28°0'30"	90°35'34"	4877	85			5160	SE	Cs	E
Cham_gl 299		77L/12	28°0'35"	90°35'33"	6093	95	555	Chamkr_gr35	5160	SE	Cs	E
Cham_gl 300		77L/12	28°0'35"	90°35'40"	33801	210	520	Chamkr_gr36	5160	SE	Cs	E
Cham_gl 301		77L/12	28°0'12"	90°36'15"	56079	275	725	Chamkr_gr49	5200	SW	Cs	C
Cham_gl 302		78I/9	27°59'42"	90°36'20"	13462	95	180	Chamkr_gr37	5160	SW	Cs	E
Cham_gl 303		78I/9	27°58'57"	90°36'9"	64402	405	350	Chamkr_gr38	5040	W	Cs	V
Cham_gl 304		78I/9	27°55'55"	90°37'47"	18385	180			4640	SE	Ds	V
Cham_gl 305		78I/9	27°56'54"	90°36'50"	14801	150			4960	SE	Ds	V
Cham_gl 306		78I/9	27°57'13"	90°36'41"	28540	275			5040	SE	Cs	V
Cham_gl 307		78I/9	27°57'21"	90°36'51"	6123	110			5000	SE	Ds	V
Cham_gl 308		78I/9	27°57'28"	90°36'37"	31801	170			5040	SE	Cs	E
Cham_gl 309		78I/9	27°57'30"	90°36'27"	7570	80			5040	SE	Cs	E
Cham_gl 310		78I/9	27°57'35"	90°36'37"	8446	155			5040	SE	Cs	E
Cham_gl 311		78I/9	27°57'41"	90°36'31"	2862	65			5040	SE	Ds	V
Cham_gl 312		78I/9	27°57'46"	90°37'4"	33017	215			4920	SE	Ds	V
Cham_gl 313		78I/9	27°58'19"	90°36'27"	6093	110	540	Chamkr_gr40	5120	SE	Ds	V
Cham_gl 314		78I/9	27°58'19"	90°36'54"	25109	235	205	Chamkr_gr40	5049	S	Ds	V
Cham_gl 315		78I/9	27°58'20"	90°37'19"	13493	110	0	Chamkr_gr41	5240	W	Ds	S

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 316		78I/9	27°57'25"	90°37'52"	77188	490			4880	SW	Ds	V
Cham_gl 317		78I/9	27°57'39"	90°37'57"	14939	180			4920	S	Cs	V
Cham_gl 318		78I/9	27°57'40"	90°38'10"	6969	145			4920	W	Ds	V
Cham_gl 319		78I/9	27°57'44"	90°38'14"	7200	160			4920	SW	Cs	V
Cham_gl 320		78I/9	27°58'7"	90°38'24"	79895	135			5000	SW	Ds	V
Cham_gl 321		78I/9	27°58'18"	90°38'17"	30340	330	853	Chamkr_gr41	5000	SE	Ds	V
Cham_gl 322		78I/9	27°58'28"	90°38'0"	6662	115	340	Chamkr_gr41	5120	SE	Ds	V
Cham_gl 323		78I/9	27°57'39"	90°38'28"	5816	130			4960	SW	Cs	E
Cham_gl 324		78I/9	27°56'59"	90°38'26"	16431	125			5040	S	Ds	V
Cham_gl 325		78I/9	27°57'9"	90°38'31"	4616	55			5080	SE	Cs	E
Cham_gl 326		78I/9	27°57'14"	90°38'36"	3477	45			5080	SE	Cs	E
Cham_gl 327		78I/9	27°57'20"	90°38'43"	10862	140			5120	SE	Cs	E
Cham_gl 328		78I/9	27°56'48"	90°38'51"	3646	70			5000	SE	Cs	E
Cham_gl 329		78I/9	27°55'53"	90°39'42"	6708	95			4760	SE	Cs	E
Cham_gl 330		78I/9	27°56'3"	90°39'40"	49402	330			4800	SE	Cs	C
Cham_gl 331		78I/9	27°56'19"	90°39'43"	10939	145			4760	SE	Ds	V
Cham_gl 332		78I/9	27°56'49"	90°39'10"	2477	60			5040	NE	Ds	E
Cham_gl 333		78I/9	27°56'53"	90°39'12"	3077	65			5040	SE	Ds	E
Cham_gl 334		78I/9	27°56'21"	90°40'58"	6446	80			4600	SE	Cs	V
Cham_gl 335		78I/9	27°57'16"	90°40'56"	11477	165			4640	WE	Ds	V
Cham_gl 336		78I/9	27°57'20"	90°40'5"	18724	240			4800	E	Ds	V
Cham_gl 337		78I/9	27°57'11"	90°39'31"	15124	200			4880	E	Ds	V
Cham_gl 338		78I/9	27°57'24"	90°39'44"	8339	210			4840	SE	Ds	V
Cham_gl 339		78I/9	27°57'53"	90°39'16"	11108	150	190	Chamkr_gr42	5120	SE	Cs	E
Cham_gl 340		78I/9	27°57'60"	90°39'16"	3292	85	15	Chamkr_gr42	5160	SE	Cs	E
Cham_gl 341		78I/9	27°58'3"	90°39'40"	21785	190			5060	SE	Ds	V
Cham_gl 342		78I/9	27°58'14"	90°39'58"	4569	70			4920	SE	Ds	V
Cham_gl 343		78I/9	27°58'29"	90°39'16"	4216	65	320	Chamkr_gr43	5000	NE	Cs	E
Cham_gl 344		78I/9	27°58'46"	90°38'49"	9785	160			5080	NW	Cs	E
Cham_gl 345		78I/9	27°59'27"	90°38'45"	68480	450	671	Chamkr_gr44	4800	NE	Ds	V
Cham_gl 346		78I/9	27°59'43"	90°38'39"	114974	1005	0	Cjhamkr_gr50	4840	SE	Ds	M&S
Cham_gl 347		78L/12	28°0'2"	90°38'21"	12370	140	0	Cjhamkr_gr50	4960	SE	Cs	S
Cham_gl 348		78L/12	28°0'10"	90°38'11"	23493	200	0	Cjhamkr_gr50	5240	SW	Cs	S
Cham_gl 349		78I/9	27°59'37"	90°37'37"	55387	415	20	Cjhamkr_gr47	5120	SE	Ds	E
Cham_gl 350		78I/9	27°59'52"	90°37'23"	5600	75	60	Cjhamkr_gr48	5160	SE	Cs	E
Cham_gl 351		78I/9	27°59'58"	90°37'40"	12708	145	70	Cjhamkr_gr50	5160	NE	Cs	E
Cham_gl 352		78L/12	28°0'7"	90°37'38"	11862	125	0	Cjhamkr_gr50	5240	SE	Cs	V
Cham_gl 353		78L/12	28°1'32"	90°38'59"	11662	130	710	Cjhamkr_gr53	5070	NE	Cs	E
Cham_gl 354		78L/12	28°1'28"	90°38'50"	15324	170	475	Cjhamkr_gr53	5000	NE		C
Cham_gl 355		78L/12	28°1'39"	90°38'48"	12462	125	750	Cjhamkr_gr53	4960	NE		E
Cham_gl 356		78L/12	28°1'30"	90°38'25"	5046	90	430	Cjhamkr_gr53	5080	NE		E

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 357		78L/12	28°1'29"	90°38'15"	12739	115	375	Cjhamkr_gr53	5080	NE		E
Cham_gl 358		78L/12	28°1'40"	90°38'9"	24139	175	500	Cjhamkr_gr54	5120	E		E
Cham_gl 359		78L/12	28°1'49"	90°38'7"	11400	135	805	Cjhamkr_gr55	5120	SE		E
Cham_gl 360		78L/12	28°2'6"	90°37'46"	103958	485			5120	SE		V
Cham_gl 361		78L/12	28°2'9"	90°37'27"	128943	410	325	Cjhamkr_gr57	5120	SE		V
Cham_gl 362		78L/12	28°2'10"	90°37'12"	4631	90	465	Cjhamkr_gr57	5120	SE		V
Cham_gl 363		78L/12	28°2'14"	90°37'7"	19047	255	620	Cjhamkr_gr57	5160	SE		V
Cham_gl 364		78L/12	28°1'59"	90°38'22"	6185	85			5080	SE	Cs	E
Cham_gl 365		78L/12	28°2'4"	90°38'20"	20616	120			5080	SE	Cs	E
Cham_gl 366		78L/12	28°2'7"	90°38'16"	10708	85			5080	SE	Cs	E
Cham_gl 367		78L/12	28°2'12"	90°38'12"	9293	100			5080	SE	Cs	E
Cham_gl 368		78L/12	28°1'50"	90°38'31"	6139	85			5040	SE	Cs	V
Cham_gl 369		78L/12	28°2'7"	90°38'36"	21385	210			5040	SE	Cs	V
Cham_gl 370		78L/12	28°2'4"	90°39'0"	31694	165			5000	S	Cs	V
Cham_gl 371		78L/12	28°2'4"	90°39'11"	29232	130			5000	S	Cs	V
Cham_gl 372		78L/12	28°2'13"	90°39'22"	36186	265			5080	NE	Ds	V
Cham_gl 373		78L/12	28°2'11"	90°39'57"	295488	965			4720	S	Ds	V
Cham_gl 374		78L/12	28°2'37"	90°40'27"	83357	280			4920	SW	Cs	C
Cham_gl 375		78L/12	28°1'43"	90°40'31"	7754	110			4720	SW	Ds	E
Cham_gl 376		78L/12	28°1'51"	90°40'42"	31278	315			4720	SW	Ds	E
Cham_gl 377		78L/12	28°2'0"	90°40'54"	8677	130	775	Chamkr_gr61	4760	SW	Ds	E
Cham_gl 378		78L/12	28°2'4"	90°41'9"	41017	240	275	Chamkr_gr61	4800	SW	Ds	V
Cham_gl 379		78L/12	28°2'19"	90°41'41"	19693	205	0	Chamkr_gr61	5000	S	Cs	S
Cham_gl 380		78L/12	28°1'49"	90°41'2"	13416	135	740	Chamkr_gr61	4800	NW	Cs	M
Cham_gl 381		78L/12	28°1'43"	90°41'43"	21539	225	540	Chamkr_gr61	4960	NW	Cs	C
Cham_gl 382		78L/12	28°0'51"	90°41'52"	18108	155	0	Chamkr_gr71	4840	SW	Cs	S
Cham_gl 383		78L/12	28°1'26"	90°42'32"	1035132	2645	0	Chamkr_gr71	4840	SW	Cs	S
Cham_gl 384		78L/12	28°2'18"	90°42'49"	3523	65	550	Chamkr_gr62	5000	S	Cs	E
Cham_gl 385		78L/12	28°2'35"	90°42'40"	7323	80	115	Chamkr_gr62	5160	SE	Cs	E
Cham_gl 386		78L/12	28°0'16"	90°42'27"	321812	915	555	Chamkr_gr72	4880	NW	Cs	V
Cham_gl 387		78L/12	28°0'30"	90°43'24"	47294	170	335	Chamkr_gr72	5080	S	Cs	C
Cham_gl 388		78L/12	28°0'46"	90°43'47"	45648	270	675	Chamkr_gr71	5160	S	Cs	V
Cham_gl 389		78L/12	28°1'1"	90°43'42"	10708	130	340	Chamkr_gr71	5160	SE	Cs	V
Cham_gl 390		78I/9	27°59'24"	90°41'19"	37663	270			4720	SW	Ds	V
Cham_gl 391		78I/9	27°59'27"	90°41'37"	5323	115			4800	W	Ds	V
Cham_gl 392		78I/9	27°59'16"	90°42'9"	43325	315			4920	NW	Ds	V
Cham_gl 393		78I/9	27°59'8"	90°42'26"	62002	255			5080	NW	Ds	V
Cham_gl 394		78I/9	27°59'28"	90°42'35"	7446	135			5160	SW	Ds	V
Cham_gl 395		78I/9	27°58'37"	90°41'58"	15262	150			4800	SW	Ds	V
Cham_gl 396		78I/9	27°58'43"	90°42'15"	7693	60			4960	W	Ds	V
Cham_gl 397		78I/9	27°57'49"	90°43'5"	42494	335			4640	S	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 398		78I/9	27°58'2"	90°43'2"	14893	170			4680	S	Ds	V
Cham_gl 399		78I/9	27°58'20"	90°43'8"	14231	155			4720	SW	Ds	V
Cham_gl 400		78I/9	27°58'59"	90°43'13"	18616	225			4840	SW	Ds	V
Cham_gl 401		78I/9	27°58'43"	90°43'34"	24262	435			4780	SW	Ds	V
Cham_gl 402		78I/9	27°59'8"	90°43'46"	16139	170	385	Chamkr_gr73	4840	SW	Ds	V
Cham_gl 403		78I/9	27°59'14"	90°44'13"	26955	290	670	Chamkr_gr74	4960	SW	Ds	V
Cham_gl 404		77L/12	28°0'8"	90°44'45"	8016	110	135	Chamkr_gr74	5160	SE	Cs	E
Cham_gl 405		77L/12	28°0'22"	90°44'54"	8293	110	640	Chamkr_gr74	5200	SW	Cs	E
Cham_gl 406		78I/13	27°59'53"	90°46'4"	9400	115	0	Chamkr_gr75		SW	Cs	S
Cham_gl 407		78I/13	27°59'56"	90°46'16"	9585	125	0	Chamkr_gr75		SW	Cs	S
Cham_gl 408		78I/13	28°0'40"	90°47'2"	5831	70	0	Chamkr_gr75		SW	Cs	S
Cham_gl 409		78I/13	28°0'42"	90°46'57"	4785	95	0	Chamkr_gr75		SW	Cs	S
Cham_gl 410		78I/13	28°0'45"	90°47'1"	5723	95	0	Chamkr_gr75		SW	Cs	S
Cham_gl 411		78I/13	28°0'28"	90°47'31"	32401	260				SW	Ds	B
Cham_gl 412		78I/13	28°0'27"	90°47'57"	62095	220				SW	Ds	V
Cham_gl 413		78I/13	28°0'1"	90°47'50"	48017	255				W	Cs	E
Cham_gl 414		78I/13	27°59'57"	90°47'39"	10293	135				W	Cs	E
Cham_gl 415		78I/13	27°59'55"	90°47'47"	6600	85				W	Cs	E
Cham_gl 416		78I/13	27°59'38"	90°47'22"	30632	205				SW	Cs	E
Cham_gl 417		78I/13	27°59'18"	90°47'19"	8385	95				W	Ds	E
Cham_gl 418		78I/13	27°59'12"	90°46'47"	51371	265				W	Ds	E
Cham_gl 419		78I/13	27°57'49"	90°45'22"	7246	95	335	Chamkr_gr80		W	Ds	E
Cham_gl 420		78I/13	27°57'11"	90°46'24"	13677	115				NW	Cs	E
Cham_gl 421		78I/13	27°57'4"	90°45'58"	34278	205				NW	Cs	E
Cham_gl 422		78I/13	27°56'58"	90°45'34"	32647	245				NW	Cs	E
Cham_gl 423		78I/13	27°56'35"	90°45'15"	178114	675	250	Chamkr_gr82		NW	Ds	E
Cham_gl 424		78I/9	27°56'47"	90°44'52"	10108	90			4880	SW	Ds	E
Cham_gl 425		78I/9	27°56'37"	90°44'44"	78418	570	1045	Chamkr_gr82	4800	NW	Ds	V
Cham_gl 426		78I/9	27°55'52"	90°44'29"	5939	85	335	Chamkr_gr83	5120	NE	Cs	V
Cham_gl 427		78I/9	27°55'47"	90°44'28"	5016	80	230	Chamkr_gr83	5120	NE	Cs	V
Cham_gl 428		78I/9	27°55'52"	90°44'25"	1908	65	415	Chamkr_gr83	5120	NE	Cs	V
Cham_gl 429		78I/9	27°56'28"	90°44'10"	12108	160			4840	NW	Ds	V
Cham_gl 430		78I/9	27°56'17"	90°44'3"	43171	170			5000	NW	Cs	E
Cham_gl 431		78I/9	27°56'7"	90°44'7"	11477	85			5040	NW	Cs	V
Cham_gl 432		78I/9	27°56'30"	90°43'30"	21093	275			4840	NW	Ds	V
Cham_gl 433		78I/9	27°56'8"	90°43'45"	9108	110			5000	NE	Cs	E
Cham_gl 434		78I/9	27°56'11"	90°42'25"	2815	65			4720	W	Ds	V
Cham_gl 435		78I/9	27°55'44"	90°42'46"	37278	385			4700	NW	Ds	V
Cham_gl 436		78I/9	27°55'53"	90°43'13"	3523	80			4960	SW	Cs	E
Cham_gl 437		78I/9	27°55'34"	90°44'24"	6569	125	85	Chamkr_gr83	5080	SW	Cs	E
Cham_gl 438		78I/9	27°55'31"	90°44'26"	6293	150	50	Chamkr_gr83	5080	SW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 439		78I/9	27°54'3"	90°44'2"	16508	155			4840	SW	Cs	V
Cham_gl 440		78I/9	27°54'17"	90°44'28"	11293	175	115	Chamkr_gr86	4960	SW	Ds	V
Cham_gl 441		78I/13	27°54'59"	90°45'33"	22632	190	700	Chamkr_gr85		SE	Ds	E
Cham_gl 442		78I/13	27°55'18"	90°45'42"	114097	470	480	Chamkr_gr87		S	Ds	E
Cham_gl 443		78I/9	27°53'54"	90°44'4"	20924	225			4860	SW	Cs	E
Cham_gl 444		78I/9	27°53'39"	90°43'60"	4108	100			4760	SW	Ds	V
Cham_gl 445		78I/9	27°53'6"	90°43'31"	8739	140			4720	NE	Cs	V
Cham_gl 446		78I/9	27°52'59"	90°43'15"	5400	90			4800	NE	Cs	E
Cham_gl 447		78I/9	27°53'9"	90°43'16"	5954	105			4800	NW	Cs	E
Cham_gl 448		78I/9	27°53'20"	90°43'9"	38232	280			4720	NE	Ds	V
Cham_gl 449		78I/9	27°52'57"	90°42'57"	123282	495			4840	NE	Cs	V
Cham_gl 450		78I/9	27°54'15"	90°41'52"	4785	110			4680	NW	Cs	E
Cham_gl 451		78I/9	27°54'18"	90°41'42"	7985	145			4640	NW	Ds	V
Cham_gl 452		78I/9	27°52'34"	90°41'30"	14047	150			4600	NW	Ds	V
Cham_gl 453		78I/9	27°51'57"	90°42'12"	2523	100			4760	SW	Cs	E
Cham_gl 454		78I/9	27°51'51"	90°42'22"	5846	110			4760	SW	Cs	E
Cham_gl 455		78I/9	27°51'46"	90°42'23"	6046	115			4760	SW	Cs	E
Cham_gl 456		78I/9	27°51'42"	90°42'39"	18124	145			4800	SW	Ds	V
Cham_gl 457		78I/9	27°51'7"	90°42'46"	78803	490			4560	NW	Ds	V
Cham_gl 458		78I/9	27°50'25"	90°42'10"	6400	130			4760	SW	Ds	V
Cham_gl 459		78I/9	27°50'28"	90°42'45"	14954	80			4840	SE	Cs	E
Cham_gl 460		78I/9	27°49'34"	90°42'13"	108927	415			4320	SW	Ds	V
Cham_gl 461		78I/9	27°50'24"	90°43'48"	6816	125			4360	SE	Ds	V
Cham_gl 462		78I/9	27°50'27"	90°43'57"	5108	95			4400	SE	Cs	E
Cham_gl 463		78I/9	27°50'35"	90°43'56"	11416	155			4400	SE	Cs	V
Cham_gl 464		78I/9	27°50'12"	90°44'53"	4985	75			4760	W	Cs	E
Cham_gl 465		78I/9	27°50'19"	90°44'57"	14508	190			4720	SE	CsS	E
Cham_gl 466		78I/13	27°50'9"	90°45'34"	17585	210				SE	Ds	E
Cham_gl 467		78I/9	27°51'18"	90°44'33"	100865	580			4400	SE	Ds	V
Cham_gl 468		78I/9	27°51'21"	90°44'2"	82942	450			4440	SE	Ds	V
Cham_gl 469		78I/9	27°51'49"	90°43'36"	2462	60			4960	SE	Ds	V
Cham_gl 470		78I/9	27°51'38"	90°44'29"	29401	145			4640	S	Ds	V
Cham_gl 471		78I/13	27°50'52"	90°45'17"	40540	245				NE	Ds	C
Cham_gl 472		78I/9	27°53'7"	90°43'55"	12893	65			4620	SE	Ds	V
Cham_gl 473		78I/9	27°53'11"	90°44'0"	3062	390			4660	SE	Ds	E
Cham_gl 474		78I/13	27°52'50"	90°47'23"	88250	270				SE	Ds	C
Cham_gl 475		78I/13	27°53'10"	90°48'0"	40109	280				SE	Ds	E
Cham_gl 476		78I/13	27°52'25"	90°48'11"	200131	730				SW	Ds	V
Cham_gl 477		78I/13	27°50'48"	90°47'47"	21201	210				E	Ds	V
Cham_gl 478		78I/13	27°52'2"	90°48'53"	374568	1055				S	Ds	V
Cham_gl 479		78I/13	27°53'5"	90°49'2"	34801	250				SE	Cs	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 480		78I/13	27°53'33"	90°49'20"	8846	120				S	Ds	V
Cham_gl 481		78I/13	27°53'50"	90°48'58"	437817	1120	770	Chamkr_gr92		SE	Ds	V
Cham_gl 482		78I/13	27°53'60"	90°48'23"	54956	145	405	Chamkr_gr92		E	Ds	V
Cham_gl 483		78I/13	27°54'8"	90°48'16"	12616	115	620	Chamkr_gr92		SW	Ds	E
Cham_gl 484		78I/13	27°54'25"	90°48'44"	393615	1035	185	Chamkr_gr94		SE	Ds	V
Cham_gl 485		78I/13	27°54'30"	90°49'25"	76911	345				SW	Ds	C
Cham_gl 486		78I/13	27°53'27"	90°49'37"	13354	135				W	Ds	E
Cham_gl 487		78I/13	27°53'10"	90°49'45"	166899	460				W	Ds	V
Cham_gl 488		78I/13	27°52'43"	90°49'38"	42879	310				SW	Ds	V
Cham_gl 489		78I/13	27°49'50"	90°48'36"	95311	660				SW	Ds	V
Cham_gl 490		78I/13	27°49'21"	90°48'29"	70264	395				NE	Ds	C
Cham_gl 491		78I/13	27°47'32"	90°46'57"	134513	760				NW	Ds	V
Cham_gl 492		78I/13	27°46'36"	90°45'25"	19508	135				SW	Ds	V
Cham_gl 493		78I/13	27°46'3"	90°45'58"	15124	115				SE	Cs	V
Cham_gl 494		78I/13	27°46'7"	90°46'22"	32832	230				S	Ds	V
Cham_gl 495		78I/14	27°44'59"	90°47'56"	23324	190			4220	NW	Cs	V
Cham_gl 496		78I/14	27°44'5"	90°48'44"	23078	235			4160	SW	Ds	V
Cham_gl 497		78I/14	27°44'21"	90°49'1"	23109	190			4320	SW	Ds	V
Cham_gl 498		78I/14	27°43'39"	90°48'57"	4031	75			4280	SW	Ds	V
Cham_gl 499		78I/14	27°44'0"	90°46'35"	12139	155			3960	NW	Ds	V
Cham_gl 500		78I/14	27°43'53"	90°46'47"	20832	245			4160	NW	Ds	V
Cham_gl 501		78I/14	27°43'21"	90°47'21"	73495	150			4160	SW	Ds	C
Cham_gl 502		78I/14	27°42'28"	90°46'58"	7139	95			4080	W	Ds	V
Cham_gl 503		78I/14	27°43'11"	90°48'44"	10200	135			4120	W	Ds	V
Cham_gl 504		78I/14	27°42'25"	90°49'5"	5539	105			4200	S	Ds	V
Cham_gl 505		78I/14	27°43'19"	90°49'38"	53279	135			4000	NE	Ds	V
Cham_gl 506		78I/14	27°43'5"	90°49'22"	17647	250			4080	NE	Ds	V
Cham_gl 507		78I/14	27°43'36"	90°49'20"	24847	265			4160	SE	Ds	V
Cham_gl 508		78I/14	27°43'41"	90°49'8"	8077	140			4200	SE	Ds	V
Cham_gl 509		78I/14	27°44'1"	90°49'43"	14677	150			4160	SE	Ds	V
Cham_gl 510		78I/14	27°44'52"	90°49'30"	136759	620			4000	NE	Ds	V
Cham_gl 511		78I/14	27°44'42"	90°49'16"	12877	145			4080	NE	Ds	V
Cham_gl 512		78I/13	27°45'28"	90°48'24"	180007	775				NW	Cs	C
Cham_gl 513		78I/13	27°45'52"	90°49'19"	23170	195				W	Ds	E
Cham_gl 514		78I/13	27°46'34"	90°49'22"	80542	310				SW	Ds	V
Cham_gl 515		78I/13	27°48'36"	90°48'54"	9954	120				SE	Cs	E
Cham_gl 516		78I/13	27°50'31"	90°49'52"	147206	590				W	Ds	V
Cham_gl 517		78I/13	27°45'59"	90°52'20"	71833	465				SE	Ds	V
Cham_gl 518		78I/13	27°46'31"	90°52'19"	16416	185				SE	Ds	E
Cham_gl 519		78I/13	27°46'25"	90°52'12"	9600	100				SE	Cs	E
Cham_gl 520		78I/13	27°46'54"	90°52'28"	38371	290				NE	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
Cham_gl 521		78I/13	27°46'59"	90°52'22"	11431	130				NE	Ds	V
Cham_gl 522		78I/13	27°47'5"	90°51'51"	30832	255				NE	Ds	V
Cham_gl 523		78I/13	27°48'31"	90°51'52"	137021	675				SE	Ds	V
Cham_gl 524		78I/13	27°48'53"	90°51'47"	35355	315				SE	Ds	V
Cham_gl 525		78I/13	27°49'7"	90°51'48"	16308	190				SE	Ds	V
Cham_gl 526		78I/13	27°50'12"	90°51'13"	126543	485				E	Ds	E
Cham_gl 527		78I/13	27°48'16"	90°53'13"	28601	240				SW	Cs	V
Cham_gl 528		78I/13	27°47'45"	90°54'48"	72480	475				SW	Ds	V
Cham_gl 529		78I/13	27°46'23"	90°54'30"	27016	225				W	Ds	V
Cham_gl 530		78I/13	27°46'3"	90°54'45"	33463	280				W	Ds	E
Cham_gl 531		78I/13	27°45'47"	90°55'17"	10985	120				SE	Cs	E
Cham_gl 532		78I/13	27°45'45"	90°55'39"	4862	75				SW	Ds	V
Cham_gl 533		78I/13	27°45'20"	90°55'17"	24555	200				S	Ds	V
Cham_gl 534		78I/14	27°44'6"	90°53'56"	25832	225			4000	NW	Ds	V
Cham_gl 535		78I/14	27°44'3"	90°54'5"	11800	140			4000	NW	Ds	V
Cham_gl 536		78I/14	27°43'39"	90°53'43"	7462	115			4040	SW	Ds	V
Cham_gl 537		78I/14	27°43'36"	90°54'28"	12231	100			5320	S	Cs	E
Cham_gl 538		78I/14	27°42'42"	90°57'25"	16401	150			4040	SW	Ds	V
Cham_gl 539		78I/14	27°42'24"	90°57'42"	102512	505			3920	SW	Ds	V
Cham_gl 540		78I/14	27°42'20"	90°58'15"	11570	155			4150	NW	Cs	E
Cham_gl 541		78I/14	27°41'55"	90°58'15"	18770	210			4040	SW	Ds	V
Cham_gl 542		78I/14	27°41'9"	90°58'30"	34832	335			3872	SW	Ds	V
Cham_gl 543		78I/14	27°41'31"	90°59'10"	37109	140			4120	SW	Ds	V
Cham_gl 544		78I/14	27°41'24"	90°59'17"	37771	335			4160	SW	Ds	V
Cham_gl 545		78I/14	27°40'41"	90°59'21"	57033	322			3960	SW	Ds	V
Cham_gl 546		78I/14	27°40'31"	90°59'11"	11539	95			4000	NW	Ds	V
Cham_gl 547		78I/14	27°40'25"	90°59'17"	5323	100			4080	NW	Ds	V
Cham_gl 548		78I/14	27°39'51"	90°58'55"	55064	425			3960	NW	Ds	V
Cham_gl 549		78I/14	27°39'39"	90°59'4"	5446	75			4080	NW	Cs	E
Cham_gl 550		78I/14	27°39'36"	90°59'12"	13754	160			4080	NW	Cs	V
Cham_gl 551		78I/14	27°39'30"	90°59'21"	25478	240			4120	NW	Ds	V
Cham_gl 552		78I/14	27°39'5"	90°57'30"	6200	100			3970	NE	Cs	E
Cham_gl 553		78I/14	27°39'27"	90°58'49"	7570	115			4120	SW	Ds	E
Cham_gl 554		78I/14	27°38'48"	90°59'31"	4139	60			4120	SE	Cs	V
Cham_gl 555		78I/14	27°39'4"	90°59'35"	5785	85			4120	SE	Ds	V
Cham_gl 556		78I/14	27°34'56"	90°58'32"	5293	75			4040	NW	Cs	E
Cham_gl 557		78I/14	27°34'32"	90°57'42"	17185	80			4040	SW	Cs	E

Glacial Lake Inventory of Kuri Chu Basin

Total Number :179   Total Area : 11.07 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
kuri_gl 1		78M/3	27°28'37"	91°7'35"	13979	210			2920	NW	Ds	V
kuri_gl 2		78M/2	27°38'57"	91°1'12"	17384	95			4120	SW	Ds	V
kuri_gl 3		78I/14	27°42'38"	90°59'28"	9700	95			3880	N	Cs	E
kuri_gl 4		78I/14	27°42'30"	90°59'0"	16588	195			4040	NE	Ds	V
kuri_gl 5		78I/14	27°42'38"	90°58'57"	6857	90			4040	NW	Ds	V
kuri_gl 6		78I/13	27°46'4"	90°56'16"	98495	520				SW	Ds	V
kuri_gl 7		78I/13	27°47'48"	90°55'45"	11340	125				W	Cs	V
kuri_gl 8		78I/13	27°48'52"	90°54'55"	35659	315				SW	Ds	V
kuri_gl 9		78I/13	27°49'32"	90°53'10"	34175	255				SW	Ds	V
kuri_gl 10		78I/13	27°50'40"	90°55'8"	52293	250				S	Cs	V
kuri_gl 11		78I/13	27°50'52"	90°55'59"	38361	290				S	Cs	V
kuri_gl 12		78I/13	27°50'35"	90°56'21"	10496	125				SE	Ds	V
kuri_gl 13		78I/13	27°53'48"	90°50'7"	15713	130				SW	Cs	V
kuri_gl 14		78I/13	27°53'56"	90°50'17"	19118	145				S	Cs	V
kuri_gl 15		78I/13	27°54'3"	90°50'8"	23054	115				SE	Cs	V
kuri_gl 16		78I/13	27°54'2"	90°50'33"	25475	165				S	Cs	V
kuri_gl 17		78I/13	27°54'15"	90°51'12"	10918	120				S	Cs	E
kuri_gl 18		78I/13	27°54'41"	90°51'39"	51262	275				S	Ds	C
kuri_gl 19		78I/13	27°55'1"	90°51'20"	7607	100				NE	Ds	V
kuri_gl 20		78I/13	27°55'4"	90°51'15"	22867	100				NE	Ds	V
kuri_gl 21		78I/13	27°54'49"	90°50'39"	118332	370				NE	Ds	C
kuri_gl 22		78I/13	27°56'0"	90°50'59"	22601	185				NE	Cs	C
kuri_gl 23		78I/13	27°55'45"	90°50'37"	21961	180				E	Ds	C
kuri_gl 24		78I/13	27°55'31"	90°49'57"	16228	185				NE	Ds	V
kuri_gl 25		78I/13	27°55'18"	90°49'39"	153897	400				NE	Ds	V
kuri_gl 26		78I/13	27°57'38"	90°46'28"	16838	140				NE	Ds	E
kuri_gl 27		78I/13	27°57'48"	90°48'38"	15104	120				SE	Ds	E
kuri_gl 28		78I/13	27°57'60"	90°48'40"	21976	245				SW	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
kuri_gl 29		78I/13	27°59'22"	90°48'53"	75176	435				SE	Ds	V
kuri_gl 30		78I/13	27°59'42"	90°48'53"	24241	165				SE	Ds	V
kuri_gl 31		77L/16	28°0'7"	90°48'43"	7107	100			5160	SE	Cs	V
kuri_gl 32		78I/13	27°59'35"	90°49'4"	9075	115				SE	Cs	V
kuri_gl 33		78I/13	27°59'27"	90°49'19"	35831	345				SE	Ds	V
kuri_gl 34		78I/13	27°59'8"	90°49'35"	91919	390				SE	Ds	V
kuri_gl 35		78I/13	27°58'25"	90°51'9"	16369	160				SE	Cs	E
kuri_gl 36		78I/13	27°57'56"	90°51'11"	26350	215				SW	Cs	V
kuri_gl 37		78I/13	27°58'2"	90°51'25"	80877	580				SW	Ds	V
kuri_gl 38		78I/13	27°57'45"	90°51'34"	41953	325				SE	Ds	E
kuri_gl 39		78I/13	27°57'30"	90°52'26"	6295	105				S	Cs	E
kuri_gl 40		78I/13	27°57'26"	90°52'35"	54261	395				SW	Ds	E
kuri_gl 41		78I/13	27°56'9"	90°52'58"	24616	190				SW		V
kuri_gl 42		78I/13	27°55'27"	90°53'22"	14385	180				N		C
kuri_gl 43		78I/13	27°55'21"	90°54'12"	15104	170				SE	Ds	V
kuri_gl 44		78I/13	27°56'42"	90°53'49"	74113	485				SE	Ds	V
kuri_gl 45		78I/13	27°56'39"	90°53'30"	38767	345				SE		E
kuri_gl 46		78I/13	27°57'2"	90°53'18"	49966	380				SE		E
kuri_gl 47		78I/13	27°57'14"	90°53'21"	21180	215				SE	Ds	E
kuri_gl 48		78I/13	27°57'36"	90°52'56"	22211	215				SW	Ds	E
kuri_gl 49		78I/13	27°56'15"	90°54'24"	10309	175				SW		V
kuri_gl 50		78I/13	27°56'54"	90°54'31"	27927	230				SW		V
kuri_gl 51		78I/13	27°57'0"	90°54'42"	9450	120				SW		E
kuri_gl 52		78I/13	27°56'55"	90°54'50"	17868	200				SW		E
kuri_gl 53		78I/13	27°57'6"	90°54'58"	17587	240				SW		E
kuri_gl 54		78I/13	27°56'23"	90°54'58"	25694	165				S		E
kuri_gl 55		78I/13	27°56'2"	90°56'55"	10887	150				SW		V
kuri_gl 56		78I/13	27°56'16"	90°56'60"	31535	310				SW		V
kuri_gl 57		78I/13	27°56'26"	90°56'51"	8591	115				SE		V
kuri_gl 58		78I/13	27°56'24"	90°56'38"	129406	655				SE		V
kuri_gl 59		78I/13	27°56'43"	90°56'25"	26553	265				SE		V
kuri_gl 60		78I/13	27°56'35"	90°56'16"	9356	120				E		V
kuri_gl 61		78I/13	27°56'24"	90°56'10"	14307	170				SW		V
kuri_gl 62		78I/13	27°56'21"	90°55'34"	56073	310				E		E
kuri_gl 63		78I/13	27°54'57"	90°56'47"	19727	175				NW		V
kuri_gl 64		78I/13	27°54'8"	90°56'8"	56807	315				E		V
kuri_gl 65		78I/13	27°53'52"	90°56'49"	20899	245				S		V
kuri_gl 66		78I/13	27°54'5"	90°57'17"	69740	340				SW		C
kuri_gl 67		78I/13	27°53'30"	90°57'54"	241177	880				SW		E
kuri_gl 68		78M/1	27°51'37"	91°1'26"	24569	210			3350	SE	Ds	V
kuri_gl 69		78M/1	27°51'43"	91°0'49"	4483	85			3360	E	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
kuri_gl 70		78M/1	27°52'30"	91°0'5"	171297	460			5040	SE	Ds	V
kuri_gl 71		78M/1	27°52'44"	91°1'39"	18634	235	120	Kuri_gr7	3880	NE	Ds	C
kuri_gl 72		78M/1	27°53'19"	91°0'8"	125392	385	90	Kuri_gr9	4400	W	Cs	E
kuri_gl 73		78I/13	27°52'37"	90°59'33"	35971	195				SE		E
kuri_gl 74		78I/13	27°53'43"	90°59'51"	421299	1310	470	Kuri_gr9		SE		E
kuri_gl 75		78I/13	27°54'13"	90°58'49"	115083	465				NE		V
kuri_gl 76		78I/13	27°54'30"	90°58'11"	79549	460				SE		V
kuri_gl 77		78I/13	27°54'47"	90°58'32"	33816	300				E		V
kuri_gl 78		78I/13	27°55'1"	90°58'26"	9372	155				SE		V
kuri_gl 79		78I/13	27°54'48"	90°57'45"	55605	400				NE		V
kuri_gl 80		78I/13	27°55'24"	90°57'58"	90155	520				SE		V
kuri_gl 81		78I/13	27°55'42"	90°57'52"	15729	145				SW		C
kuri_gl 82		78I/13	27°55'32"	90°59'6"	58869	315				SW		V
kuri_gl 83		78I/13	27°56'52"	90°58'28"	74988	360				NE		V
kuri_gl 84		78I/13	27°56'35"	90°57'59"	47342	400				NE		V
kuri_gl 85		78I/13	27°59'4"	90°58'49"	13901	155				SW		E
kuri_gl 86		78I/13	27°57'25"	90°57'16"	160254	610				SE		V
kuri_gl 87		78I/13	27°57'50"	90°56'25"	16338	115				SE		V
kuri_gl 88		78I/13	27°57'34"	90°56'9"	32582	165				SE		E
kuri_gl 89		78I/13	27°58'39"	90°55'25"	22679	215				E	Ds	V
kuri_gl 90		78I/13	27°58'3"	90°55'10"	17384	125				NE		V
kuri_gl 91		78I/13	27°57'53"	90°55'13"	10980	155				NE		E
kuri_gl 92		78I/13	27°58'2"	90°54'55"	9778	95				NE		E
kuri_gl 93		78I/13	27°58'22"	90°54'36"	28380	200				NE		V
kuri_gl 94		78I/13	27°58'3"	90°53'36"	240256	805				NW		E
kuri_gl 95		78I/13	27°57'55"	90°53'19"	41657	255				NW		E
kuri_gl 96		77L/16	28°0'23"	90°49'52"	30380	355	0	Kuri_gr10	4805	SE	Cs	S
kuri_gl 97		77L/16	28°0'33"	90°49'59"	18196	145	0	Kuri_gr10	4820	SE	Cs	S
kuri_gl 98		77L/16	28°1'7"	90°50'29"	140214	760	785	Kuri_gr12	5000	SW	Ds	V
kuri_gl 99		77L/16	28°0'59"	90°50'51"	7544	115			5020	SW	Cs	E
kuri_gl 100		77L/16	28°0'23"	90°51'11"	19915	195			4970	S	Ds	V
kuri_gl 101		77L/16	28°0'4"	90°51'14"	9137	110			4920	SE	Cs	E
kuri_gl 102		78I/13	28°0'18"	90°54'20"	918539	1950			4774	SW	Ds	C
kuri_gl 103		78I/13	27°59'47"	90°54'18"	9153	115			4760	SW	Cs	E
kuri_gl 104		78I/13	27°59'54"	90°54'23"	8872	120			4760	SW	Cs	E
kuri_gl 105		78I/13	27°59'26"	90°54'37"	8106	100				S		V
kuri_gl 106		78I/13	27°59'41"	90°56'2"	57104	460				S	Ds	V
kuri_gl 107		77L/16	28°0'6"	90°55'60"	258827	750			4720	SE	Ds	V
kuri_gl 108		77L/16	28°0'40"	90°55'41"	7794	80			4820	SE	Cs	E
kuri_gl 109		77L/16	28°1'8"	90°55'43"	223340	845			4825	SE	Ds	E
kuri_gl 110		78I/13	27°59'49"	90°56'21"	42031	345				W	Ds	C

A	B	C	D	E	F	G	H	I	J	K	L	M
kuri_gl 111		77L/16	28°0'50"	90°56'58"	37752	420			4640	SE	Cs	E
kuri_gl 112		77L/16	27°59'25"	91°2'11"	12902	190			4480	SE	Cs	E
kuri_gl 113		78M/1	27°59'20"	91°2'5"	17993	400			3995	SW	Ds	E
kuri_gl 114		78M/1	27°58'38"	91°3'29"	8919	115			4325	SW	Cs	E
kuri_gl 115		78M/1	27°58'4"	91°3'7"	15307	210			4360	SW	Cs	E
kuri_gl 116		78M/1	27°57'55"	91°3'20"	57198	275			4180	S	Cs	C
kuri_gl 117		78M/1	27°57'58"	91°3'29"	13698	165			4220	SE	Cs	E
kuri_gl 118		78M/1	27°57'27"	91°3'14"	11902	125			4020	S	Cs	E
kuri_gl 119		78M/1	27°57'22"	91°3'33"	141355	425			4100	SW	Ds	C
kuri_gl 120		78M/1	27°56'32"	91°3'29"	41126	175			3910	SW	Ds	E
kuri_gl 121		78M/1	27°56'36"	91°3'41"	7372	135			3940	S	Ds	E
kuri_gl 122		78M/1	27°57'28"	91°5'4"	23085	265			3795	NE	Ds	C
kuri_gl 123		78M/1	27°58'0"	91°4'40"	62790	425			3925	N	Ds	C
kuri_gl 124		78M/1	27°59'47"	91°4'30"	25116	225			4255	NW	Cs	E
kuri_gl 125		77P/8	28°3'44"	91°15'14"	92154	230				S	Ds	E
kuri_gl 126		77P/8	28°3'3"	91°16'44"	109819	340				SW	Ds	E
kuri_gl 127		77P/8	28°3'39"	91°17'7"	16213	175				S	Ds	V
kuri_gl 128		77P/8	28°3'18"	91°17'35"	30067	245				SE	Ds	E
kuri_gl 129		77P/8	28°2'35"	91°17'50"	132967	715	485	Kuri_gr16		NW	Ds	E
kuri_gl 130		77P/8	28°0'42"	91°15'33"	37892	310				NW	Cs	E
kuri_gl 131		78M/1	27°59'43"	91°14'46"	80720	405			4360	NE	Ds	E
kuri_gl 132		78M/1	27°59'31"	91°14'17"	52262	255			4320	N	Ds	C
kuri_gl 133		78M/1	27°59'18"	91°13'55"	13276	130			4580	E	Cs	E
kuri_gl 134		78M/1	27°59'7"	91°13'5"	143572	600			4300	SW	Cs	E
kuri_gl 135		78M/1	27°58'2"	91°14'10"	69240	465			4540	NW	Ds	E
kuri_gl 136		77P/8	28°0'7"	91°15'55"	135638	580				NW	Cs	E
kuri_gl 137		77P/8	28°0'41"	91°16'28"	60072	295				NW	Ds	E
kuri_gl 138		78M/1	27°53'52"	91°14'29"	31832	190			4120	S	Ds	E
kuri_gl 139		78M/1	27°54'1"	91°14'38"	86671	400			4160	SE	Ds	E
kuri_gl 140		78M/1	27°54'31"	91°14'36"	105774	650	470	Kuri_gr21	4300	NE	Ds	E
kuri_gl 141		78M/5	27°55'30"	91°15'49"	92966	365	1160	Kuri_gr22		SE	Cs	E
kuri_gl 142		78M/5	27°55'53"	91°16'21"	361758	750	875	Kuri_gr23		NE	Ds	E
kuri_gl 143		78M/5	27°57'4"	91°16'1"	103837	435				N	Cs	E
kuri_gl 144		78M/5	27°58'47"	91°16'48"	83954	500	0	Kuri_gr26		SE	Ds	V
kuri_gl 145		77P/8	27°59'47"	91°17'25"	235711	500	120	Kuri_gr27		W	Cs	E
kuri_gl 146		77P/8	28°0'42"	91°17'44"	118363	370	1050	Kuri_gr28		SE	Cs	E
kuri_gl 147		77P/8	28°0'40"	91°16'49"	137965	460				E	Cs	E
kuri_gl 148		77P/8	28°0'52"	91°18'16"	20040	140	425	Kuri_gr29		SW	Cs	C
kuri_gl 149		78M/5	27°58'51"	91°19'60"	87374	355				NE	Ds	E
kuri_gl 150		78M/5	27°53'46"	91°15'8"	154319	710				E	Ds	V
kuri_gl 151		78M/5	27°53'2"	91°17'1"	381829	405				NW		E

A	B	C	D	E	F	G	H	I	J	K	L	M
kuri_gl 152		78M/1	27°51'6"	91°14'28"	16650	190			4320	N	Ds	E
kuri_gl 153		78M/1	27°51'0"	91°14'27"	18665	135			4240	N	Ds	E
kuri_gl 154		78M/1	27°50'42"	91°14'26"	38689	210			4275	N	Ds	E
kuri_gl 155		78M/1	27°50'22"	91°14'15"	40673	265			4355	NW	Ds	E
kuri_gl 156		78M/1	27°50'0"	91°12'47"	31036	285			3980	SW	Ds	C
kuri_gl 157		78M/1	27°50'5"	91°13'32"	12933	160			4110	SW	Ds	C
kuri_gl 158		78M/1	27°49'35"	91°14'8"	60993	290			4070	W	Ds	E
kuri_gl 159		78M/1	27°49'24"	91°14'9"	23038	255			4110	SW	Ds	E
kuri_gl 160		78M/1	27°49'11"	91°14'34"	45093	320			4160	SW	Ds	E
kuri_gl 161		78M/1	27°48'19"	91°13'42"	8950	90			4080	W	Cs	?
kuri_gl 162		78M/1	27°46'57"	91°14'19"	25350	210			3760	E	Cs	?
kuri_gl 163		78M/1	27°48'5"	91°14'31"	157567	345			4040	S	Ds	?
kuri_gl 164		78M/5	27°50'21"	91°16'52"	34753	175				W	Ds	V
kuri_gl 165		78M/5	27°50'39"	91°16'20"	97371	345				SW	Cs	E
kuri_gl 166		78M/5	27°52'3"	91°15'23"	95731	430				E	Ds	V
kuri_gl 167		78M/5	27°52'33"	91°15'35"	100463	410				NW	Ds	E
kuri_gl 168		78M/5	27°53'43"	91°18'39"	11808	670				NE	Ds	E
kuri_gl 169		78M/5	27°53'36"	91°18'27"	143447	185				SE	Ds	E
kuri_gl 170		78M/5	27°55'43"	91°18'41"	20133	65				E	Cs	V
kuri_gl 171		78M/5	27°55'16"	91°18'15"	81236	360				NE	Ds	C
kuri_gl 172		78M/5	27°55'48"	91°18'9"	161706	850	0	Kuri_gr33		NE		V
kuri_gl 173		78M/5	27°57'6"	91°18'39"	42094	255	580	Kuri_gr36		E	Ds	V
kuri_gl 174		77P/8	28°0'21"	91°24'44"	76972	240	115	Kuri_gr46		SE		E
kuri_gl 175		77P/8	27°56'46"	91°22'0"	43734	200				NW		C
kuri_gl 176		78M/6	27°40'45"	91°20'53"	6669	130			3810	SW	Ds	E
kuri_gl 177		78M/6	27°40'30"	91°20'59"	20071	230			3900	W	Ds	V
kuri_gl 178		78M/6	27°40'23"	91°20'59"	5342	85			3900	N	Cs	E
kuri_gl 179		78M/6	27°40'18"	91°21'0"	24725	225			3900	NE	Cs	E

Glacial Lake Inventory of Dangme Chu Basin

Total Number :126   Total Area : 5.82 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
dangm_gl 1		78M/5	27°45'49"	91°20'5"	14354	180				NE	Ds	E
dangm_gl 2		78M/5	27°53'58"	91°26'15"	11964	185				SW	Ds	E
dangm_gl 3		78M/5	27°53'51"	91°26'9"	12230	150				SW	Ds	E
dangm_gl 4		78M/5	27°52'37"	91°25'20"	17494	150				SW	Cs	C
dangm_gl 5		78M/5	27°52'50"	91°25'25"	7107	110				SW	Ds	V
dangm_gl 6		78M/5	27°52'3"	91°26'21"	28630	250				NW	Ds	V
dangm_gl 7		78M/5	27°52'59"	91°26'19"	22164	280				SW	Cs	V
dangm_gl 8		78M/5	27°52'19"	91°27'15"	21133	210				SW	Cs	V
dangm_gl 9		78M/5	27°52'9"	91°27'45"	93700	540				SW	Cs	V
dangm_gl 10		78M/5	27°52'12"	91°28'40"	31301	270	1107	Dangm_gr20		NW	Cs	V
dangm_gl 11		78M/5	27°52'37"	91°28'40"	20696	230				SW	Ds	E
dangm_gl 12		78M/5	27°52'35"	91°28'52"	10277	110				SW	Ds	V
dangm_gl 13		78M/5	27°53'3"	91°29'21"	81048	475				SE	Ds	V
dangm_gl 14		78M/5	27°53'47"	91°28'40"	70693	480	250	Dangm_gr21		SE	Ds	V
dangm_gl 15		78M/5	27°54'48"	91°28'4"	43531	265	0	Dangm_gr21		SE	Cs	E
dangm_gl 16		78M/9	27°54'45"	91°32'18"	49170	325			4840	W	Ds	E
dangm_gl 17		78M/9	27°53'15"	91°32'47"	373285	995			4405	N	Ds	V
dangm_gl 18		78M/9	27°53'48"	91°32'42"	41516	330			5080	NW	Cs	E
dangm_gl 19		78M/9	27°53'14"	91°32'23"	28130	360			5000	NW	Ds	E
dangm_gl 20		78M/9	27°53'4"	91°32'17"	14339	155			4960	NE	Ds	E
dangm_gl 21		78M/9	27°53'5"	91°32'25"	13214	170			4920	N	Ds	V
dangm_gl 22		78M/9	27°53'50"	91°31'24"	24085	210			4960	NE	Ds	E
dangm_gl 23		78M/9	27°53'37"	91°30'4"	29786	345			4280	SE	Cs	V
dangm_gl 24		78M/9	27°53'57"	91°30'14"	89811	540			4340	SE	Cs	C
dangm_gl 25		78M/9	27°52'50"	91°30'26"	55714	280			4120	SE	Ds	C
dangm_gl 26		78M/9	27°52'13"	91°31'39"	311355	1015			4160	W	Cs	V
dangm_gl 27		78M/9	27°52'43"	91°31'52"	15697	170			4240	W	Cs	E
dangm_gl 28		78M/5	27°51'10"	91°30'60"	8591	110				SW	Cs	E

A	B	C	D	E	F	G	H	I	J	K	L	M
dangm_gl 29		78M/5	27°51'56"	91°29'36"	103447	420				NW	Ds	E
dangm_gl 30		78M/5	27°50'37"	91°29'48"	8294	110				NW	Ds	E
dangm_gl 31		78M/5	27°50'14"	91°29'43"	7747	105				NW	Ds	V
dangm_gl 32		78M/5	27°51'11"	91°30'14"	262076	820				S	Ds	V
dangm_gl 33		78M/5	27°49'60"	91°27'36"	9278	145				SW	Ds	V
dangm_gl 34		78M/5	27°48'26"	91°27'56"	3108	60				S	Ds	E
dangm_gl 35		78M/5	27°48'30"	91°27'32"	4826	75				S	Ds	E
dangm_gl 36		78M/5	27°49'6"	91°28'13"	8653	110				SW	Ds	E
dangm_gl 37		78M/5	27°49'10"	91°28'28"	13964	135				W	Ds	E
dangm_gl 38		78M/5	27°49'12"	91°28'41"	7950	195				SW	Ds	E
dangm_gl 39		78M/5	27°49'46"	91°28'53"	13776	140				SE	Cs	V
dangm_gl 40		78M/5	27°49'1"	91°30'34"	64914	410				W	Ds	E
dangm_gl 41		78M/5	27°49'58"	91°29'15"	9825	130				N	Ds	E
dangm_gl 42		78M/5	27°48'12"	91°30'38"	188337	625				N	Ds	C
dangm_gl 43		78M/9	27°52'2"	91°32'33"	16619	140			4360	S	Cs	E
dangm_gl 44		78M/9	27°53'8"	91°35'16"	15557	160			4520	S	Cs	E
dangm_gl 45		78M/9	27°53'30"	91°34'48"	4889	100			4760	SE	Cs	E
dangm_gl 46		78M/9	27°53'37"	91°34'50"	9012	125			4760	SE	Cs	E
dangm_gl 47		78M/9	27°54'46"	91°34'4"	24304	225			4800	SE	Cs	E
dangm_gl 48		78M/9	27°53'29"	91°35'16"	8669	95			4680	S	Cs	E
dangm_gl 49		78M/9	27°53'37"	91°35'37"	45405	270			4680	NW	Cs	V
dangm_gl 50		78M/9	27°53'53"	91°35'43"	48217	305			4680	SW	Cs	V
dangm_gl 51		78M/9	27°53'38"	91°35'27"	15651	165			4720	SW	Cs	E
dangm_gl 52		78M/9	27°53'19"	91°36'24"	127063	410			5000	NE	Cs	E
dangm_gl 53		78M/9	27°53'52"	91°35'12"	144119	530			4560	S	Cs	C
dangm_gl 54		78M/9	27°52'22"	91°36'37"	100822	605			4440	NW	Ds	V
dangm_gl 55		78M/9	27°52'58"	91°36'7"	107055	435			4880	SE	Ds	E
dangm_gl 56		78M/9	27°52'10"	91°37'15"	63336	325			4880	SE	Ds	E
dangm_gl 57		78M/9	27°52'53"	91°33'1"	25288	245			4560	SE	Ds	E
dangm_gl 58		78M/9	27°50'26"	91°33'35"	33660	375			4520	W	Cs	E
dangm_gl 59		78M/9	27°50'21"	91°33'1"	642109	1300			4560	W	Cs	E
dangm_gl 60		78M/9	27°49'40"	91°33'26"	104587	480			4680	NW	Cs	E
dangm_gl 61		78M/9	27°48'2"	91°33'28"	232524	650			4200	W	Cs	C
dangm_gl 62		78M/9	27°49'4"	91°33'3"	16431	150			4640	SE	Cs	E
dangm_gl 63		78M/9	27°47'49"	91°34'59"	176092	580			4720	SW	Ds	E
dangm_gl 64		78M/9	27°48'45"	91°34'29"	18118	195			4920	S	Cs	E
dangm_gl 65		78M/9	27°45'21"	91°33'22"	121034	440			4160	NW	Ds	E
dangm_gl 66		78M/9	27°46'8"	91°32'11"	6810	100			4200	N	Ds	C
dangm_gl 67		78M/9	27°45'55"	91°31'20"	141183	570			3840	NW	Ds	E
dangm_gl 68		78M/9	27°44'32"	91°31'45"	19384	190			4160	NW	Ds	V
dangm_gl 69		78M/9	27°44'53"	91°30'47"	39782	230			4240	N	Ds	E

A	B	C	D	E	F	G	H	I	J	K	L	M
dangm_gl 70		78M/9	27°44'38"	91°30'47"	7029	100			4160	NW	Cs	E
dangm_gl 71		78M/9	27°45'29"	91°30'3"	21164	205			4040	NE	Cs	E
dangm_gl 72		78M/9	27°44'14"	91°30'60"	20602	210			4120	NW	Ds	E
dangm_gl 73		78M/9	27°44'22"	91°30'50"	8872	150			4120	NW	Cs	E
dangm_gl 74		78M/9	27°44'6"	91°30'50"	6357	135			4120	NW	Cs	E
dangm_gl 75		78M/6	27°44'52"	91°29'56"	8700	120			4040	S	Cs	E
dangm_gl 76		78M/6	27°44'45"	91°29'38"	17712	180			3960	NW	Ds	V
dangm_gl 77		78M/6	27°44'38"	91°29'33"	5810	90			3960	NW	Ds	V
dangm_gl 78		78M/6	27°44'45"	91°29'28"	6591	100			4000	NW	Ds	E
dangm_gl 79		78M/6	27°44'36"	91°29'30"	10824	145			3960	NW	Ds	E
dangm_gl 80		78M/6	27°43'8"	91°29'60"	34690	335			3720	W	Ds	V
dangm_gl 81		78M/9	27°44'33"	91°33'33"	79752	415			3880	SW	Cs	E
dangm_gl 82		78M/9	27°47'38"	91°35'48"	160410	470			4080	E	Ds	C
dangm_gl 83		78M/9	27°48'27"	91°35'18"	127266	545			4360	SW	Cs	C
dangm_gl 84		78M/9	27°48'45"	91°35'53"	103197	405			4480	SW	Cs	C
dangm_gl 85		78M/9	27°42'22"	91°37'27"	33535	275			3998	SW	Ds	V
dangm_gl 86		78M/9	27°42'52"	91°36'11"	30708	225			3840	NW	Ds	E
dangm_gl 87		78M/9	27°41'54"	91°36'32"	6451	125			4480	NW	Cs	E
dangm_gl 88		78M/9	27°41'31"	91°36'45"	31129	205			4080	N	Cs	E
dangm_gl 89		78M/9	27°41'11"	91°36'27"	18493	195			4040	W	Ds	E
dangm_gl 90		78M/9	27°41'11"	91°36'6"	9715	145			4080	W	Cs	E
dangm_gl 91		83A/3	27°28'7"	92°0'1"	8263	140			4000	SW	Ds	V
dangm_gl 92		83A/3	27°28'9"	92°0'18"	54027	345			4080	S	Ds	E
dangm_gl 93		83A/3	27°28'14"	92°0'38"	6607	100			4200	S	Ds	E
dangm_gl 94		83A/3	27°27'4"	92°1'46"	15073	220			3885	S	Ds	V
dangm_gl 95		83A/3	27°28'45"	92°0'4"	9528	120			4360	SE	Ds	V
dangm_gl 96		83A/3	27°28'46"	92°0'20"	71224	420			4560	SE	Cs	C
dangm_gl 97		83A/3	27°28'8"	92°1'25"	6216	90			4520	S	Ds	V
dangm_gl 98		83A/3	27°27'20"	92°1'40"	5482	95			4400	SW	Cs	E
dangm_gl 99		83A/3	27°26'17"	92°1'53"	7404	115			4240	NW	Cs	E
dangm_gl 100		83A/3	27°26'8"	92°1'45"	8028	135			4120	NW	Ds	V
dangm_gl 101		83A/3	27°26'20"	92°1'43"	5186	95			4240	SW	Ds	E
dangm_gl 102		83A/3	27°26'20"	92°1'31"	5014	80			4100	S	Cs	E
dangm_gl 103		83A/3	27°26'29"	92°1'32"	5873	95			4180	S	Cs	E
dangm_gl 104		83A/3	27°25'3"	92°1'49"	18134	155			4060	NW	Ds	V
dangm_gl 105		83A/3	27°25'39"	92°0'14"	9637	120			3960	W	Ds	V
dangm_gl 106		83A/3	27°25'51"	92°0'27"	9153	130			4140	SW	Ds	V
dangm_gl 107		83A/3	27°25'44"	92°0'6"	6248	100			4020	NW	Cs	E
dangm_gl 108		83A/3	27°25'34"	92°0'5"	9793	140			4100	N	Cs	E
dangm_gl 109		83A/3	27°24'27"	92°0'48"	5732	95			4040	NW	Ds	V
dangm_gl 110		83A/3	27°24'19"	92°0'25"	5482	90			4080	N	Ds	V

A	B	C	D	E	F	G	H	I	J	K	L	M
dangm_gl 111		78M/15	27°20'32"	91°59'57"	16510	165			4200	N	Cs	E
dangm_gl 112		78M/15	27°21'28"	91°58'39"	16619	140			4120	N	Cs	E
dangm_gl 113		78M/15	27°21'30"	91°58'28"	12823	175			4160	N	Cs	E
dangm_gl 114		78M/15	27°21'16"	91°58'41"	9309	210			4120	NE	Cs	E
dangm_gl 115		78M/15	27°21'46"	91°57'26"	23132	260			4000	NW	Ds	E
dangm_gl 116		78M/15	27°19'53"	91°57'49"	9059	125			4120	NW	Ds	V
dangm_gl 117		78M/15	27°20'56"	91°56'1"	13417	165			3840	W	Cs	E
dangm_gl 118		78M/15	27°19'24"	91°57'25"	2359	45			4040	NW	Ds	V
dangm_gl 119		78M/15	27°19'27"	91°57'9"	8028	140			4120	N	Ds	V
dangm_gl 120		78M/15	27°18'33"	91°57'45"	6123	100			4160	SW	Ds	E
dangm_gl 121		78M/15	27°18'33"	91°57'36"	5217	95			4120	SW	Ds	E
dangm_gl 122		78M/15	27°18'60"	91°57'33"	15323	165			4160	NE	Ds	E
dangm_gl 123		78M/15	27°18'9"	91°58'46"	14339	175			4200	S	Cs	E
dangm_gl 124		78M/15	27°18'18"	91°55'59"	35409	245			4080	E	Ds	E
dangm_gl 125		78M/15	27°19'13"	91°55'8"	10918	100			4160	SE	Cs	E
dangm_gl 126		78M/15	27°19'43"	91°54'36"	44890	360			4080	E	Ds	E

Glacial Lake Inventory of Nyere Ama Chu Basin

Total Number :9   Total Area : 0.076 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code	Latitude	Longitude	Total Area	Mean Length	Distance to Glacier	Associated Glacier Number	Elevation	Orientation	Drainage Condition	Classification
Nyere_gl 1		78M/15	27°17'41"	91°54'40"	17842	185			4040	SW	Cs	E
Nyere_gl 2		78M/15	27°16'24"	91°55'58"	8371	120			4000	NW	Cs	E
Nyere_gl 3		78M/15	27°16'50"	91°55'43"	5515	90			4120	NW	Cs	E
Nyere_gl 4		78M/15	27°16'58"	91°55'44"	12922	170			4160	W	Cs	E
Nyere_gl 5		78M/15	27°16'40"	91°55'35"	6254	105			4160	NW	Cs	E
Nyere_gl 6		78M/15	27°15'30"	91°48'55"	5892	90			4240	NE	Ds	V
Nyere_gl 7		78M/15	27°15'25"	91°48'57"	3868	80			4240	N	Ds	V
Nyere_gl 8		78M/15	27°16'59"	91°47'9"	7002	110			4140	N	Ds	V
Nyere_gl 9		78M/15	27°15'59"	91°47'60"	8560	145			4180	N	Ds	V

Glacial Lake Inventory of Northern Basin

Total Number : 10 Total Area : 7.81 (km²)

A	B	C	D	E	F	G	H	I	J	K	L	M
Lake Number	Lake Name	Map Code_60s	Latitude	Longitude	Area (m2)	Mean Length (m)	Distance to Glacier (m)	Associated Glacier Number	Elevation (m)	Orientation	Drainage Condition	Classification
Out_gl 1		77L/8	42°39'55"	90°18'32"	219072	780	470	Out_gr 26	*	NW		E
Out_gl 2		77L/8	42°39'21"	90°19'51"	49712	250	85	Out_gr 26	*	NW		E
Out_gl 3		77L/4	42°31'39"	90°7'15"	5640910	4510	0	Out_gr 34	*	NW		M
Out_gl 4		77H/16	42°23'32"	89°57'46"	151160	865	0	Out_gr 50	*	N		S
Out_gl 5		77H/16	42°22'15"	89°56'49"	15634	180	280	Out_gr 51	*	NE		V
Out_gl 6		77H/16	42°22'14"	89°56'48"	13407	185	0	Out_gr 51	*	NE		S
Out_gl 7		77H/16	42°19'5"	89°52'43"	1484188	2120	0	Out_gr 57	*	NE		M
Out_gl 8		77H/16	42°18'2"	89°50'12"	33111	240	315	Out_gr 58	*	NE		E
Out_gl 9		77H/16	42°17'32"	89°49'49"	129144	540	815	Out_gr 58	*	NE		E
Out_gl 10		77H/16	42°17'7"	89°49'31"	77160	355	150	Out_gr 58	*	NE		E

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