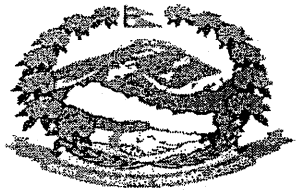
５．セミナー資料

2008年6月4日に本調査団の氷河湖現地踏査結果の報告とGLOF対策、調査に関する情報共有を目的としてセミナーを開催した。ネパール政府関係機関（MoEST、DHM、MOHA、DWIDP、WECS等）やICIMOD、トリブバン大学、カトマンズ大学、UNDPなどから多数の参加があった。本セミナーの議事次第、プレゼン資料を次ページ以降に示す。



Schedule for the Seminar Program

1. **Date:** Wednesday, June 4, 2008

2. **Venue:** Himalaya Hotel, Rato Baithak Hall

3. **The Objectives of the seminar are:**
   (1) Share the findings in the field survey on Imja Tsho and Tsho Rolpa by JICA study team during 20th to 30th May.
   (2) Share the frontline activity on the countermeasure for GLOF
   (3) Share the achievement of the research on GLOF

4. **Program**

13:00 ~14:00	Registration
14:00~14:10	Welcome (Resident Representative of JICA Nepal)
14:10 ~14:30	Opening Remarks and Sharing on Government Policy on Climate Change including GLOF (Mr. Mathbar K. Adhikari, Under Secretary, MOEST)
14:30~15:00	Research achievement on GLOF (Dr. Yamada, JICA study team member)
15:00~15:10	Q&A
15:10~15:30	Addressing GLOF risk in the HKH – past experiences and future needs (Mr. Mats Eriksson, ICIMOD)
15:30~15:40	Q&A
15:40~15:55	Break
15:55~16:25	Major findings of the sector survey on Climate Change and GLOF (JICA study Team)
16:25~16:35	Q &A
16:35~16:50	Discussions
16:50~17:00	Closing Remarks (Dr. Madhav Karki, ICIMOD)
17:00~17:30	Hi -Tea

on sharing and discussion on Climate Change and GLOF (Glacier Lake Outbrust Flood) in Nepal

Registration Sheet

	Name	Designation	Organization	Tel/Fax	Email	Signature
1	Mr. Laxman Mainali	Officiating Secretary	MOEST			
2	Mr. Mathbar K. Adhikari	Under Secretary	MOEST			
3	Dr. Chhewang N. Lama	Ag. Officer	MOEST			
4	Mr. Nirmal Hari Rajbhandari	Director General	DMH			
5	Mr. Keshav Prasad Sharma	Deputy. Director General	DHM			
6	Mr. Om Ratna Bajracharya	Sr. Divisional Engineer	DHM		om@dhm.gov.np	
7	Mr. Kamal P. Budhathoki	Sr. Divisional Metrologist	DHM		Kamal@dhm.gov.np	
8	Mr. Thir Bahadur G. C.	Under Secretary	Ministry of Home Affairs			
9	Mr. Narayan P. Bhattarai	Director General	DWIDP			
10	Mr. Sheetal Babu Regmi	Executive Director	WECS			
11	Ms. Indu Ghimire		NPCS		ighimire@npcnepal.gov.np	
12	Mr. Shambhu Marasini		Ministry of Home Affairs	4211280	Smarasini@hotmail.com	
13	Mr. Suresh Man Shrestha		Dept of Survey		shrestha@ngiip.gov.np	
14			Nepal Redcross Society			

Seminar on sharing and discussion on Climate Change and GLOF (Glacier Lake Outbrust Flood) in Nepal

Registration Sheet

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18	Dr. D.P. Adhikari	Lecturure	TU/IoST		adhikaridp@ntc.net.np	
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20	Mr. Prajwal Acharya	PSO	UNDP	9841448989	—	
21	Mr. Gajendra Gurung		Pratcal Action	4446015	gehendra.gurung@practicalaction.org.np	
22	Mr. Bibek Chapagain	ARR	WinRock International			
23	Mr. Sagar Subedi		WinRock International			
24	Mr. Ram Chandra Khanal		IUCN	5528781	khanal@iucn.org.np	
25	Mr. Rohit Gautam	Director	NISHAKU Corporation	5525979	nepal@nishkn.wlink.com.np	
26	Mr. D.B. Basnet	Tech. Adv.	NISHAKU Corporation	-"-	-"-	
27	Dr. Madhav Karki	DDG-PW	ICIMOD	5003222		
28	Dr. Ramesh Ananda Vaidya		ICIMOD			
29	Dr. Mats Eriksson	Program Manager	ICIMOD	5003222	meriksson@icimod.org	

Seminar on sharing and discussion on Climate Change and GLOF (Glacier Lake Outbrust Flood) in Nepal

Registration Sheet

Sr. no	Name	Designation	Organization	Tel/Fax	Email	Signature
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31	Dr.Arun Bhakta Shrestha	Climate Change Specialist	ICIMOD		abshrestha@icimod.org	
32	Sharad Joshi	GIS Data Analyst	ICIMOD		Joshi999n@yahoo.com	
Embassy of Japan						
V33	Makoto Yoshino	1st Secretary	Embassy of Japan, KTM		makoto.yoshino@mofa.go.jp	
Mission Team						
34	Mr. Mikio Ishiwatari	Mission Leader	JICA, Tokyo			
35	Dr.Tomomi Yamada	Glacier Hydrology				
36	Dr. Yuji Maruo	Sr. Advisor	JICA, Tokyo			
37	Mr. Osamu Hattori	Program Officer	JICA, Tokyo			
38	Ms. Haruko Kamei	Sr. Country Officer	JICA, Tokyo			
39	Mr. Makoto Komada	Consultant	IDEA			
JICA Nepal Office						
40	Mr. Noriaki Niwa	RR	JICA Nepal			

41	Mr. Yusuke Tsumori	ARR				
42	Ms. Miwa Hiasa	ARR	JICA Nepal			[illegible]
43	Mr. Narendra K. Gurung	SPO	JICA Nepal			
44	Mr. Sourab B. Rana	PO	JICA Nepal			

Seminar on sharing and discussion on Climate Change and GLOF (Glacier Lake Outbrust Flood) in Nepal

Registration Sheet

	Name	Designation	Organization	Phone no./Fax	e-mail	Signature
45	Mr. Krishna P. Lamsal	PO	JICA Nepal			
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48	Samjwal R. Bajracharya	Geologist	ICIMOD	5003222	sbajracharya@icimod.org	[illegible]
49	Pradeep Mool	RS Specialist	ICIMOD	5003222	pmool@icimod.org	[illegible]
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	H Kato	DWIDP		98510-81203	katouh8456@gmail.com	
	Jagadishwar Karmacharya	S.D.M.	DHM	9851095733.	Jagadish@dhm.gov.np	[illegible]
	Kazuo Suganuma	MD CJ		9851001475		[illegible]

Climate Change Activities

Mathbar Adhikary
Under Secretary
Ministry of Environment, Science and Technology

VISIBLE IMPACTS OF *Climate Change*

- Accelerated snow and glacial melting process.
- Increasing size of Glacial Lakes up to critical geostatic threshold, leading to the danger of glacial outburst.
- Formation of new Glacial Lakes.
- Rainfall variation.
- Impacts on forests and biodiversity.

Initiatives on Climate Change (1990-2005)

- Particpation at Rio de Janerio, Brazil, June 1992.
- Establishment of Environment Protection Council (EPC).
- EPC initiated the process and approved " National Environment Policy and Action Plan" 1994.
- Ratification of UNFCCC and entry into force in 1994.
- Ministry of Population and Environment ,1995.
- Environment Protection Act 1996

- Ministry of Science and Technology 1996.
- Alternative Energy Promotion Centre, 1996.
- Environment Division of then Ministry of Population and Environment merged into then Ministry of Science and Technology and the MoEST came into existence.
- Environment Protection Regulation 1997.
- Environment Protection Fund.
- Sustainable Development Agenda for Nepal 2003

- First Initial National Communication Report prepared on July 2004 and shared with Parties (with the assistance of UNEP/GEF).
  - Some features of the Report:
    - Projected that Western Nepal might receive more precipitation than Eastern Nepal. (reversal of current trend).
    - About 20% of the Glaciated area above 5000m is likely to become snow and glacier free, if temperature rises by one degree Centigrade.
- Kyoto Protocol: entry into force from 22 December 2005.
- To this date Nepal has been party to 16 environment related Conventions, including Kyoto Protocol and Montreal Protocol

Initiatives: 2006 onwards

Capacity Building

- Workshop and consultations- capacity building on CDM, respond to climate change, CDM/DNA, International negotiations, pre- and post Bali consultations.
- Signature Campaigns.

CDM Approval Process

- 1) Inputs from Steering Committee (SC), Technical Advisory Committee (TAC) and stakeholder consultations and 2) evaluation with SD criteria.

Policy and Coordination

- Policies in Interim Plan
- Climate Change Policy formulation initiated-ongoing studies.
- Formation of 23 member Climate Change Network (CCN)- Carbon financing; Adaptation and mitigation; carbon sinks; Financial mechanism and Knowledge management.

Project initiatives

- NCSA under implementation.
- NAPA at the final stage of entering into agreement with UNDP/GEF for implementation.
- Proposal preparation for Second National Communication

Major Policies in the Interim Plan

Objectives (Environment Management)

- Implement MEAs to promote economic development by reducing the pressure on environment.

Policies

- Formulate and integrate environmental policy
- Implement environmental standard, EIA Reports, expand environmental monitoring and auditing.
- Promote cleaner production and energy efficiency programs.
- Promote Carbon trade to benefit from CDM.
- Develop and implement a mechanism on polluters pay principle and pollution prevention pays.
- Formulate national policy on Climate Change along with public awareness activities on MEA.

Other Sectors

- **Forest:** Utilize environmental services and benefits obtained from Kyoto Protocol provisions for poverty reduction and forest conservation.
- **Industry:** Adopt cleaner production technologies and green productivity concept.
- **Alternative Energy**: Develop, promote and expand alternative energy technology such as micro-hydro, solar, biomass, and wind energies to reduce GHG emission and develop projects for long-term economic benefits from CDM.
- Expand existing rural energy fund to central rural energy fund.

Sustainable Development Criteria

Environment

- Environmental sustainability by practicing natural resources conservation.
- Local Community health and safety.
- GHG emissions reductions.

Economic

- Poverty reductions and local community welfare.

Social

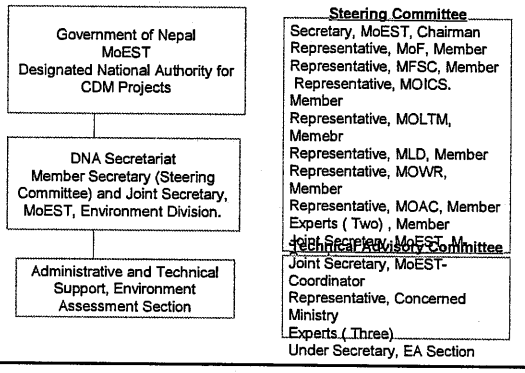
- Local community participation in the project.
- Local community social integrity

Technology

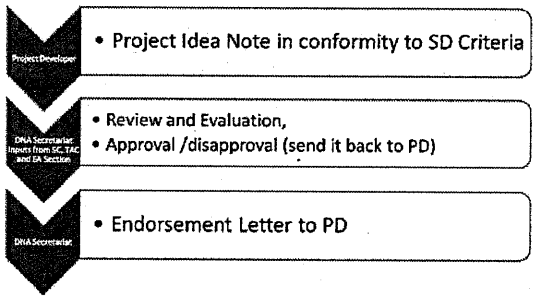
- Technology Transfer

- The proposal should comply with existing policies and laws.
- Proof of consultations, comments and complaints of local communities should be submitted by proponent.

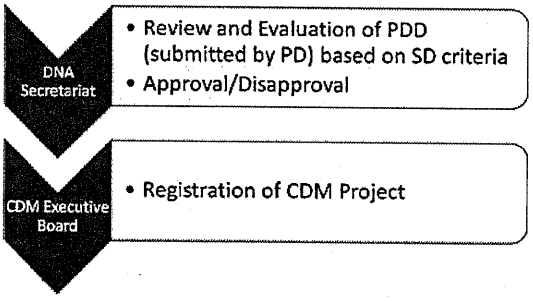
CDM Institutional structure



Approval Procedure for CDM Projects (First Step)



Approval Procedure for CDM Projects (Second Step)



Composition of the Climate Change Network

Secretary, Ministry of Environment, Science and Technology		Chairman
Representative, Ministry of forest and Conservation	Member	
Representative, Ministry of industry, Commerce and Supply		Member
Representative, Ministry of Water Resources	Member	
Representative, Ministry of Agriculture and Cooperatives	Member	
Director General, Dept. of Hydrology and Meteorology	Member	
Executive Director, Alternative Energy Promotion Center	Member	
Representative, ICIMOD		Member
Representative, National Trust for Nature Conservation	Member	
Representative, World Wildlife Fund		Member
Representative, The World Conservation Union (IUCN), Nepal		Member
Representative, Practical Action	Member	
Representative, WINROCK Nepal	Member	
Representative, CARE Nepal	Member	
Representative, Center for Energy Study, Institute of Engineering	Member	
Representative, FNCCI		Member
President, Independent Power Producer Association of Nepal		Member
Representative, UNDP, Nepal	Member	
Representative, JICA, Nepal	Member	
Representative, World Bank	Member	
Representative, Asian Development Bank	Member	
Executive Director, Biogas Sector Partnership Nepal	Member	
Joint Secretary, MoEST-Environment Division	Member Secretary	

Function of CCN

- Identify working areas on climate change amongst the government, NGOs, private and development partners.
- Conduct policy/field level research and studies and implement activities based on the capacity and expertise.
- Promote CDM related activities and launch public awareness and capacity program.
- Develop position papers for the parties meeting and enhance negotiation capacity.
- Develop climate change clearing house for easy information sharing.

National Capacity Needs Self-Assessment, Second Communication and CC Policy

NCSA Project-$200.000 (GEF/UNDP funding, Completion by Sept. 2008).

- Addresses 3 Rio Conventions: CBD, UNCCD and UNFCCC.
- Need assessment on the capacity building and synergy programs.
- Status- Stocktaking report finalized, thematic assessment nearing to completion.

Second National Communication: $15,000 GEF/UNDP funding, to be started soon

- Major Activities: stocktaking report, stakeholder consultations and preparation of proposal for second national communication.
- Outsourcing for stocktaking and proposal presentation.

Climate Change Policy

- Stakeholders consultations completed in Dhangadi, Pokhara and Biratnagar.
- Consultants draft to be ready by mid-June 2008 and National consultations to be continued.

National Adaptation Program of Action (NAPA)

- Objective: Prepare NAPA to adapt and cope with the likely adverse impacts of global warming, through consultative process and ensure Sustainable Development.
- Specific Objective:
  - Assess vulnerability to CC on socio-economic conditions, economic prosperity, and ecosystem, including biodiversity and natural resources.
  - Identify existing coping strategies, including indigenous knowledge base, in the event of disasters.
  - Identify key CC adaptation actions including capacity development needs at different levels
  - Link country CC action plan to broader national environmental management and SD

- NAPA process will:
  - Create and enhance awareness of CC issues.
  - Identify linkages between environmental management issues and capacity building efforts.
  - Enhance capacity of key institutions including community organizations/civil society.
  - Identify and improve the role of and relationship with partners

Government Focus

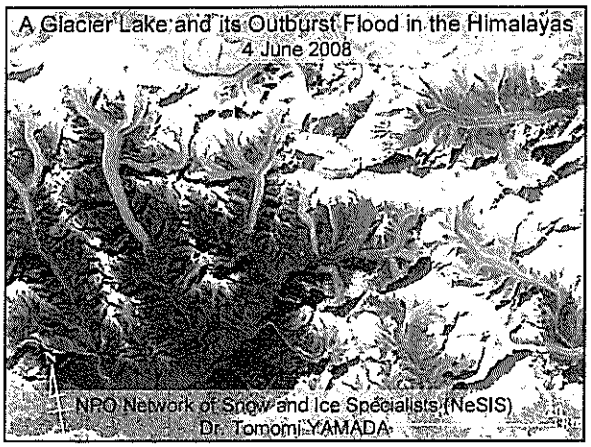
- Promotion of Alternative and Renewable Energy
- Energy efficiency improvement in Industry
- Environmental standards and compliance
- Incentives to clean vehicles
- National Adaptation Program
- Participatory Forest management programs

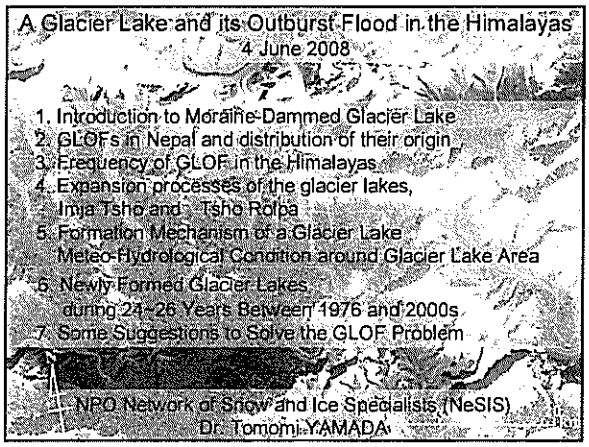
CC Related issues

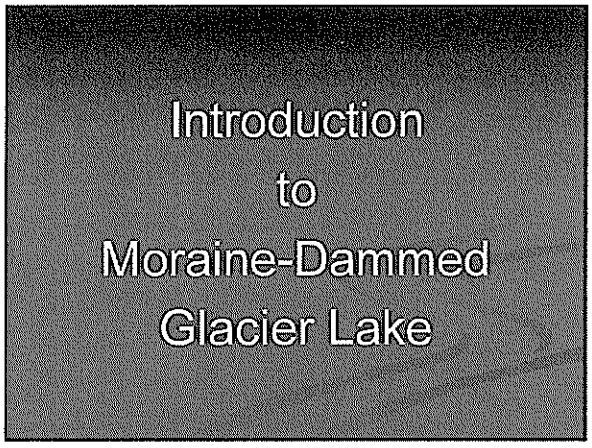
- Institutional
- Legal instruments
- Research and data inventory
- Adaptation plan and programs
- More talk and paper work

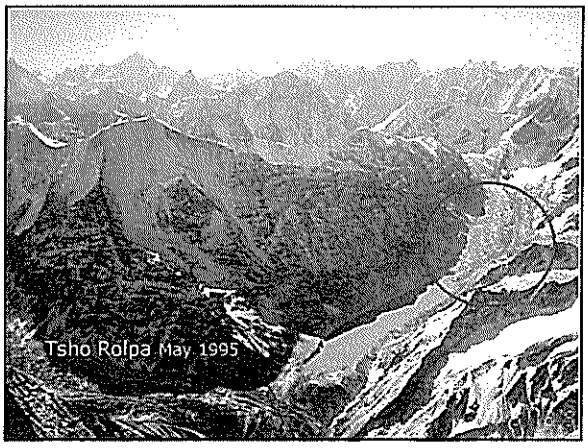
There is one key rule in any sort of communication...
start from where your audience is, not from where you are."
- Sue Ward, Getting the Message Across

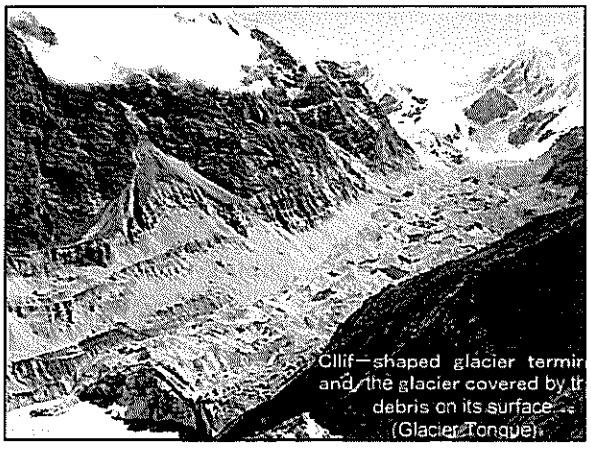
It is not enough to aim, you must hit.
- Italian Proverb


A Glacier Lake and its Outburst Flood in the Himalayas
4 June 2008
NPO Network of Snow and Ice Specialists (NeSIS)
Dr. Tomomi YAMADA

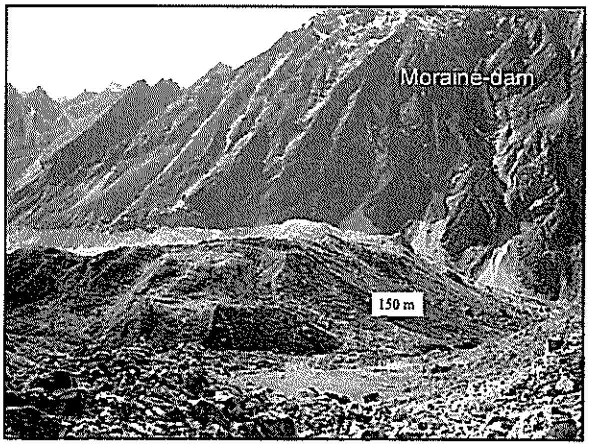

A Glacier Lake and its Outburst Flood in the Himalayas
4 June 2008
1. Introduction to Moraine-Dammed Glacier Lake
2. GLOFs in Nepal and distribution of their origin
3. Frequency of GLOF in the Himalayas
4. Expansion processes of the glacier lakes,
Imja Tsho and Tsho Rolpa
5. Formation Mechanism of a Glacier Lake
Meteo-Hydrological Condition around Glacier Lake Area
6. Newly Formed Glacier Lakes
during 24~26 Years Between 1976 and 2000s
7. Some Suggestions to Solve the GLOF Problem
NPO Network of Snow and Ice Specialists (NeSIS)
Dr. Tomomi YAMADA


Introduction
to
Moraine-Dammed
Glacier Lake


Tsho Rolpa May 1995


Cliff-shaped glacier termir
and the glacier covered by tr
debris on its surface
(Glacier Tongue)


Tsho Rolpa's
Moraines-dam
Lateral Moraine
or Side Moraine
Outlet Stream
Terminal Moraine
or End Moraine



Characteristics of a Moraine-Dammed Glacier Lake

1. The lake is created only on the terminal part of a debris-covered glacier (glacier tongue).

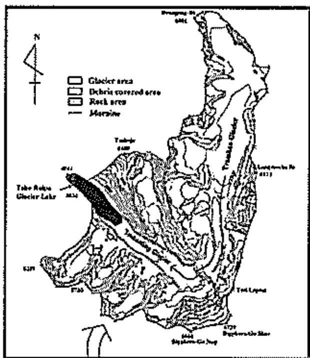
   The debris randomly consists of various material sizes such as huge rock, rock, stone, sand and silt.

2. The lake is surrounded by a huge moraine, i.e., dammed up by the moraine.

   The moraine is quite fresh and not yet consolidated, because it was formed during little ice-age in 16-19 century.

   A huge moraine is essential for glacier lake formation. Unstable moraine plays key role for GLOF occurrence.

3. Upstream end of the lake contacts with a cliff-shaped glacier terminus.

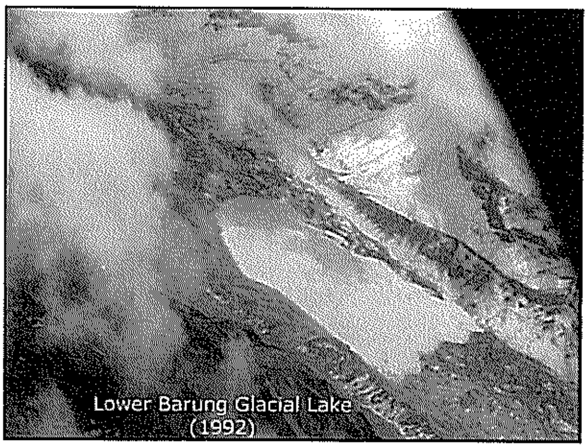


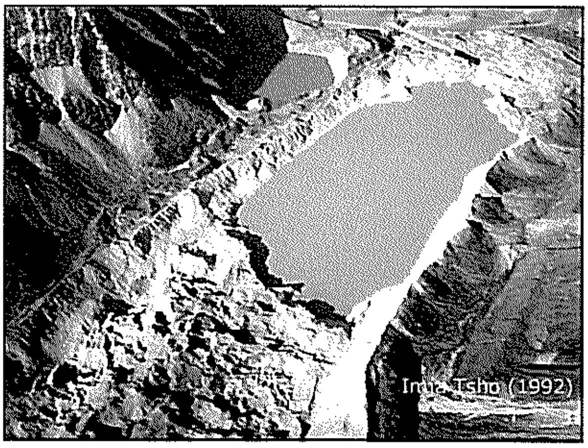
Tsho Rolpa watershed

Characteristics of a moraine-dammed glacier lake

Cont.

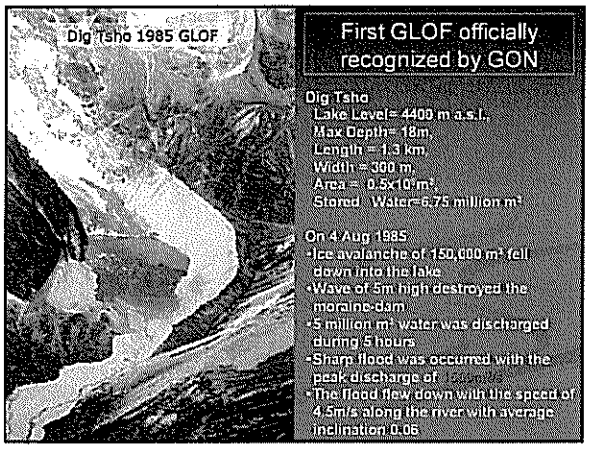
All melt- and rain-waters in the watershed are drained out through the drainage system in the glacier body and pours into the lake.





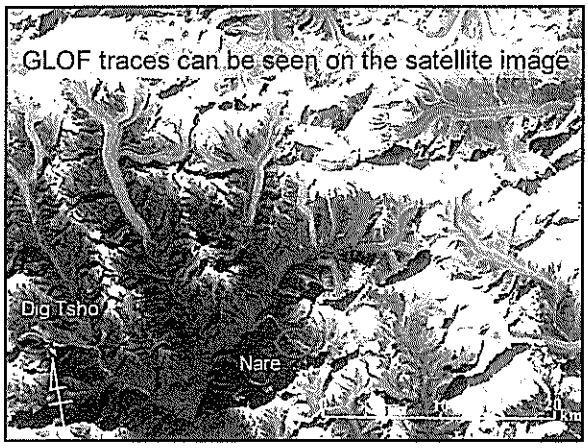
Thulagi glacier lake (1992)

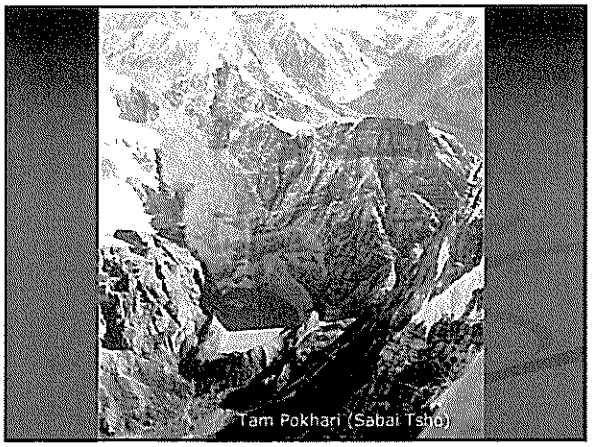
GLOFs in Nepal and Distribution of Their Origin

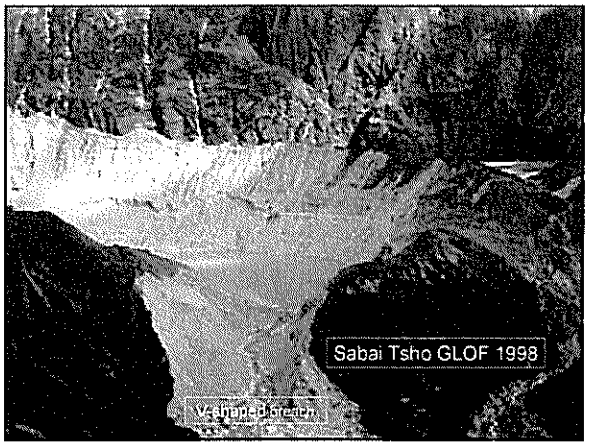


Dig Tsho GLOF impacts

- Full destruction of Namche Hydo-plant
- 14 Bridges、30 houses, cultivated land、trails、livestock, human lives
- slope failure due to bank erosion
- huge amount of erosion along the river and also deposition on the riverbed







Causes of the dam break

Break due to external triggers

1 Large mass falling into the lake
- avalanche of snow and ice • slope failure
- glacier mass sliding or collapsing suddenly into the lake

2 Large wave generated

3 When the wave flowing over the moraine, a moraine-dam being destroyed

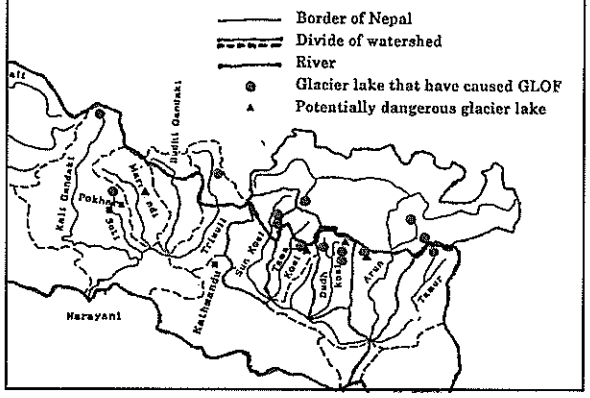
Self break
- Water leakage of the moraine
- Melting of permanently frozen moraine

GLOF History in Nepal

No	Date	River basin	Name of lake	Cause of GLOF	Remarks and Damages
1	450 yrs ago	Seti Khola	Bachhapokhhare	Ice-cored moraine collapse	Pokhara covered by 60-80 m-thick debris
2	Aug. 1935	Sun Kosi (Tangyaling Gully)	Terraco	moraine collapse due to seepage	66,700 m² of wheat field, livestock, etc.
3	21 Sep. 1964	Arun	Gelhaipco	moraine collapse due to glacier sliding into the lake	dam breach 40 m deep and 23 million m³ of water draining out. Bulk density of 1.45 t/m³, highway and 12 trucks etc.
4	1964	Sun Kosi	Zhangzangbo	moraine collapse due to seepage	No remarkable damages
5	1964	Trisuli	Lonada		
6	1968	Arun (Zangbonan river)	Ayaco	the lake bursting three times in 1968, 1969 and 1970	road, concrete bridge etc.
7	1969	Arun	Ayaco		
8	1970	Arun	Ayaco		
9	3 Sep. 1977	Dudh Kosi	None	ice-cored moraine collapse	mini-hydro plant, road, bridges, farm land
10	1980	Tamur	Punchen		one village destroyed; villager migrated after GLOF
11	11 July 1981	Sun Kosi	Zhangzangbo	moraine collapse due to glacier falling into the lake	dam breach 50 m deep and 40-60 m in width; max drainage being 16,900 m³; 19 million m³ of water drained out. Arniko Highway, friendship bridge, Sun Kosi hydropower station, farm land etc.
12	27 Aug. 1982	Arun	Jinco	moraine dam collapse due to glacier sliding into the lake	1660 heads of livestock, 167,000 m² of farm land, houses of eight villages washed away
13	4 Aug. 1985	Dudh Kosi	Dig Tsho	moraine collapse due to glacier ice avalanche	Namche hydropower station, 14 bridges, trails, cultivated land etc.
14	12 July 1991	Tama Kosi	Chubung	moraine dam collapse of Ripimo Shar glacier	houses, farm land etc.
15	May 1995	Kali Gandaki	?	Tsarang Chu upstream in Mustan	
16	3 Sep. 1998	Hinku Khola	Sabai Tsho	Hanging glacier and falling down	Two people, Bridges, roads etc.

9 GLOFs (2, 3, 4, 5, 6, 7, 8, 11, 12) were originated in Tibet

Distribution of 16 GLOFs origin



Frequency of GLOF in the Himalayas

Nepal: 14 times since 1964;
almost once every 3 years;
GLOF concentrating in monsoon season of Jun to Sep, especially in Jul and Aug

Tibet: 21 times since 1935
(9 GLOFs flowing down to Nepal)

Bhutan: 5 times since 1950

India: Not data
Moraine-dammed lakes may exist in Garuwaru Himal

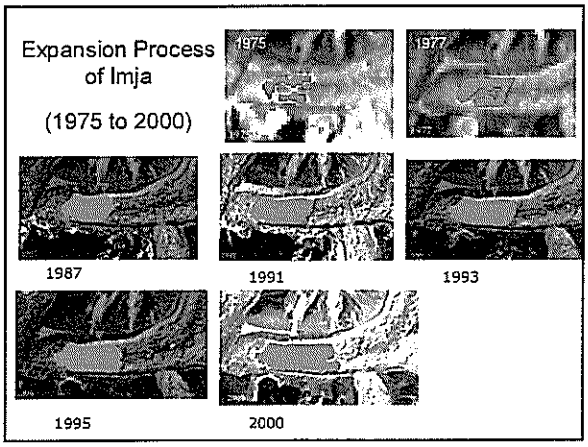
Pakistan: No moraine-dammed lakes
GLOFs due to ice-dammed lake failure frequently occurred in Karakoram.

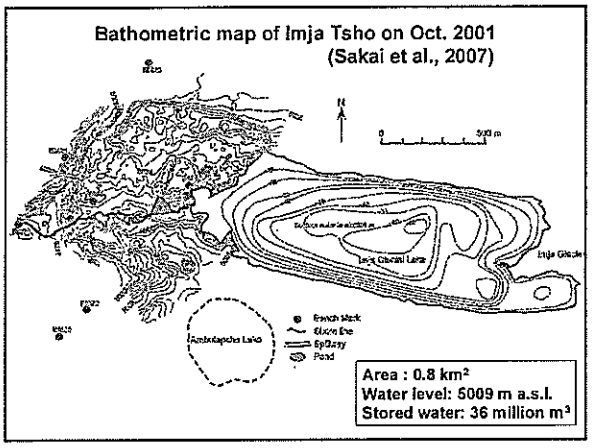
No enough information of GLOF situation in the entire Himalayas and in the high Land of Asia

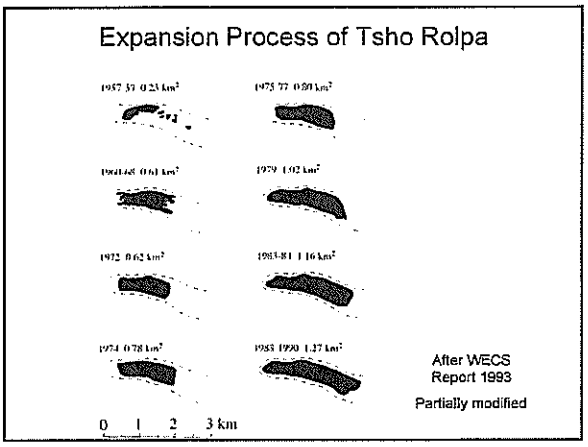
Expansion Processes of Glacier Lakes

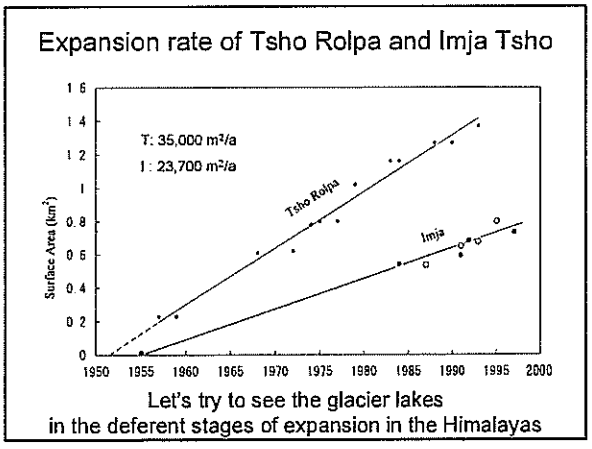
In the cases of
Imja Tsho and Tsho Rolpa


Imja Tsho, 1992

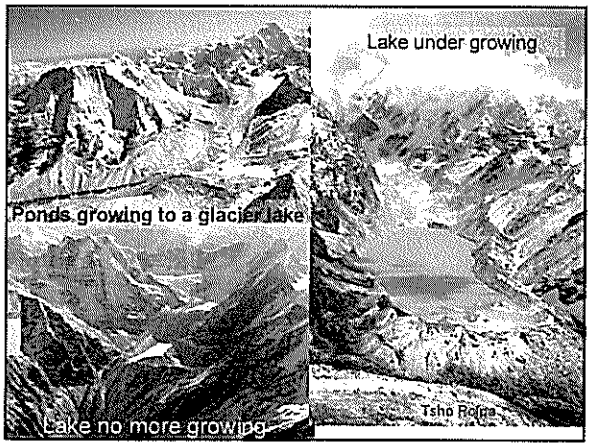

Expansion Process
of Imja
(1975 to 2000)
1975
1977
1987
1991
1993
1995
2000

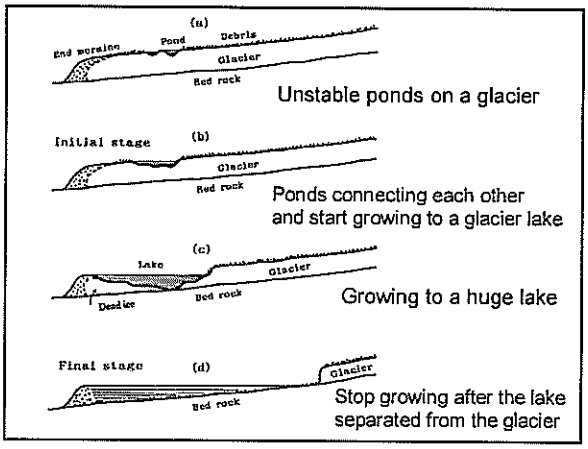

Bathometric map of Imja Tsho on Oct. 2001
(Sakai et al., 2007)
Area : 0.8 km²
Water level: 5009 m a.s.l.
Stored water: 36 million m³

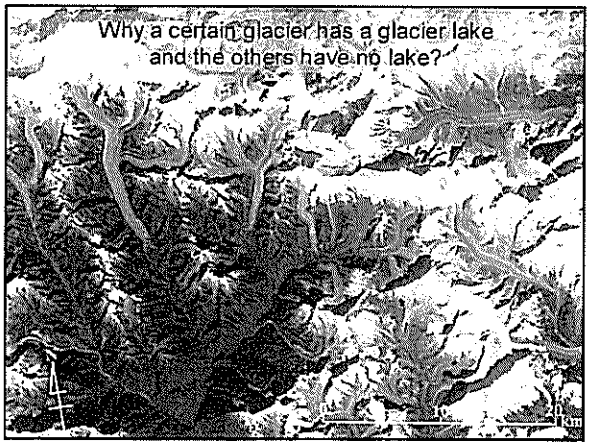

Expansion Process of Tsho Rolpa
After WECS
Report 1993
Partially modified
0 1 2 3 km


Expansion rate of Tsho Rolpa and Imja Tsho
T: 35,000 m²/a
I : 23,700 m²/a
Tsho Rolpa
Imja
Surface Area (km²)
Let's try to see the glacier lakes
in the deferent stages of expansion in the Himalayas


Debris-covered glacier have many supra-glacial ponds on it.
The ponds are usually quite unstable.
They suddenly disappear and newly appear.

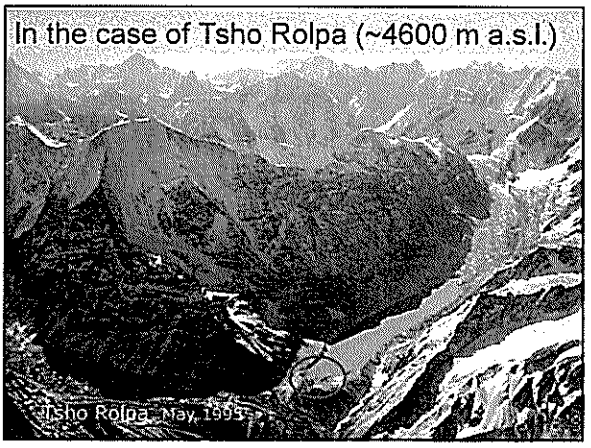


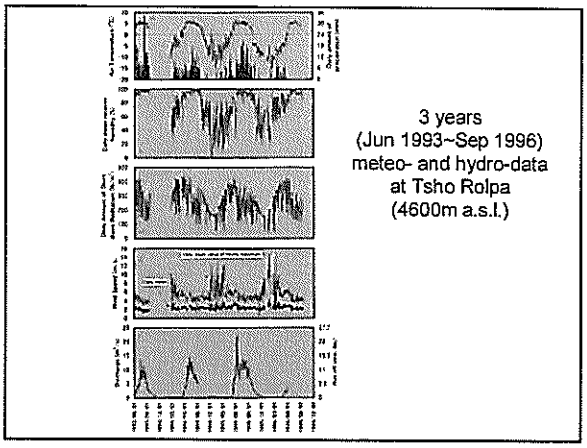




Formation Mechanism of a Glacier Lake

Meteo-Hydrological Condition
around Glacier Lake Area
(4000~5000 m a.s.l.) in the Himalaya





3 years
(Jun 1993~Sep 1996)
meteo- and hydro-data
at Tsho Rolpa
(4600m a.s.l.)

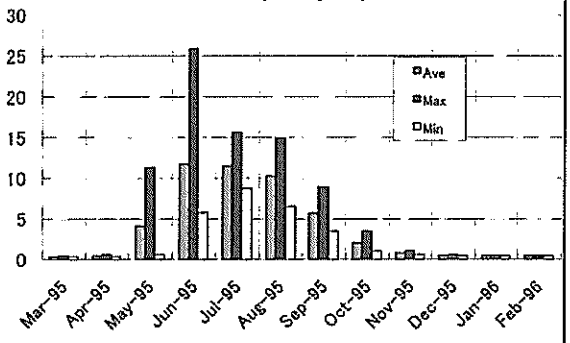
Air Temperature

Measured on Jun 1993~Sep 1996
at Tsho Rolpa Meteorological Station
(~4600 m a.s.l)

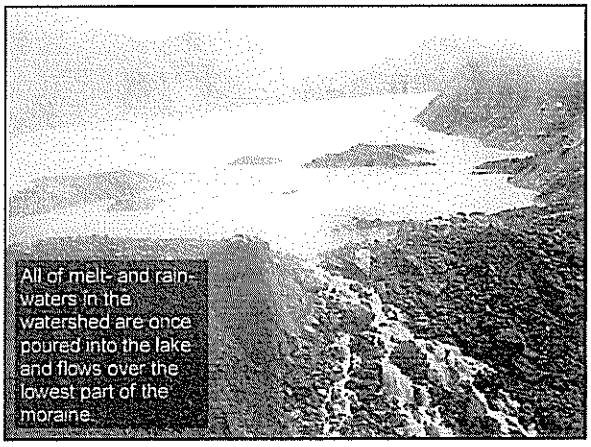
T>0 °C	mid-May to mid-Oct	
T<0 °C	mid-Oct to mid-May	
Annual Ave.	-1.2 ~ -1.9 °C	
Monsoon Season	5~6 °C	mid-Jun to mid-Sep
Warmest Month	+5.3 ~ +5.5 °C	Jul
Coldest Month	-9.2 ~ -11.5 °C	Jan or Feb
Extreme Max	14.6 °C	6 Jul 1993
Extreme Min	-23.2 °C	16 Feb 1995

The lake freezes about 6 months in mid-Nov to early May

Monthly Average Discharge (m^3/s)
1995~96 hydrological year



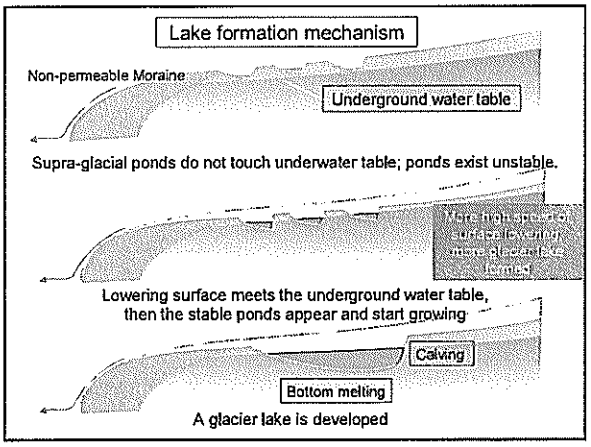
Hydrological year starts from mid-March in Tsho Rolpa



Hydrological Situation of Tsho Rolpa

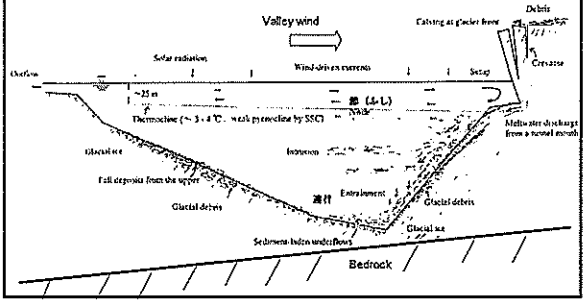
Measured on 1993~1996

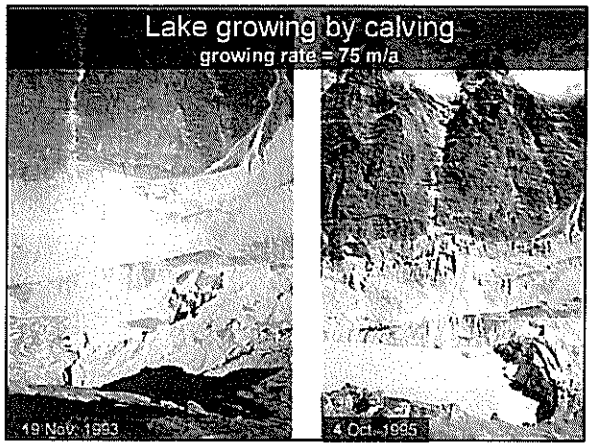
Tsho Rolpa Drainage Basin	77.6	km^2
Rate of Glacier Area	~71.8	%
Debris Free	55.3	%
Debris Covered	16.5	%
Annual Discharge	93~129	million m^3
Annual Runoff	1193~1661	mm
Extreme Annual Max	16.2~25.9	m^3/s
Extreme Annual Min	0.30~0.41	m^3/s
Coefficient of river regime	~60	

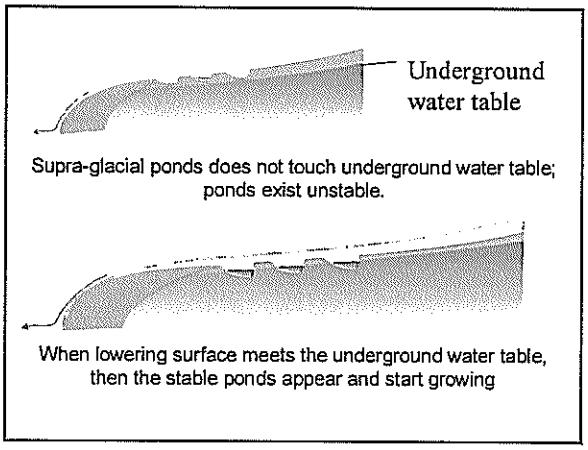


Lake Growing by Two Ways, Calving and Bottom melting

Sunshine heating up surface water, which is transported to the cliff-shaped glacier terminus by valley wind and melting its foot

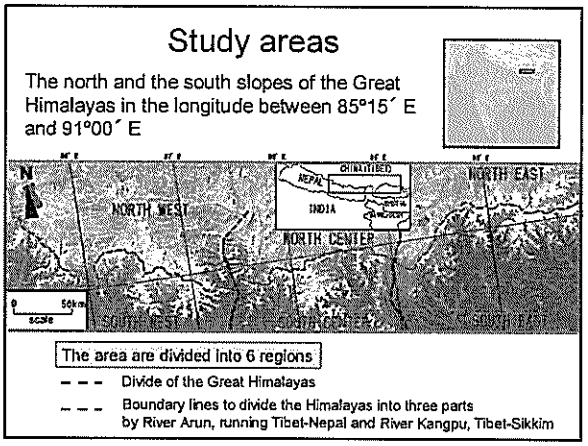


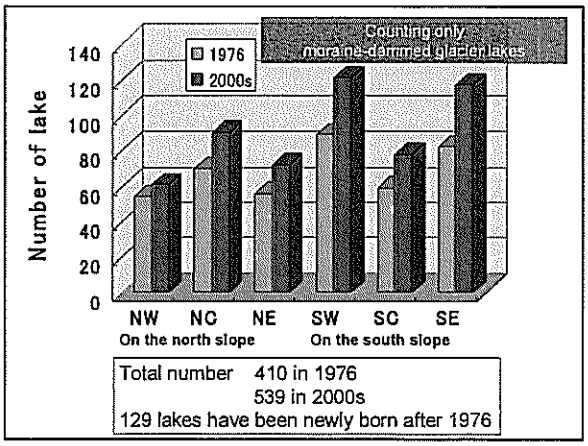


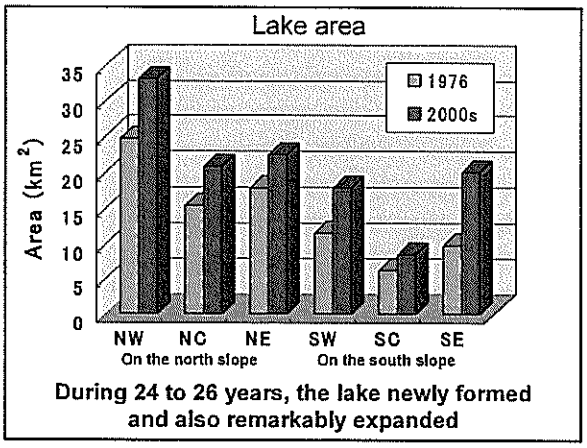


Newly Formed Glacier Lakes during 24~26 Years Between 1976 and 2000s

– from satellite images –







Some Suggestions to Solve the GLOF Problem

1. Short-term Perspective
   - Direct countermeasures against GLOF
     =completely draining out the lake water
     Development of proper method for lake water reduction
   - Second-best way
     = Mitigating GLOF impact
     monitoring of glacier lakes, hazard mapping, early warning system, shifting the infrastructure, GLOF campaign for residents
2. Long-term Perspective
   - Human resource development in glaciology sector
     = reinforcement of educational / research institutes

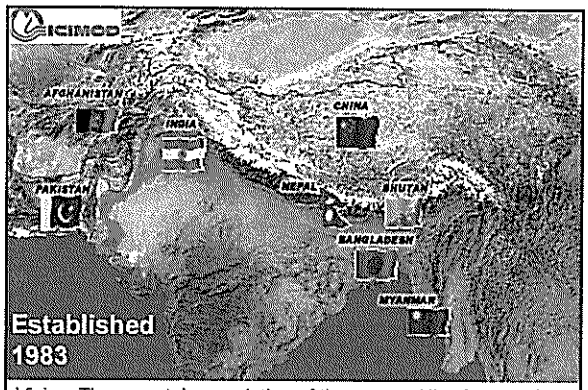
The End

Thank You
for Your Attendance

Sayonara

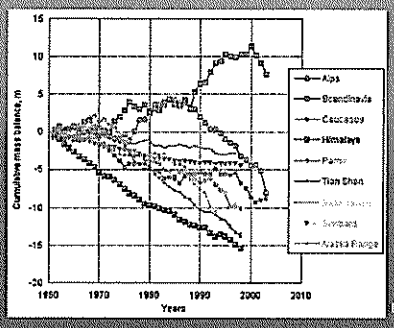
Himalayan GLOF Risk Assessment - past experiences and future needs

Mats Eriksson
Integrated Water and Hazard Management
International Centre for Integrated Mountain Development (ICIMOD)
www.icimod.org



Vision: The mountain population of the greater Himalayas enjoys improved well-being in a sustainable global environment

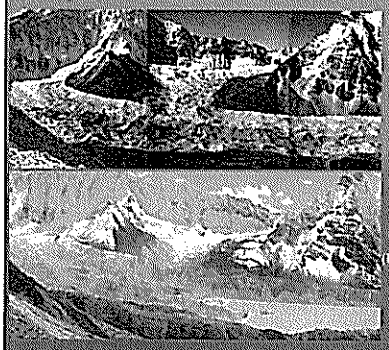
Glacier Mass Balance



- Himalayan glaciers are shrinking more rapidly than elsewhere

Dyurgerov and Meier 2005

Imja Glacier, Nepal – Repeat Photography

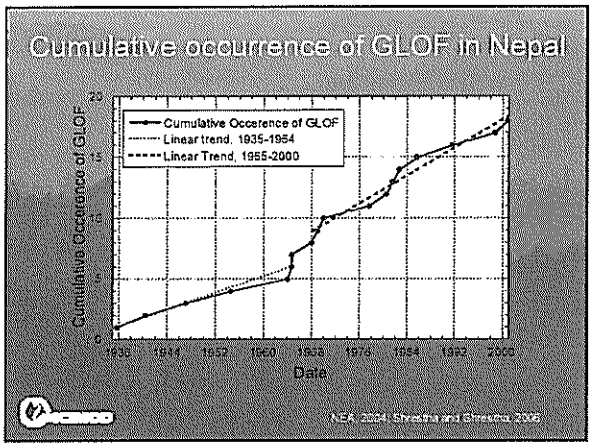


1956
photograph of Imja glacier (Photo: Fritz Müller, courtesy of Jack Ives)

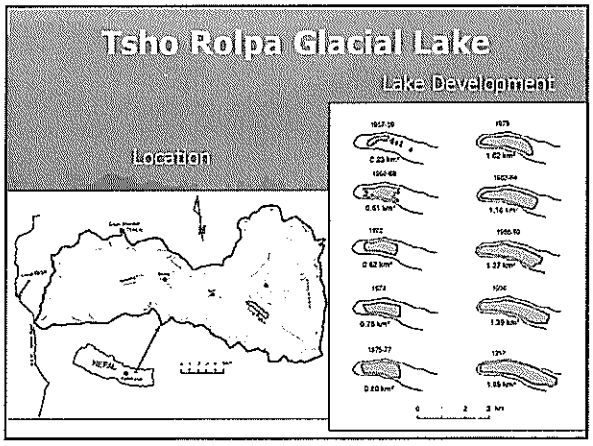
2006
photograph of Imja glacier (Photo: Giovanni Kappenberger, courtesy of Alton C Byers)

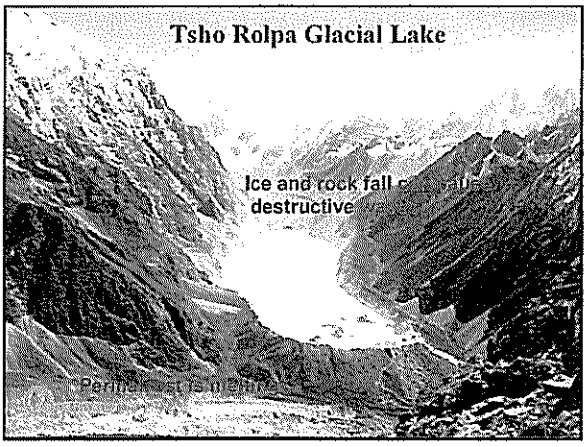
Climate Change Impact in the Himalayas

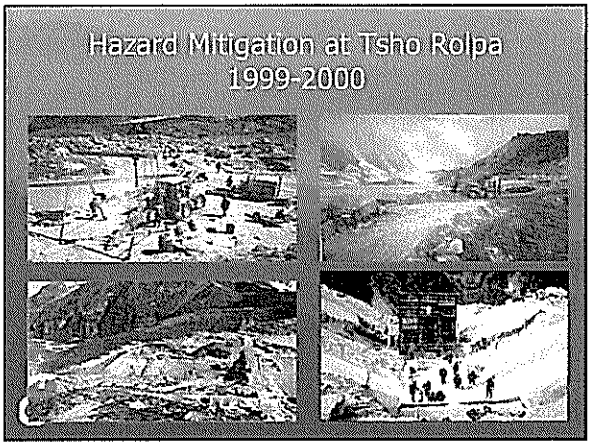
- Increased frequency and magnitude of water induced hazards
  - Floods
  - Flash Floods
  - Landslides
  - Debris Flows
  - Droughts

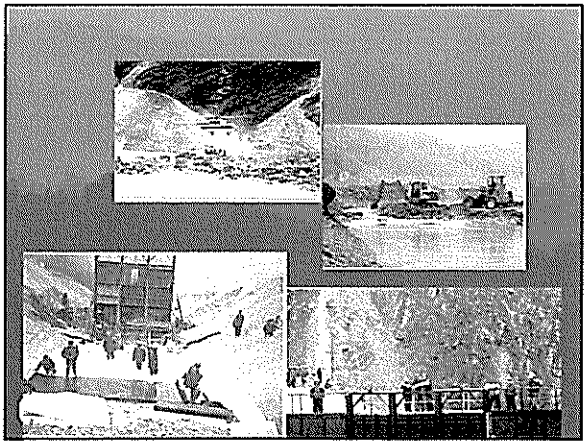

Cumulative occurrence of GLOF in Nepal
Cumulative Occurence of GLOF
Linear trend, 1935-1954
Linear Trend, 1955-2000
Cumulative Occurence of GLOF
Date
NEA, 2024, Shrestha and Shrestha, 2005

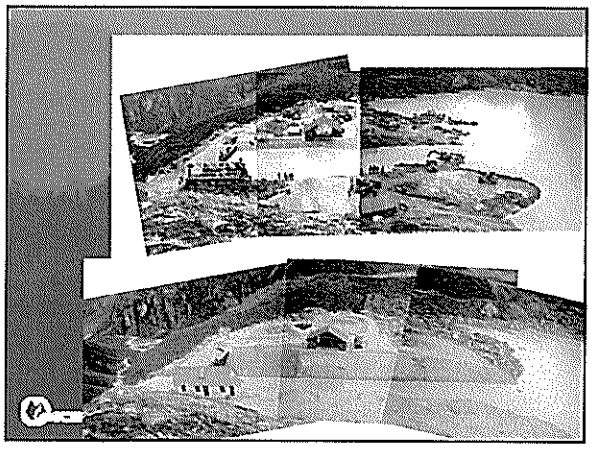

Past Activities in Nepal

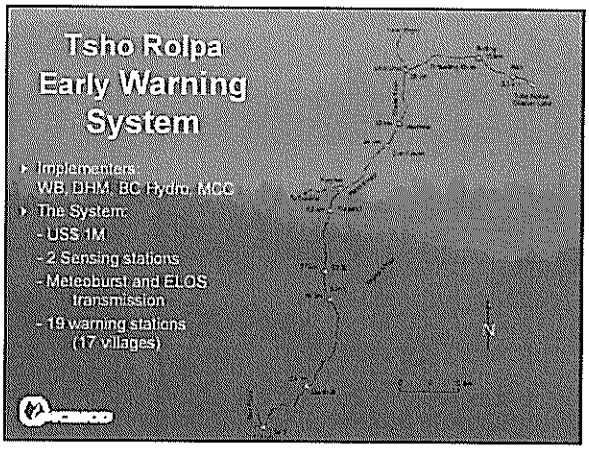

Tsho Rolpa Glacial Lake
Lake Development
Location
NEPAL

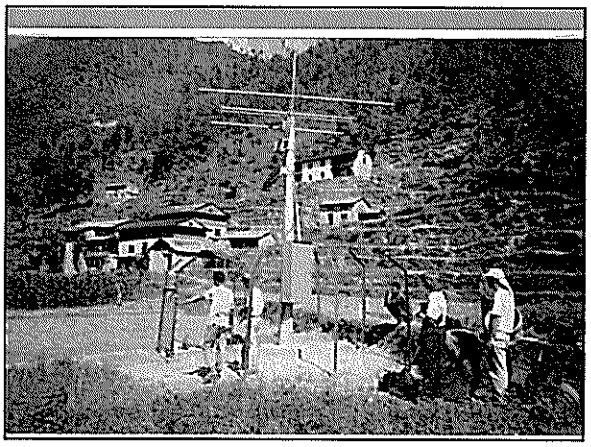

Tsho Rolpa Glacial Lake
destructive

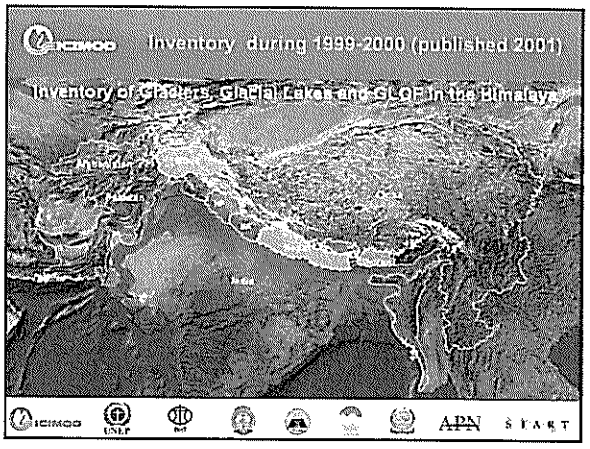

Hazard Mitigation at Tsho Rolpa
1999-2000

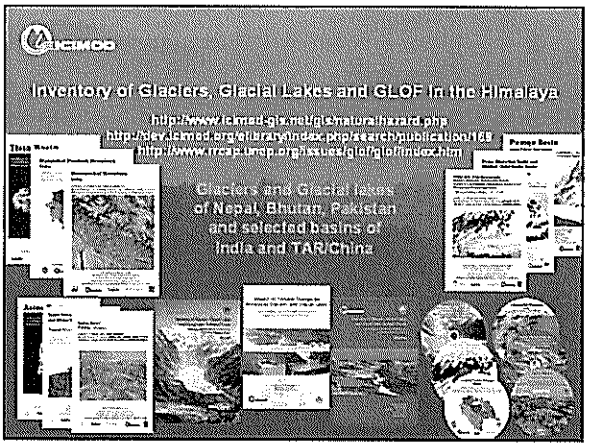


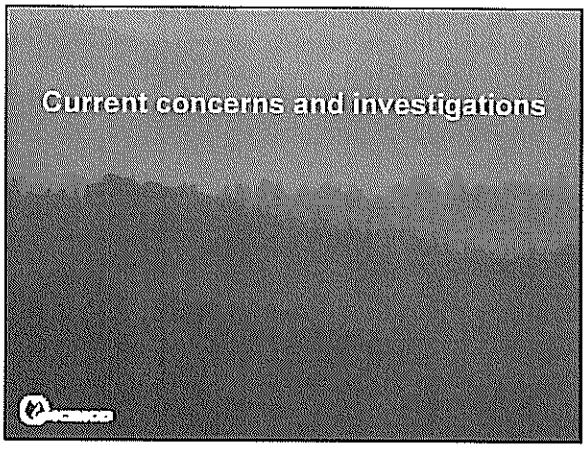


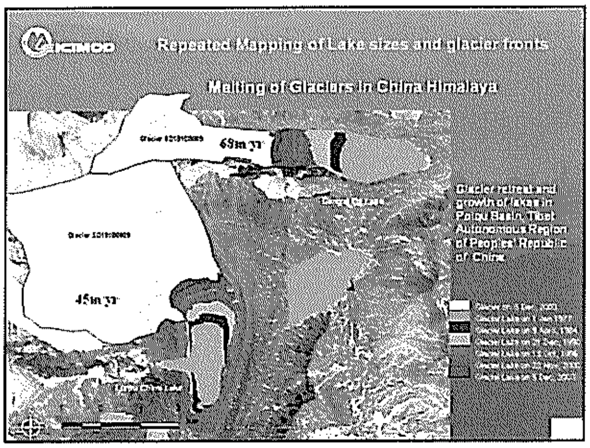

Tsho Rolpa
Early Warning
System
Implementers:
WB, DHM, BC Hydro, MCC
The System:
- US$ 1M
- 2 Sensing stations
- Meteoburst and ELOS transmission
- 19 warning stations (17 villages)

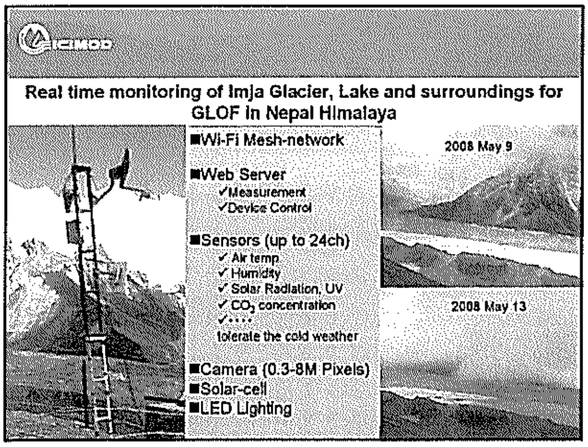


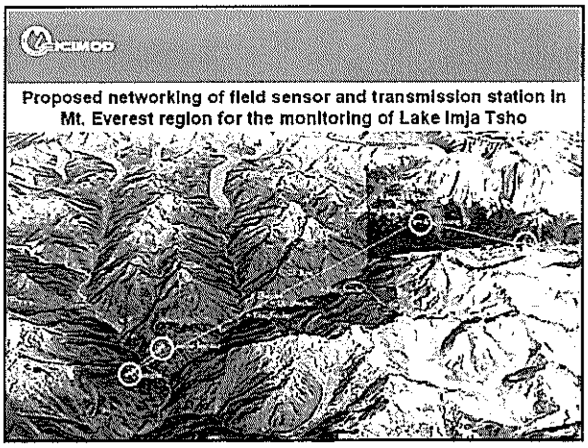

Inventory during 1999-2000 (published 2001)
Inventory of Glaciers, Glacial Lakes and GLOF in the Himalaya
APN
START

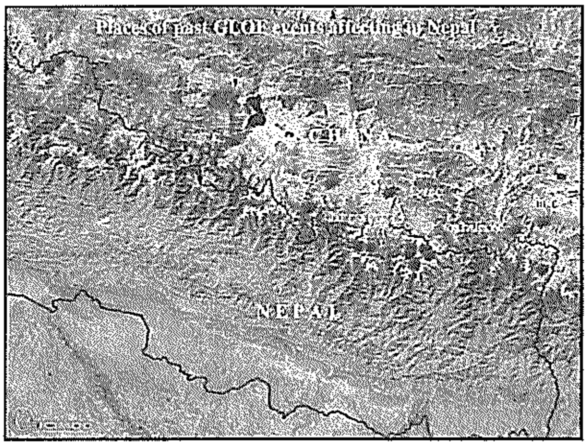

Inventory of Glaciers, Glacial Lakes and GLOF in the Himalaya
Glaciers and Glacial lakes of Nepal, Bhutan, Pakistan and selected basins of India and TAR/China

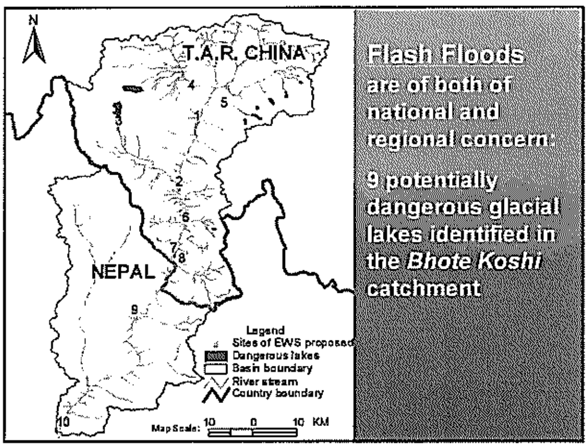

Current concerns and investigations

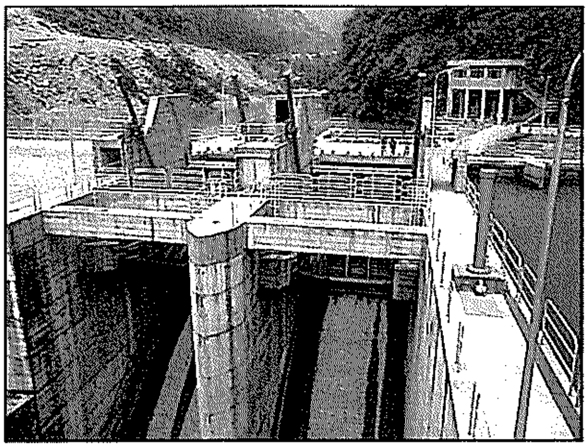

ICIMOD
Repeated Mapping of Lake sizes and glacier fronts
Melting of Glaciers in China Himalaya
69m/yr
45m/yr
Glacier retreat and growth of lakes in Poiqu Basin, Tibet Autonomous Region of Peoples' Republic of China


ICIMOD
Real time monitoring of Imja Glacier, Lake and surroundings for GLOF in Nepal Himalaya
■Wi-Fi Mesh-network
■Web Server
✓Measurement
✓Device Control
■Sensors (up to 24ch)
✓Air temp.
✓Humidity
✓Solar Radiation, UV
✓CO_2 concentration
✓....
tolerate the cold weather
■Camera (0.3-8M Pixels)
■Solar-cell
■LED Lighting
2008 May 9
2008 May 13

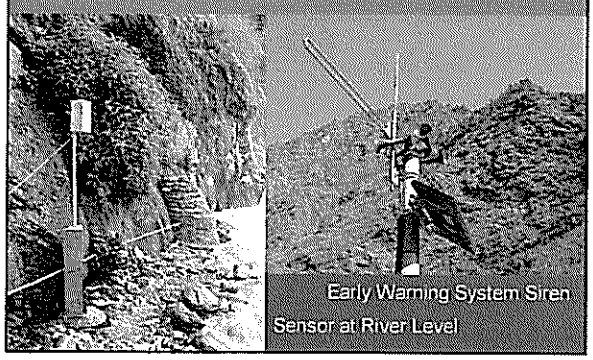

ICIMOD
Proposed networking of field sensor and transmission station in Mt. Everest region for the monitoring of Lake Imja Tsho


Places of past GLOF events affecting to Nepal
NEPAL


N
T.A.R. CHINA
NEPAL
Legend
Sites of EWS proposed
Dangerous lakes
Basin boundary
River stream
Country boundary
Map Scale: 10 0 10 KM
Flash Floods are of both of national and regional concern:
9 potentially dangerous glacial lakes identified in the Bhote Koshi catchment



Early Warning System – 5 min!



GLOF related activities 2008-2012

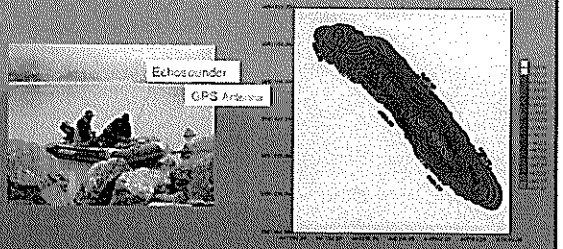
- Develop a database for potential GLOF lakes (build on current inventory)
- Regularly produce a Status Report on snow & ice in the HKH region
- Build capacity in the ICIMOD Regional Member Countries for monitoring of glaciers and GLOF risk
- Create awareness of GLOF risks where relevant, and then involve communities in mitigation and adaptation activities
- Work together with national partners in all activities

GLOF related activities 2008-2012

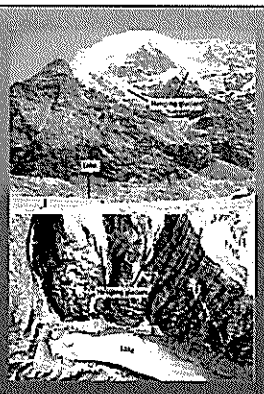
A step wise approach building on past experiences

1) Revisit GLOF lake inventory – update
2) Select most dangerous lakes for field work using a set of criteria
3) Undertake field based GLOF risk assessment
   - o Assess moraine stability
   - o Undertake bathymetric measurements
   - o Geo-technical, hydro-meteorological, glaciological studies of lake, moraines, glaciers and surrounding

Bathymetric Survey



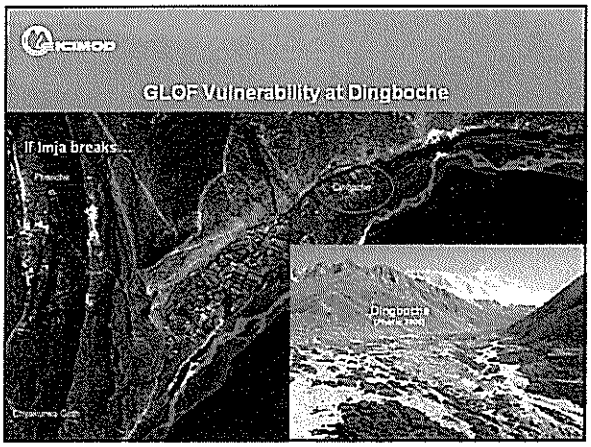
Mapping the Environment Surrounding the Lake



GLOF related activities 2008-2012

A step wise approach building on past experiences

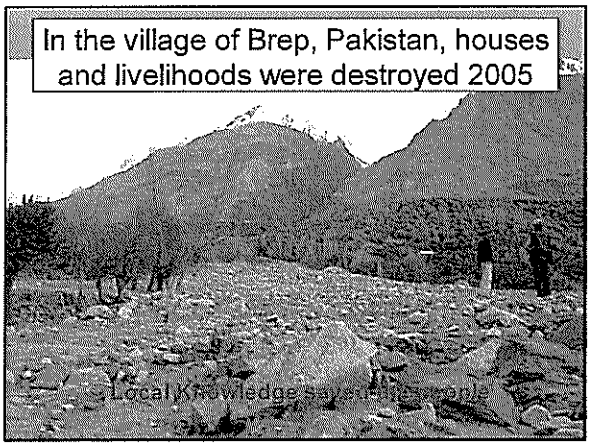
4) Run models for downstream impact studies



GLOF related activities 2008-2012

A step wise approach building on past experiences

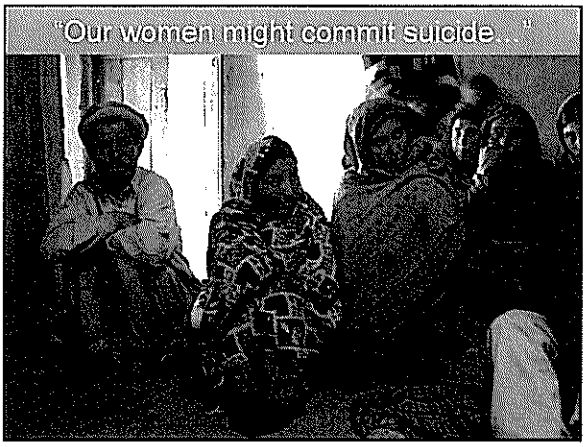
4) Run models for downstream impact studies
5) Assess vulnerability of communities, infrastructure etc.

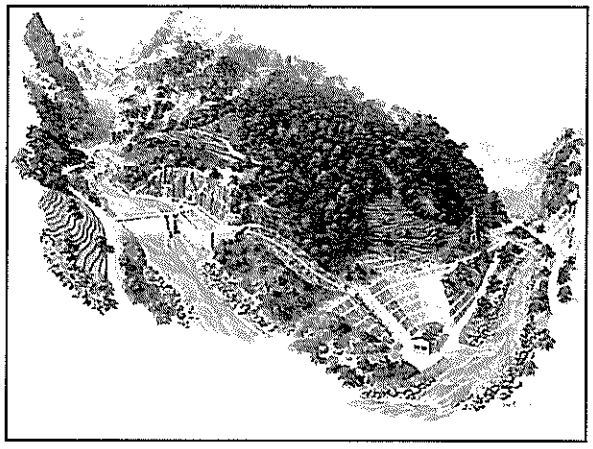


GLOF related activities 2008-2012

A step wise approach building on past experiences

4) Run models for downstream impact studies
5) Assess vulnerability of communities, infrastructure etc.
6) Assess socio-economic impact





GLOF related activities 2008-2012

A step wise approach building on past experiences

4) Run models for downstream impact studies
5) Assess vulnerability of communities, infrastructure etc.
6) Assess socio-economic impact
7) Recommend mitigation and adaptation strategies to relevant governmental institutions; Awareness creation
8) Install Early Warning Systems involving local communities

Actions under Action Area 1.1

Monitoring and assessment of ice and water resources

- Develop schemes for monitoring and assessment of cryosphere and water resources on a ***regional*** scale
- Support strengthening of national capacities to monitor and assess cryosphere and water resources on a ***national*** and field based scale
- Assessment of functions and services provided by high altitude wetlands
- Establishment of a regional water-related database

Actions under Action Area 1.2

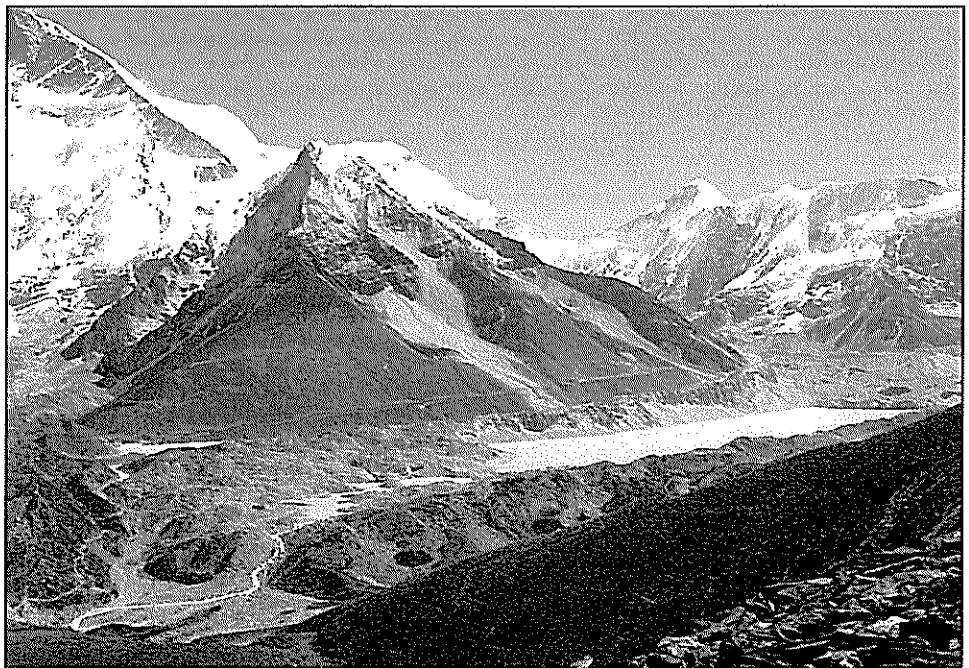
Disaster Risk Reduction and community resilience

- Develop and deliver training courses in disaster risk reduction
- Knowledge sharing in disaster risk reduction
- Assess the impacts of climate change on ecosystems, natural hazards, and human health
- Assess the vulnerability of communities and build their resilience to multihazards

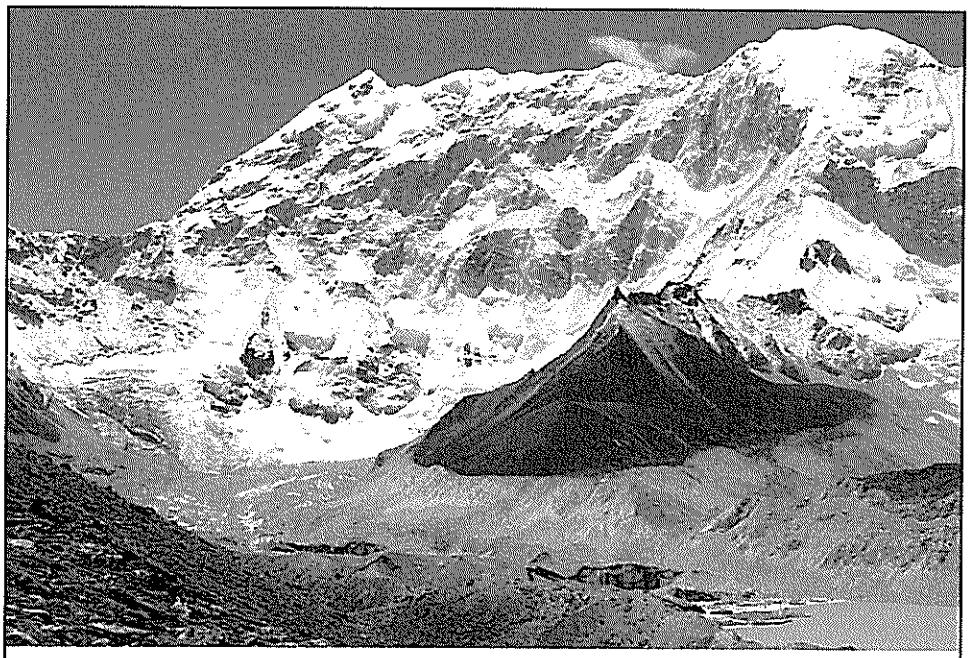
Actions under Action Area 1.3

Strengthening upstream-downstream linkages

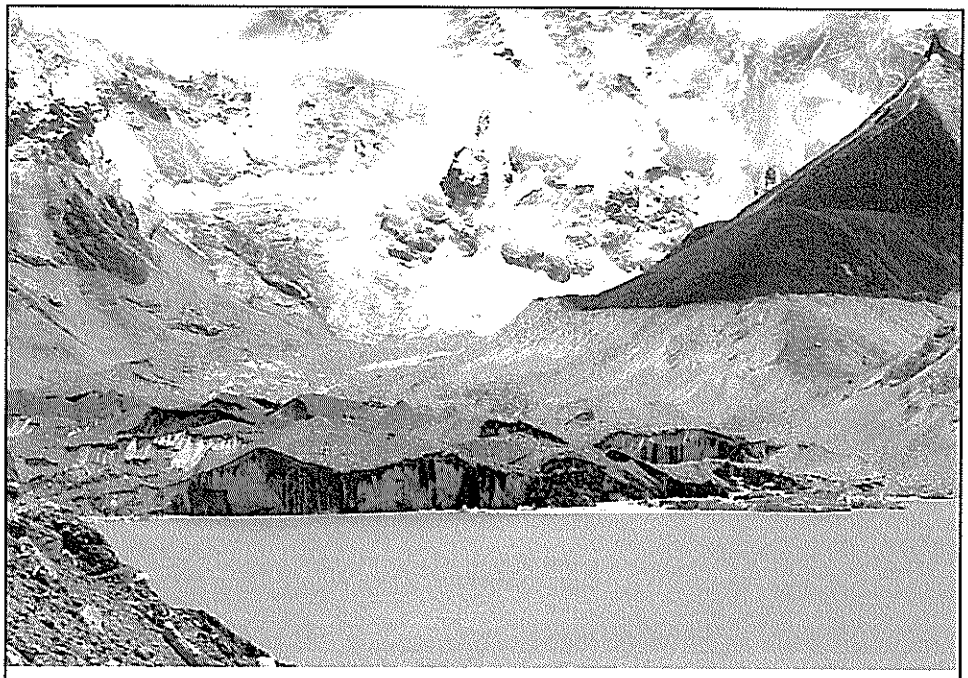
- Facilitate regional cooperation for flood disaster mitigation
- Development of flash flood management, forecasting and early warning systems
- Support Integrated Water Resources Management (IWRM) approaches and water governance
- Development of basin-wide scenarios on water availability and demand



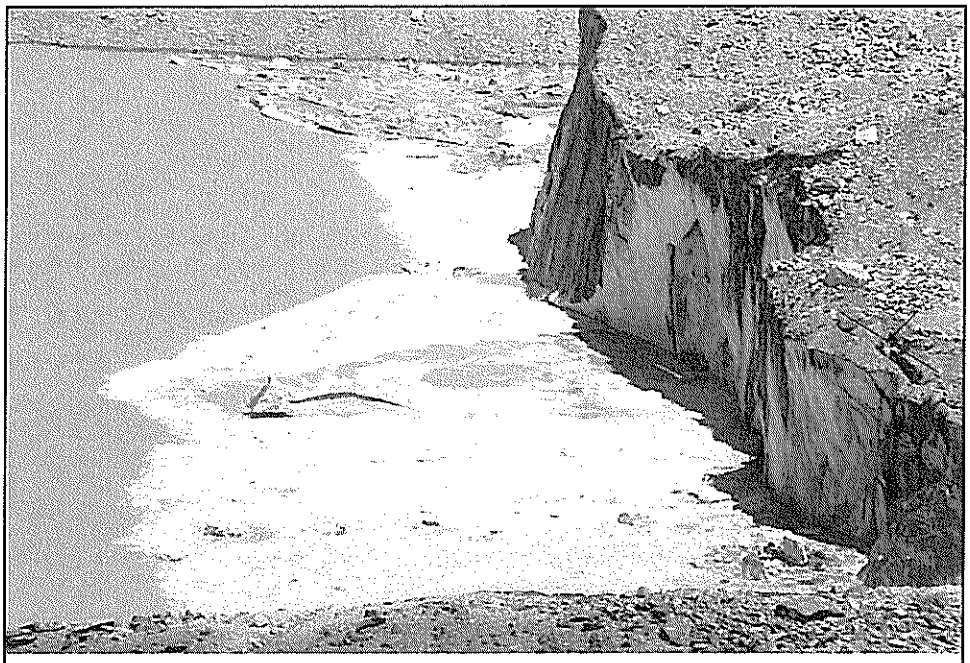
イムジャ湖全景、全長約2．5km(エンドモレーン末端から氷河の末端)、幅約700m、流出口部分の幅約500m、湖面の標高約5000m、湖面と河床部との比高約30m。 写真左下の黄色と青のテント群がJICA調査団のキャンプ地。 氷河湖の延長方向は、ほぼ東西方向。



イムジャ氷河の末端。 アンプラプチャ氷河(写真右側から中央部に流動)との合流点付近まで後退(かつては両氷河は繋がっていた)。イムジャ氷河は、かつては写真中央の黒い山稜の下方、白く見える部分辺りまで氷で覆われていた(氷の厚さが減少)。

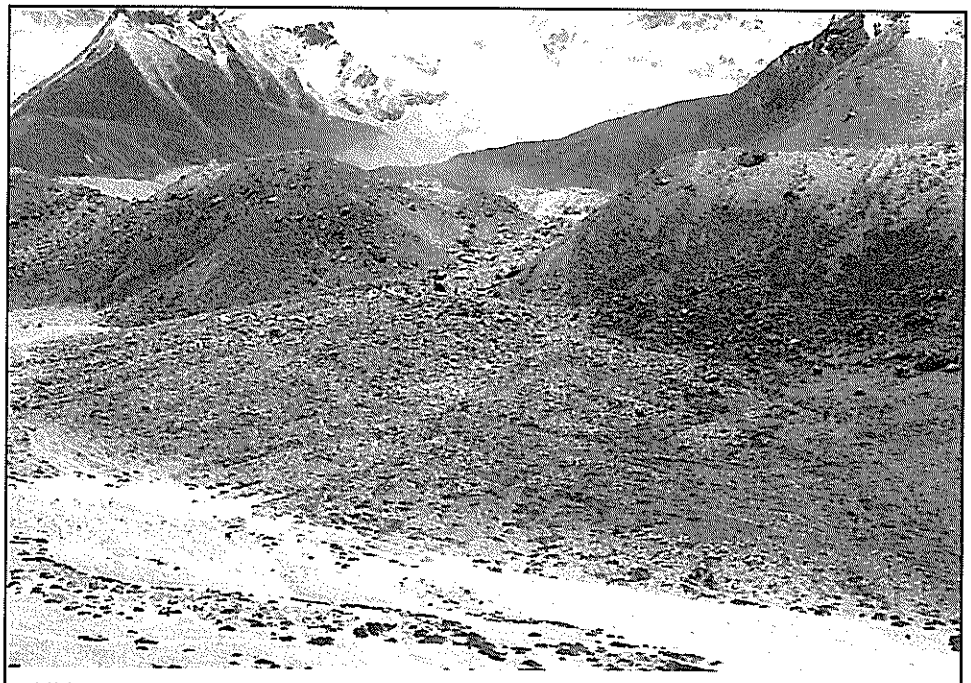


イムジャ氷河の末端部分。 水面上にある氷の高さは20－30m程度。



イムジャ氷河の末端部分。 氷の表面はデブリに覆われている。 縦方向の割れ目(矢印)に沿って氷塊が崩壊し、崩壊した氷塊が湖面に浮いている。

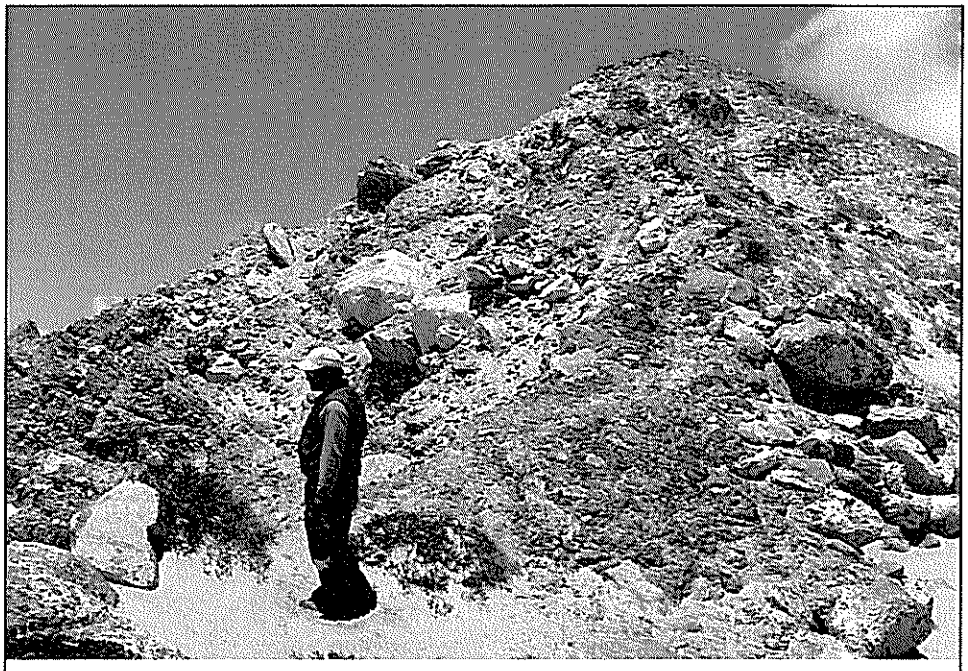
氷河湖北側のサイドモレーン上部に、かつて湖水が小規模に流出した痕跡が見られる(矢印部分)。 現在の湖面の標高は、サイドモレーンとその北側の山稜との間に存在するアブレーション・バレーの標高より低いため、サイドモレーンが崩壊しても湖水が流出することは無い。



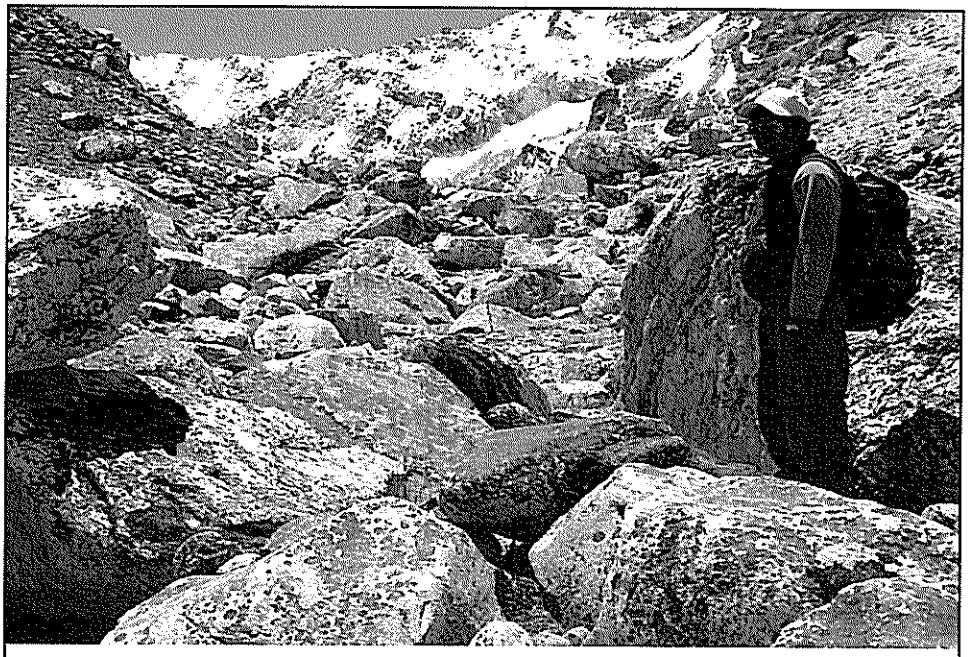
同上拡大。

氷河湖南側サイドモレーンの内側斜面。 上部は50－60度のバッドランド状の急崖。 下部は40－50度の斜面をなす。 全体に乾燥。

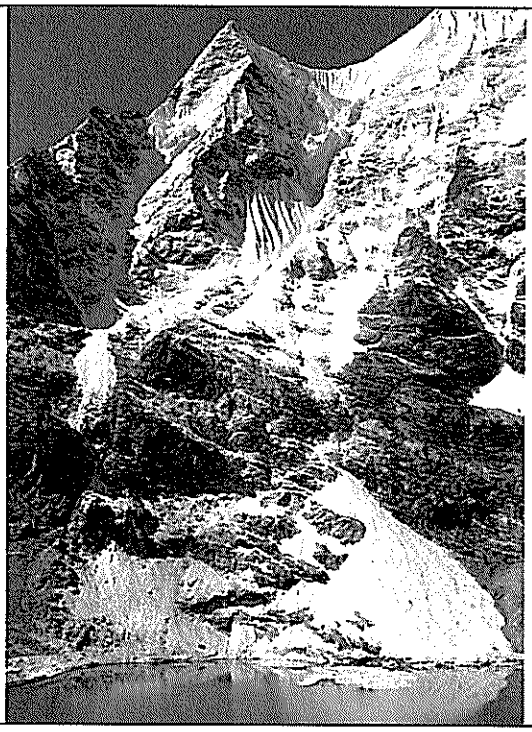
氷河湖北側のサイドモレーン内側に見られる幅約40m程度の小規模な崩落崖。



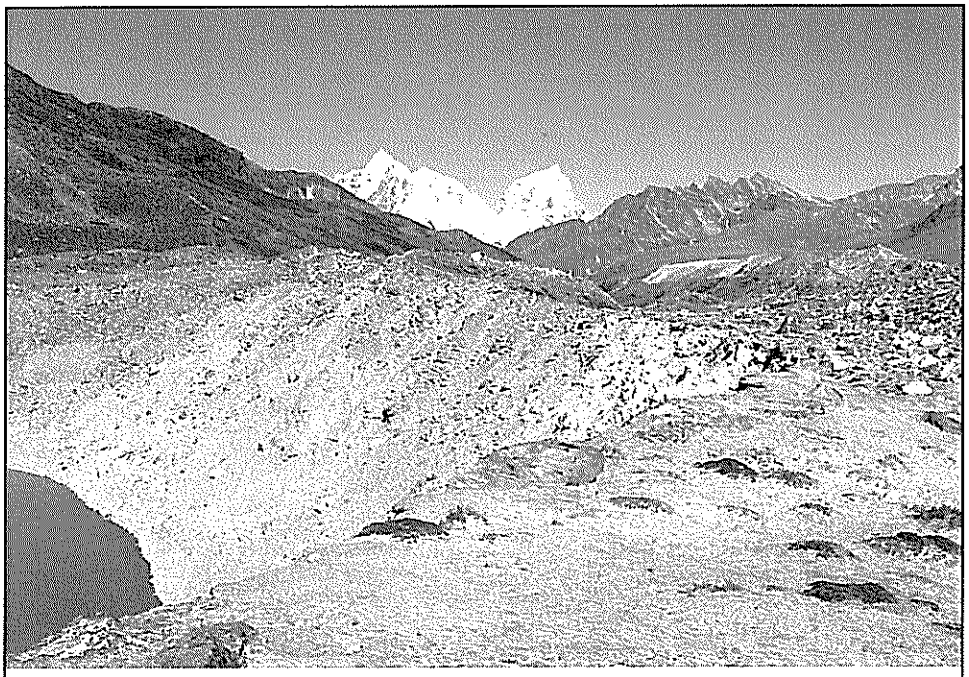
モレーンの層相は、最大直径2m程度までのあらゆるサイズの角礫の間を、粘土、シルト、細粒砂等の細粒分が埋めている。 礫質は、白い花崗岩質(塊状)か黒色片岩(板状)の2種類に大別される。 全体に水分が少なく乾燥している。



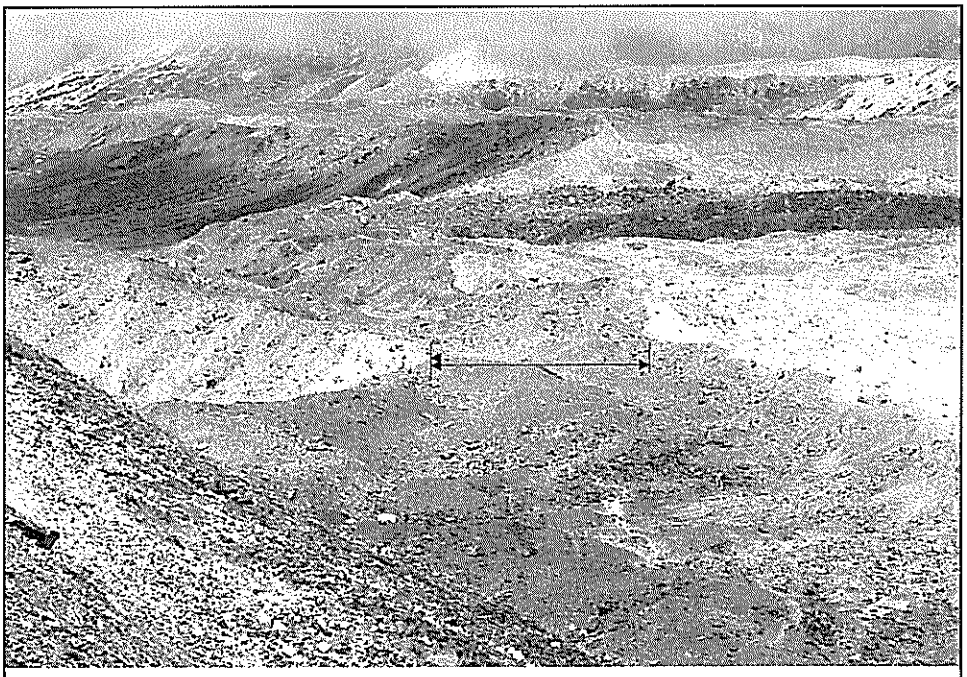
モレーンが外部の力によって動かされると、細粒部分が抜け落ちて(流失して)、巨礫のみが残る。



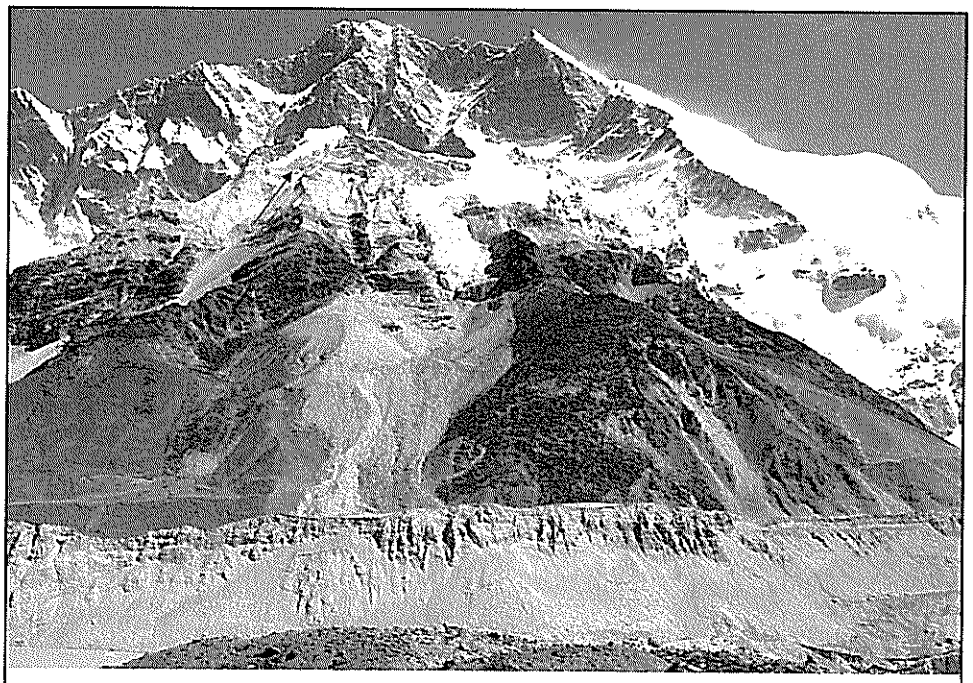
イムジャ氷河湖南側の稜線(標高約6200m)直下に2つの懸垂氷河(標高約5800m)が分布している。その直下標高約4900mに別な氷河湖が存在する。これらの懸垂氷河から氷塊がこの氷河湖に落下しても、その周りを比高約50mのモレーンが囲んでいるため、直接の衝撃がイムジャ氷河湖に及ぶことは無い、と考えられる。



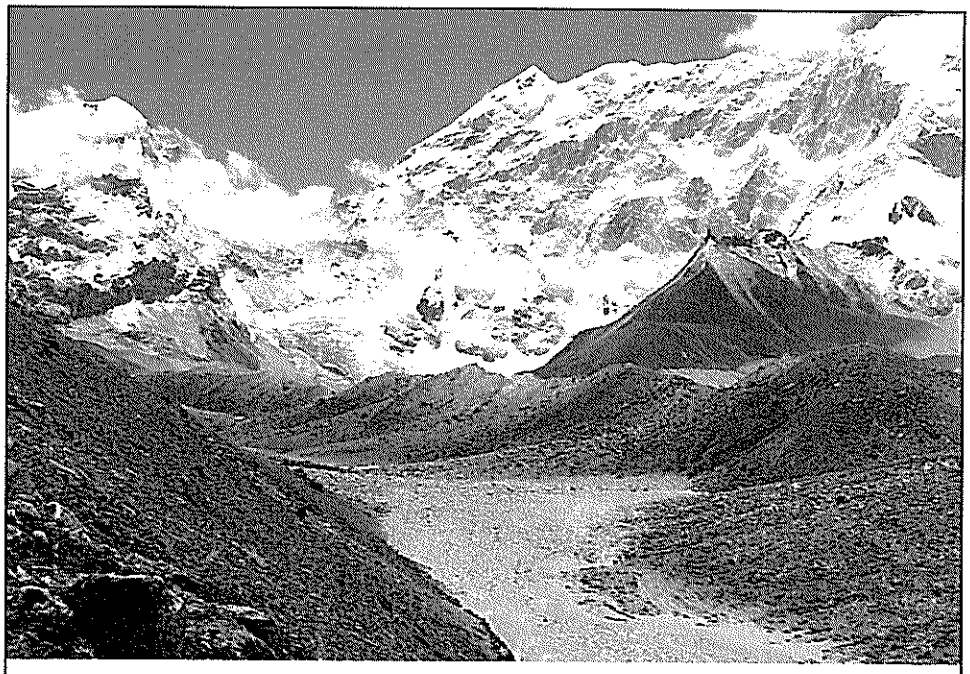
同上の氷河湖を囲むモレーン。 写真右側のイムジャ氷河のサイドモレーンとの間隔は約80m程度。



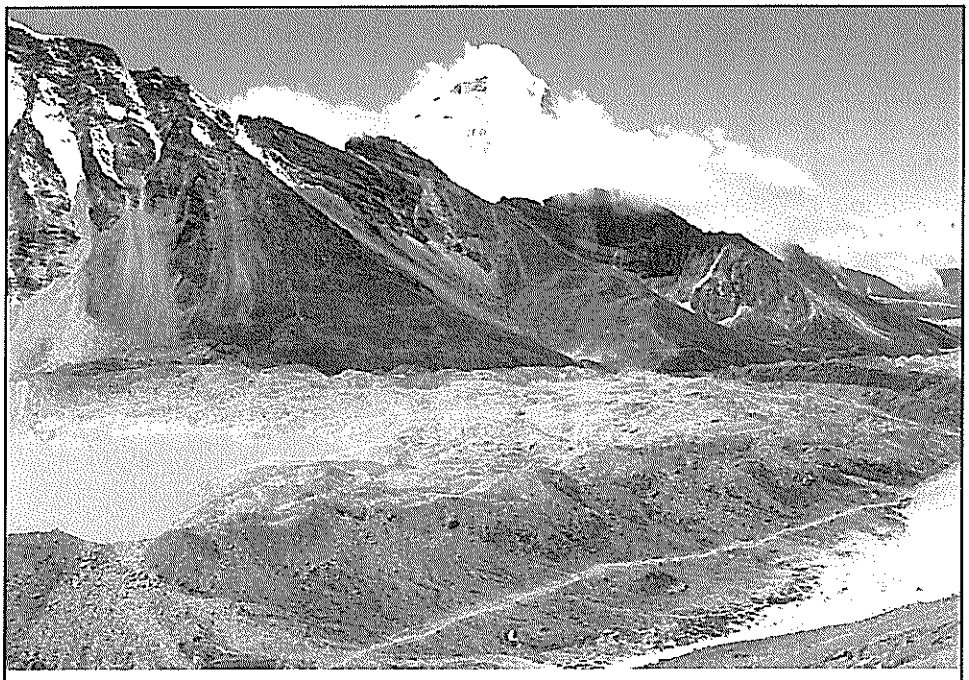
同上、イムジャ氷河のサイドモレーンとその南側の氷河湖の周りのモレーンとの間隔(矢印間は約80m)。



イムジャ氷河湖北側のアイランドピーク(標高約6200m)の南西斜面に懸垂氷河(矢印)が存在する。



上述の懸垂氷河から氷塊が落下しても、その直下は幅数十メートルのアブレーション・バレーであり、氷塊落下の直接の衝撃が氷河湖に及ぶ懸念は無い。

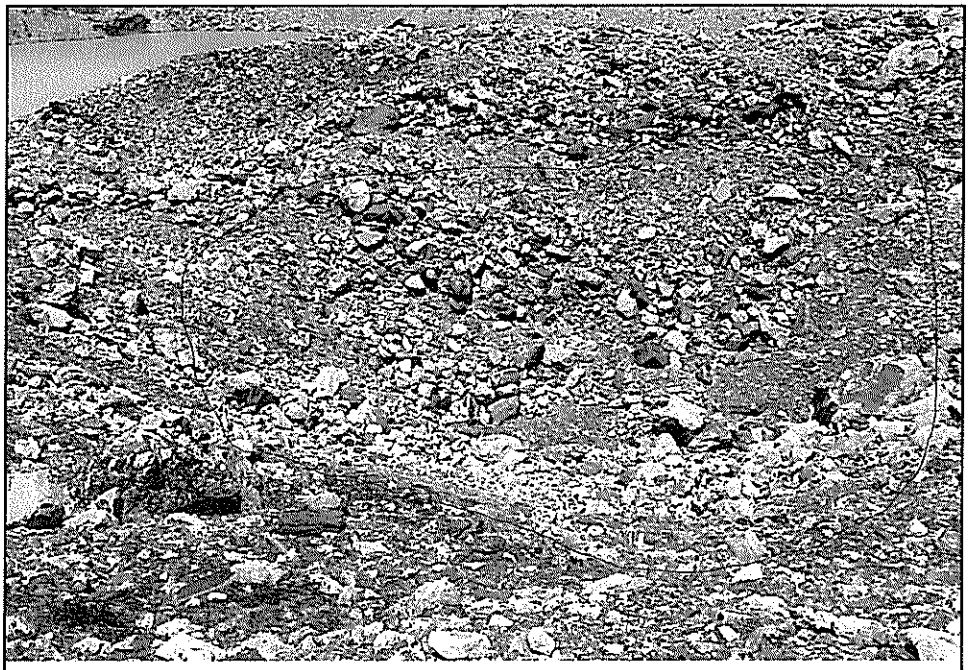


氷河湖の流出口付近のモレーンの各所に、沈下の痕跡が見られる。

流出口水路の向こう側の矢印部分、手前側の直線部分が階段状に水路側に向かって沈下。

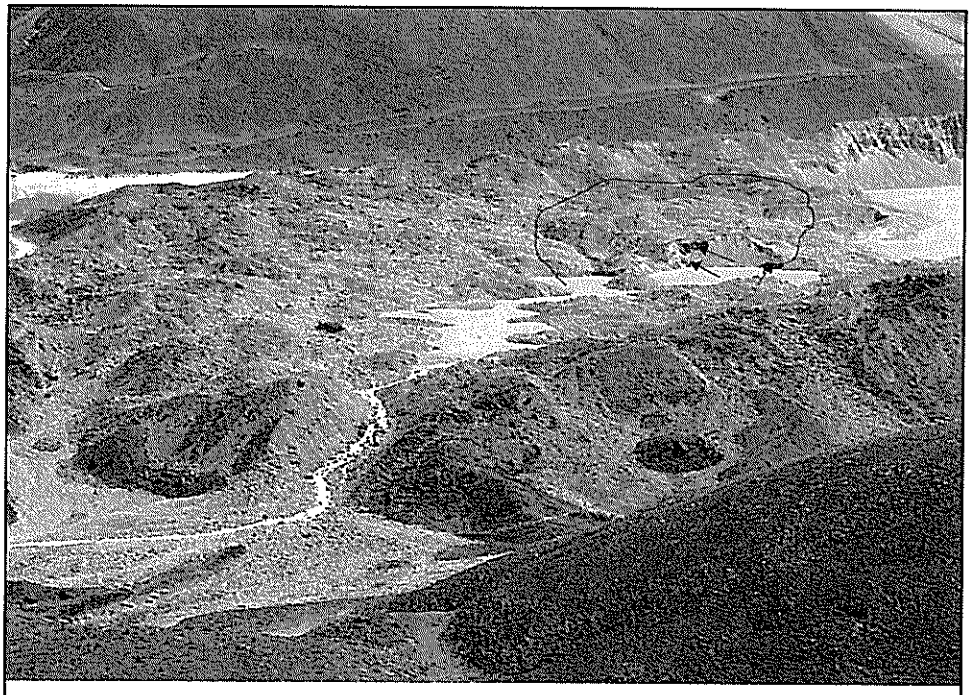
直線の右側部分が矢印方向に沈下。 斜面基部に沈下の動きによって発生した巨礫が集積している。

2つの直線の左右には、モレーンの層相が残っているが、2つの直線で囲まれた部分は、沈下の動きにより細粒部分が抜け落ちている。



石灰岩地帯に見られるシンクホール状の円形の窪地状地形。 深さ約20m、幅約50m。 かつて存在した池が干上がった跡ではないかと推定される。

流出口水路付近に見られる氷塊。

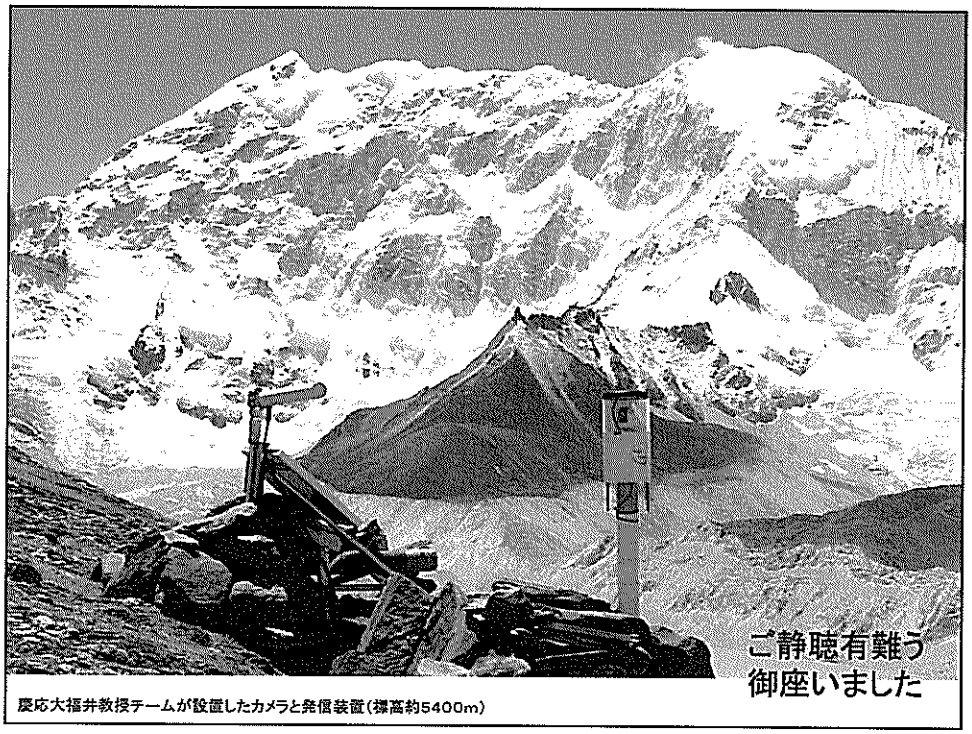


矢印部分に氷塊が確認された。 少なくとも線で囲んだ部分に氷塊の存在が推測される。

氷河湖流出口の入り口部分。 幅約10m。 湖の部分の深さは3，4m程度と推測される。

氷河湖の流出口の出口。 湖水は、ここから左側にカスケード状に落差約30mを流れ落ちる。

流出口部分の幅が約500mあり、これが一種の緩衝地帯となり、カタストロフィックな決壊の危険度を下げていると推測される。

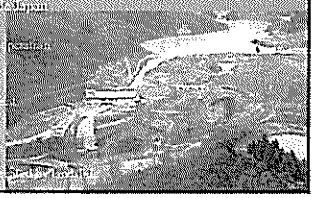


慶応大福井教授チームが設置したカメラと発信装置(標高約5400m)

Sector Survey on Climate Change and GLOF
–Initial Mission Findings–

Mitsuo ISHIWATARI
Senior Advisor
JICA
Kathmandu, Nepal, 4 June 2008

Who are we?
--Japanese Advantage--



Countermeasures
--proposed--

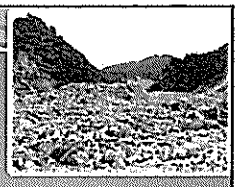
1. Data base
2. Hazard mapping
3. Early warning and evacuation
4. Civil work
5. Capacity development

challenge

No established technology
Require technology development and research works

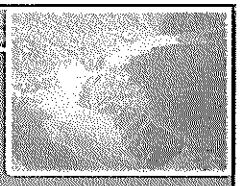
Countermeasures
--challenge-

1. Data base
   - Mechanism of GLOF, inducing factors
   - Glaciology, Meteorology, Hydrology, geology
2. Hazard mapping
   - Purpose, public awareness, evacuation, relation to evacuation
   - Target Area/domain
   - Base map
3. Early Warning and Evacuation
   - Observation, Warning level, Warning → evacuation
   - Installation of instruments
   - Communication
   - Public awareness
   - Maintenance

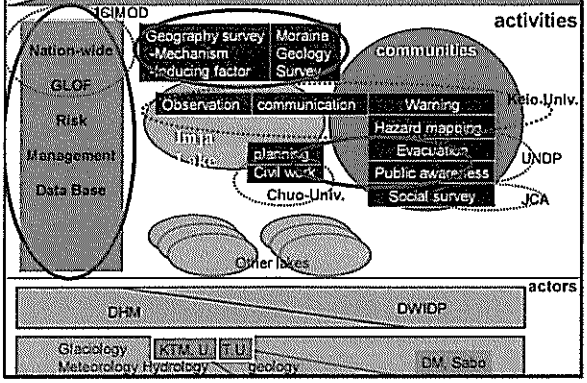


Countermeasures
--challenge-

4. Civil work
   - Cross, benefit
   - Reliable technology, Normalizing disasters
5. Capacity development
   - Research area
   - DM



Mapping of Activities & Actors



Recommendations
--Areas to be strengthened-

—To establish sustainable systems and capacities in monitoring, research, EWS of GLOF—

Areas
- Nation-wide GLOF Risk Management Data Base
- Technology development and research work
- Capacity development of Government institutions and universities
- Community based disaster management

As further steps
- Regional Cooperation

Base
--Inventory and Risk Analysis--

Lake	Area/ Volume	Expanding speed	Moraine form	Geography (influencing factor)	Potential Damage	Risk Evaluation Ranking
Imja	30mil.			2 gracious blocks	60 houses 2 bridges 1 micro-hydro	Medium
Tsho Rolpa	76mil.	None Works completed			60MW Hydro 16,000 people	High