Cryosphere Monitoring Programme in the Hindu Kush Himalayas and Cryosphere Knowledge Hub

Pradeep Mool
Programme Coordinator
Cryosphere Initiative
ICIMOD

World Meteorological Organisation (WMO)
Global Cryosphere Watch (GCW)
The First Asian CryoNet Workshop
Beijing, China
December 3-5, 2013

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International Centre for Integrated Mountain Development (ICIMOD)

Vision

Men, women, and children of the Hindu Kush Himalayas enjoy improved wellbeing in a healthy mountain environment

Mission

To enable sustainable and resilient mountain development for improved and equitable livelihoods through knowledge and regional cooperation

Regional Programmes

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Piloting, testing and monitoring innovative approaches

1) Adaptation to Change
2) Transboundary Landscapes
3) River Basins
4) Cryosphere and Atmosphere
5) Mountain Environment Regional Information System
6) Himalayan University Consortium

Thematic Areas

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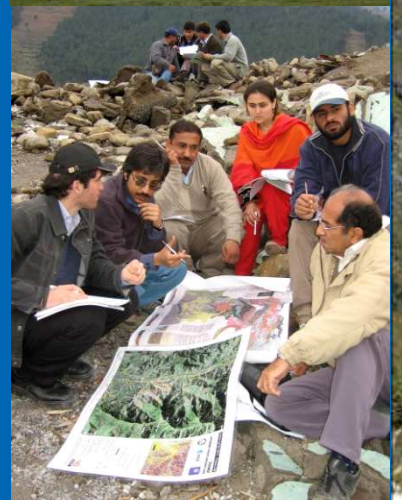
Core competency areas developed in response to the needs of the region

1) Livelihoods
2) Ecosystem Services
3) Water and Air
4) Geospatial Solution



Linking Science-Policy-Practice

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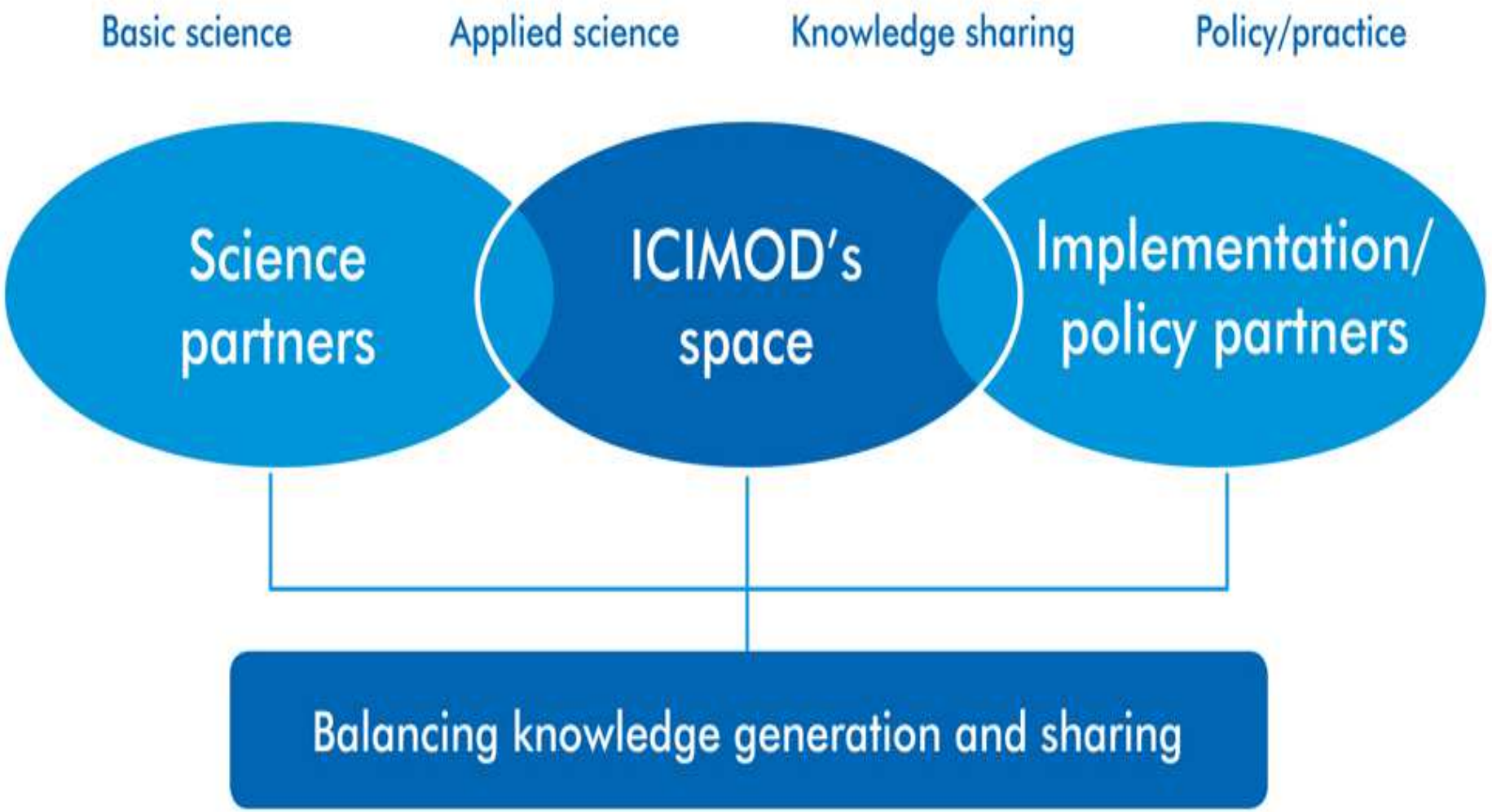

The Hindu Kush Himalaya Region and Tibetan Plateau

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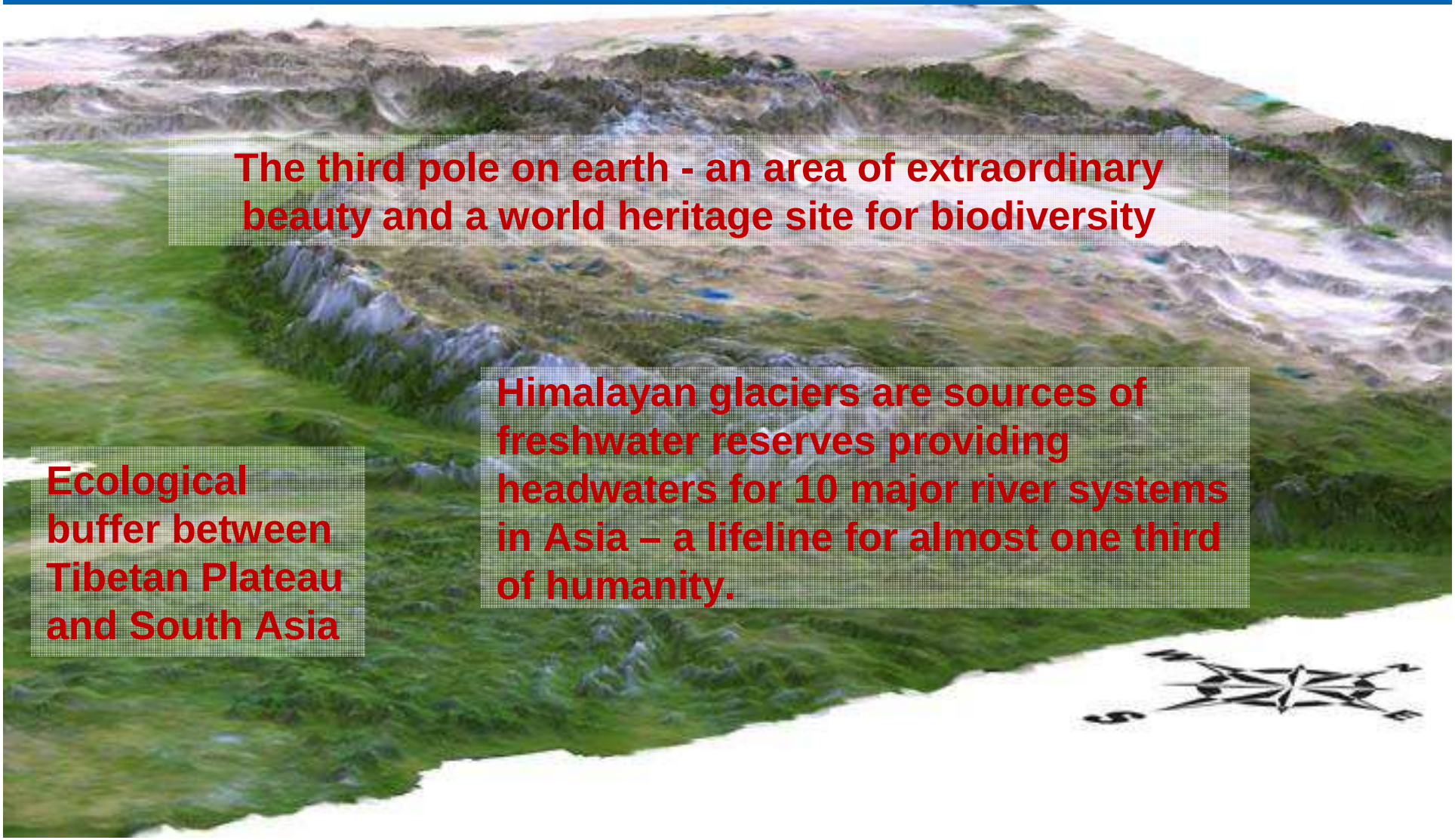

Changing Glacier Environment

“ISRO:75% of Himalayan glaciers retreating” (ToI, 16 May 2011)

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Fast retreating Gangapurna glacier at the northern slope of Annapurna Range, Manang Lake and Manang Village, Nepal

Impact of Climate Change - Imja Glacier, Nepal

(Repeat Photography)

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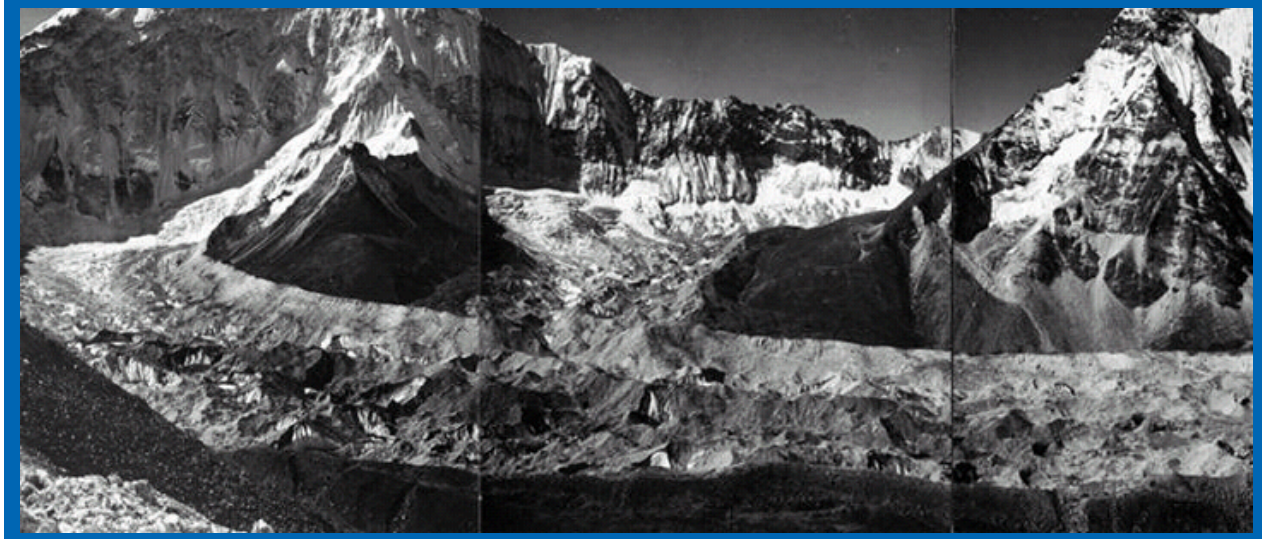

1956 photograph of Imja glacier (Photo: Fritz Muller; courtesy of Jack Ives)

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

Kyetrak glacier
2009
Photography: David Breashears, GlacierWorks

Rikha Samba Glacier
in Hidden Valley, Lower Mustang, Nepal

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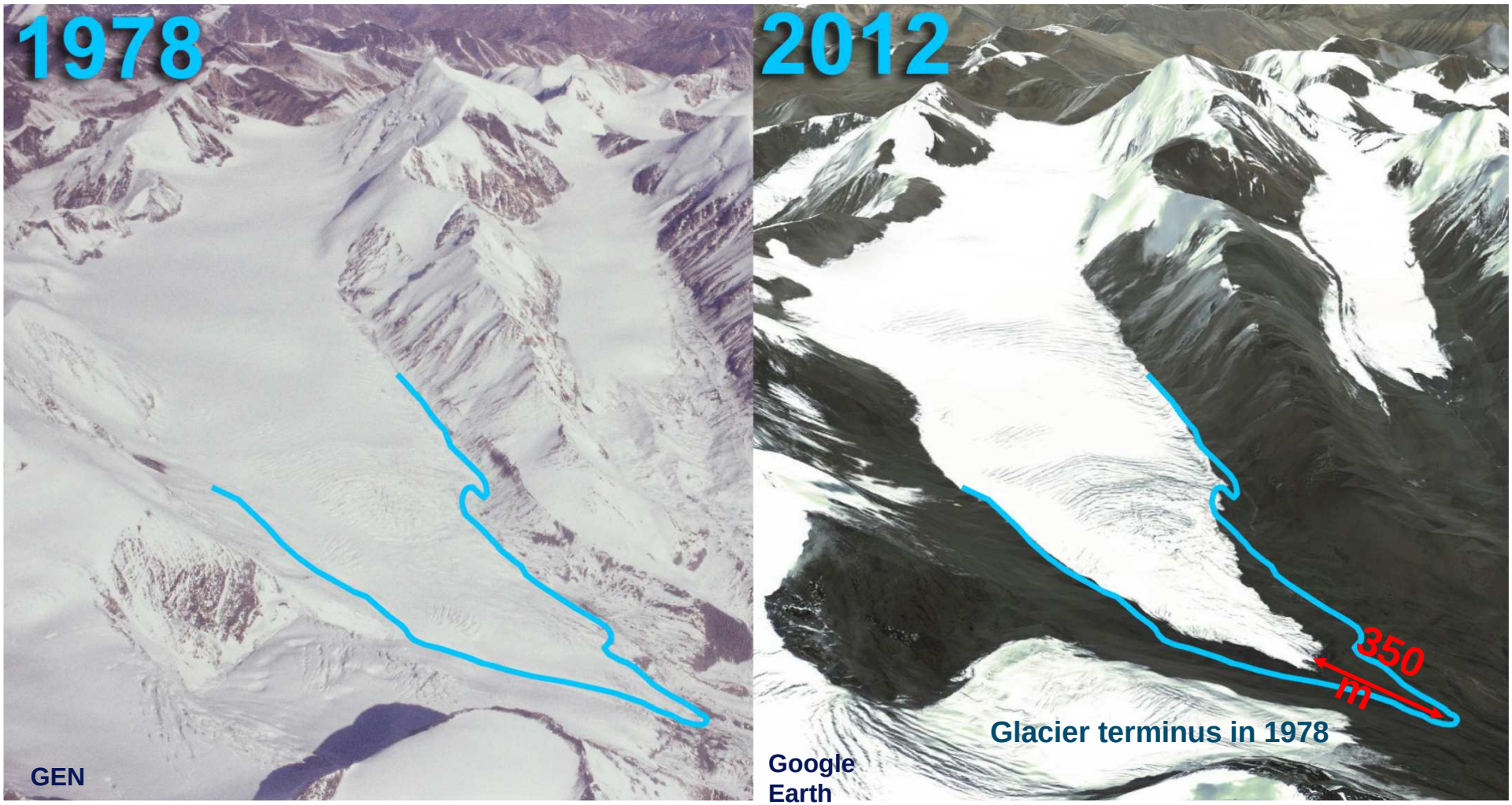

Approximate annual retreat rate in 34 years is about 10 m/y

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Change observed within one year of monitoring in the Rikha Samba Glacier

Glacier mass balance

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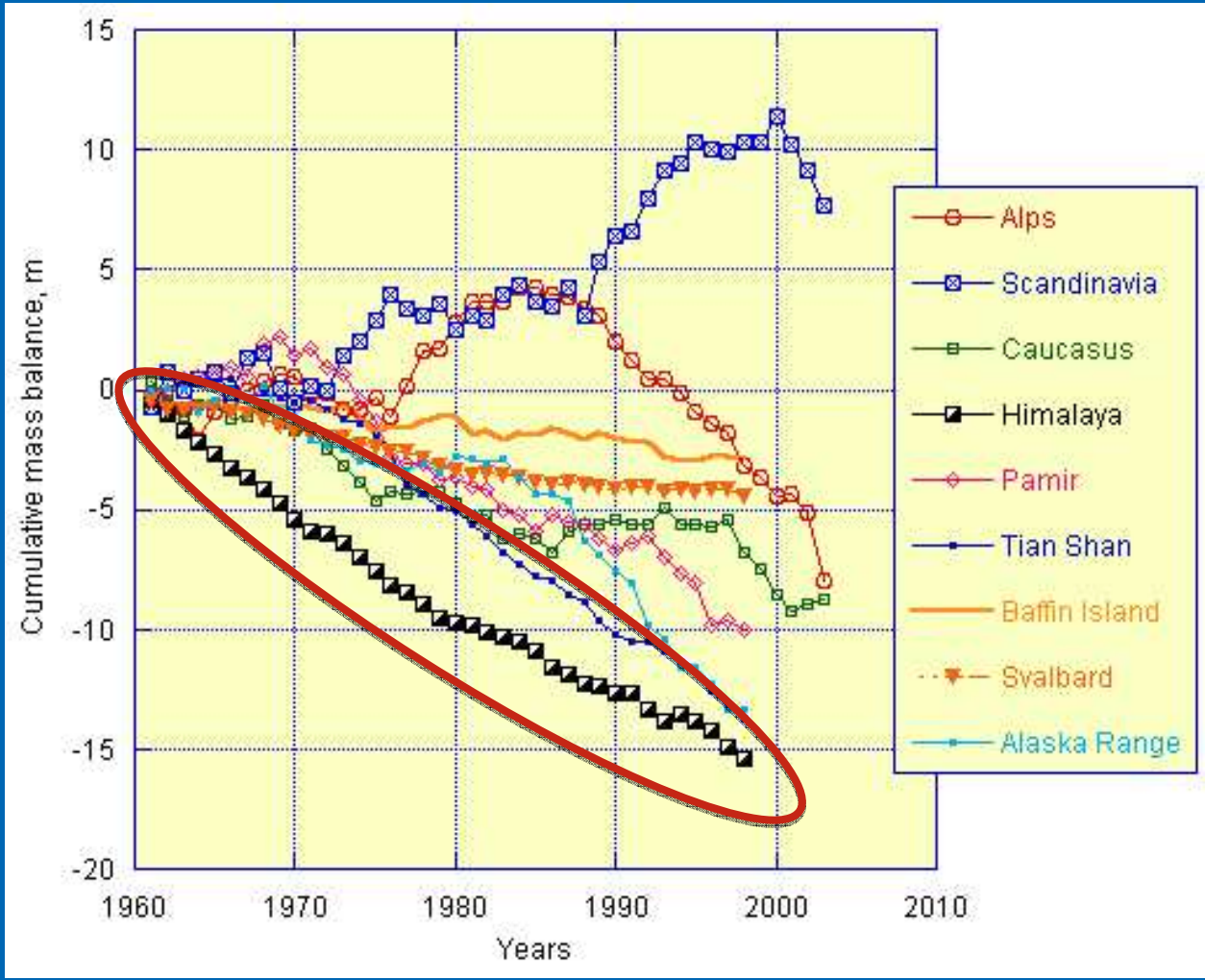
Himalayan glaciers are shrinking more rapidly than elsewhere



Dyurgerov and Meier, 2005

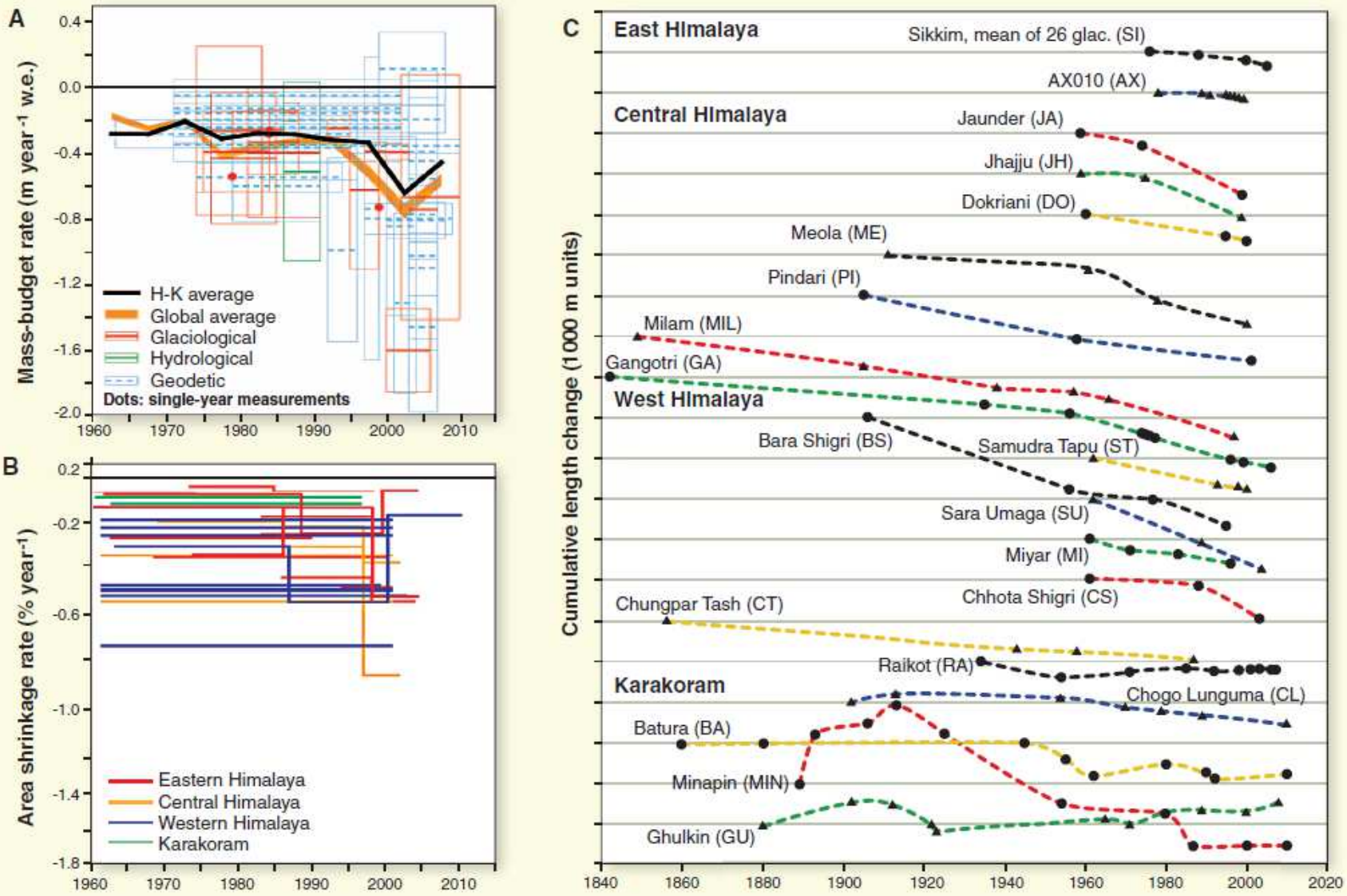


Fig. 3. Measured rates of change in mass budget (A) and area (B) and of a sample of cumulative length change measurements (C). For locations, see Fig. 1; for sources, see tables S3, S5, and S6. (**A**) Glaciological measurements are those made annually in situ; geodetic measurements, mostly multiannual, compare a later surface elevation (mostly derived from photogrammetric surveys) to an earlier one. Each budget is drawn as a thick horizontal line contained in a ±1 standard deviation box (±1 standard error for geodetic measurements). (**B**) Area shrinkage in recent decades. No statistically significant difference between the regions can be discerned. Uncertainties appear to be high but are as yet poorly assessed. (**C**) The glacier retreat since the mid-19th century is obvious in the Himalaya, with the exception of the glaciers at Nanga Parbat in the northwest (RA, CL). Glaciers in the Karakoram show complex behavior.

Himalayan glaciers are shrinking according to many studies

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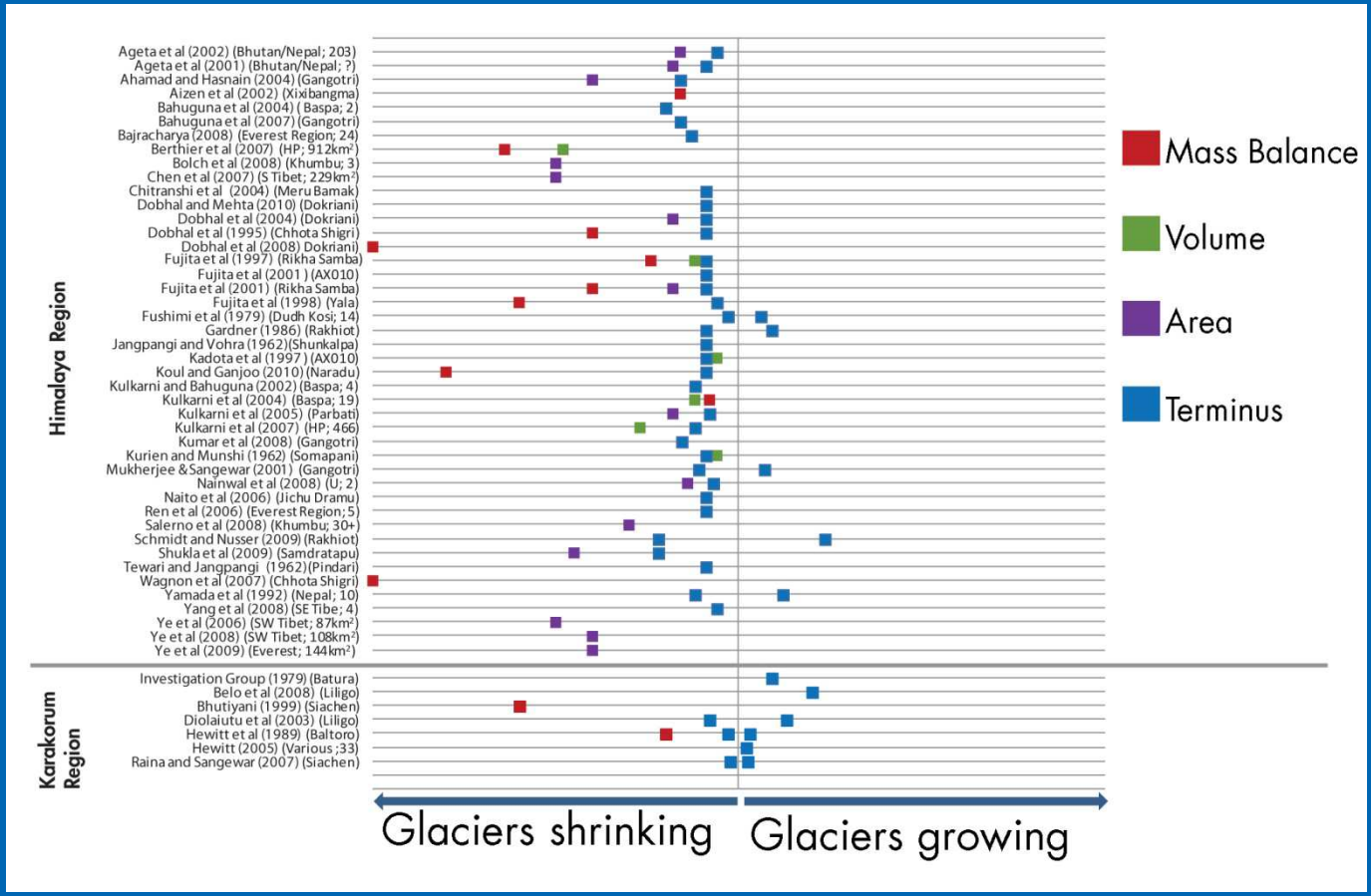

Note: Brackets include name of glacier or region with associated number/area (km2) of glaciers studied if more than one single glacier; U=Uttarakhand, HP=Himachal Pradesh

Source: Miller et al. (2011)

Both branches of the Urumqi No.1 Glacier which split into east and west branches into two independent glaciers in the year 1993 (view from north towards south)

Decadal glacier change in Nepal

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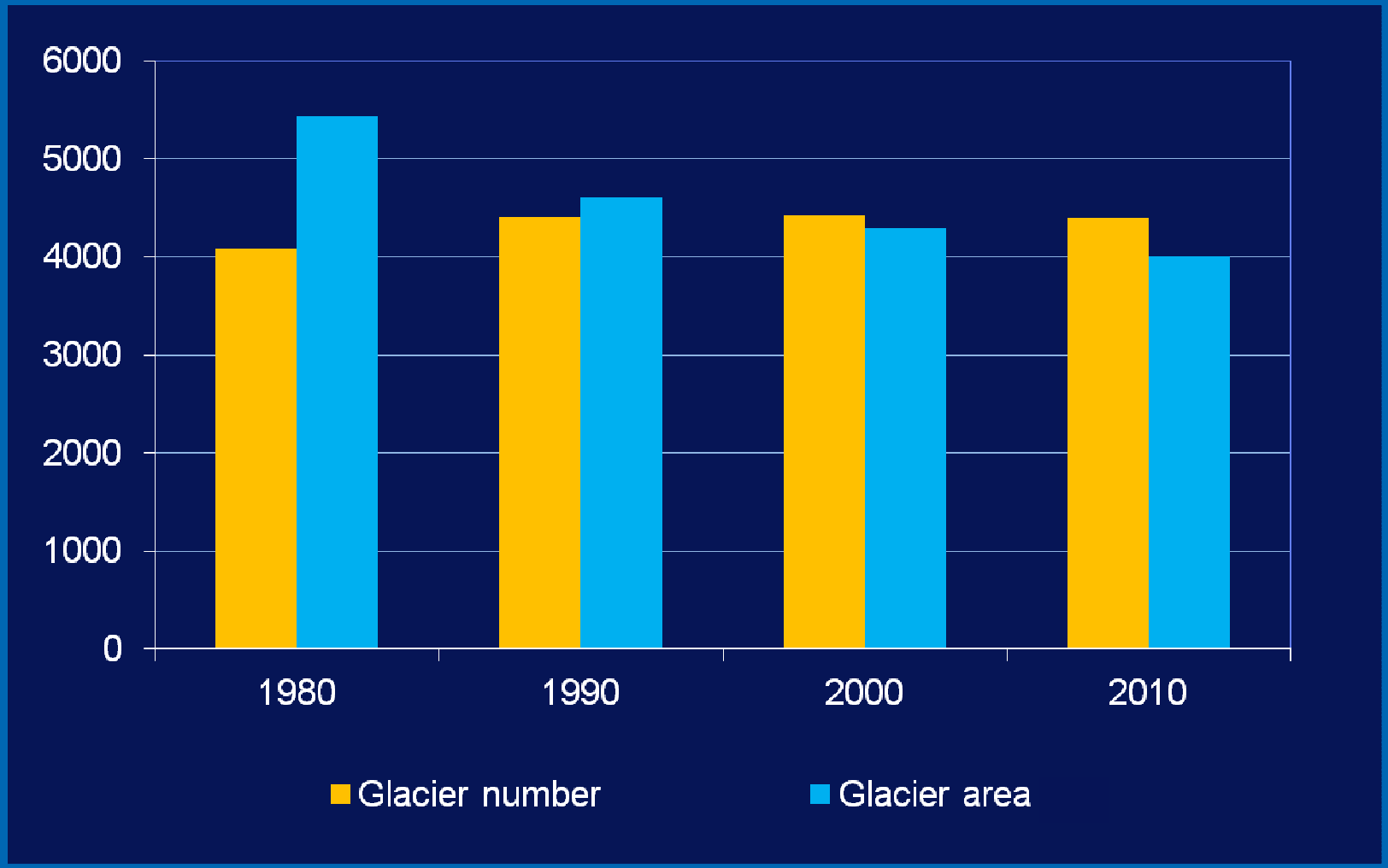

Decadal glacier area change in Nepal from 1980 to 2010

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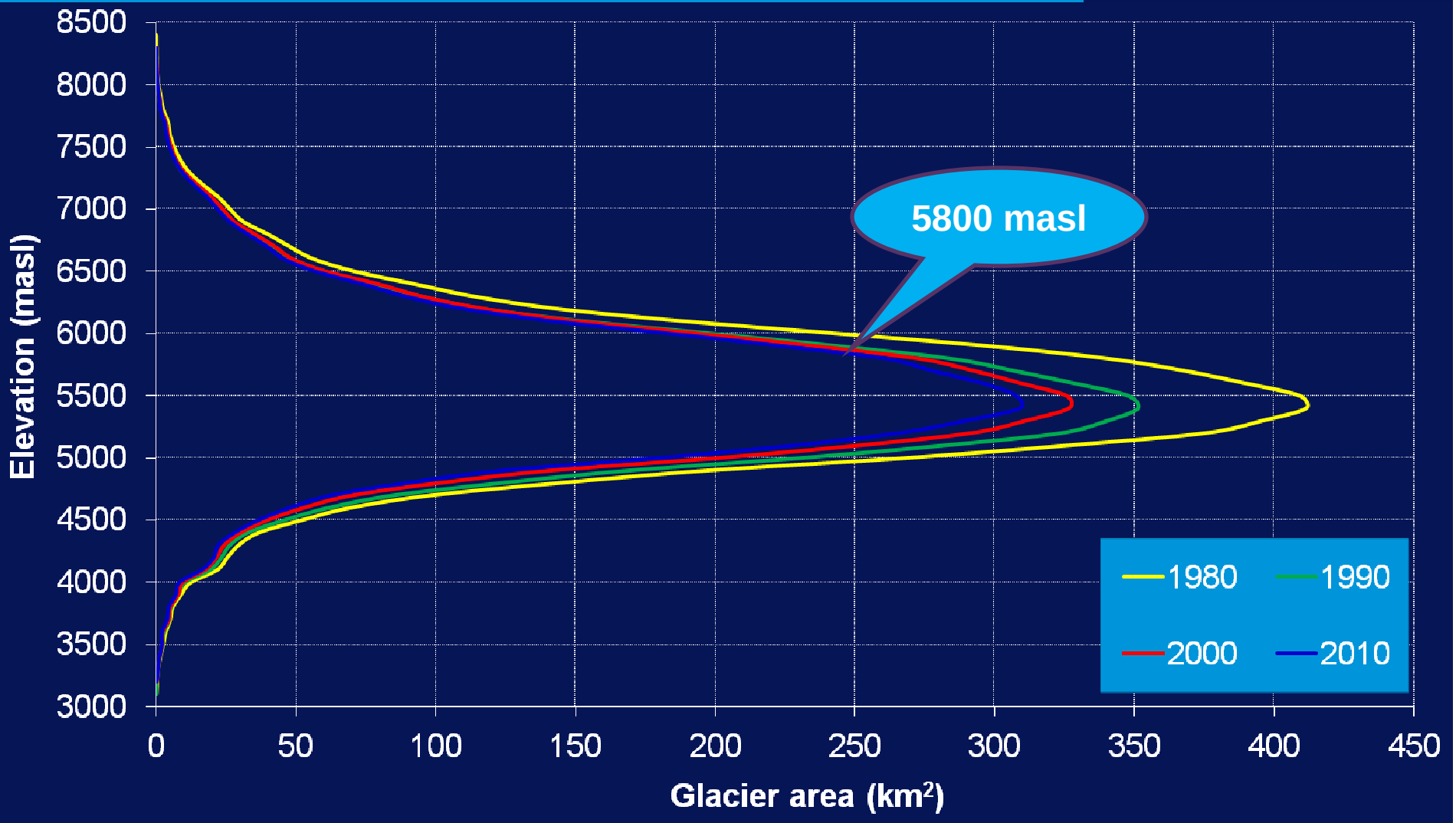

Lack of information, little preparation

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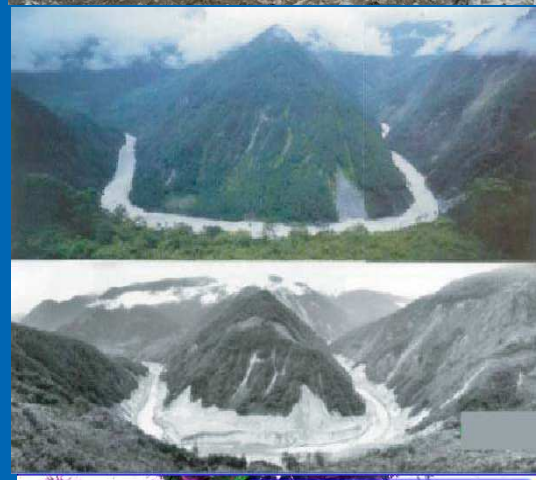
- 9 April 2000: Landslide blocked the Yigong River, a tributary of the Yarlungzangbo (Brahmaputra) River
- Outburst on 10 June 2000 created a huge flash flood of up to 1.26×10^5 m^3/s with 3,000million m^3 volume of water released. Flood height of 50m at 17 km downstream of dam in China and 15 m in Arunachal Pradesh, India
- Extensive damage, but no casualties in China
- In India, heavy causalities
  - 30 dead
  - >100 missing
  - >50,000 homeless
  - damage of USD 22.9 million



India, China sign MoU to strengthen transborder rivers cooperation

(India Water Review : October 24, 2013)

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- India and China signed a Memorandum of Understanding (MoU) on 23 October 2013 on exchanging hydrological data on trans-border rivers during the official visit of Indian Prime Minister Manmohan Singh to China
- Agreed to share flood data beginning 2014 during the monsoon from 15 May to 15 October (5 months) every year on the Yarlunzambo river (Brahmaputra)

Seti Flash Flood of 5 May 2012 in Nepal
At least 26 people have been killed and 44 are missing
20th May NASA image from ALI instrument

Seti Flash Flood of 5 May 2012 in Nepal

At least 26 people have been killed and 44 are missing

Glacial Lake formation

As glaciers retreat, glacial lakes may form and expand
Many are observed at elevations of around 4000m.

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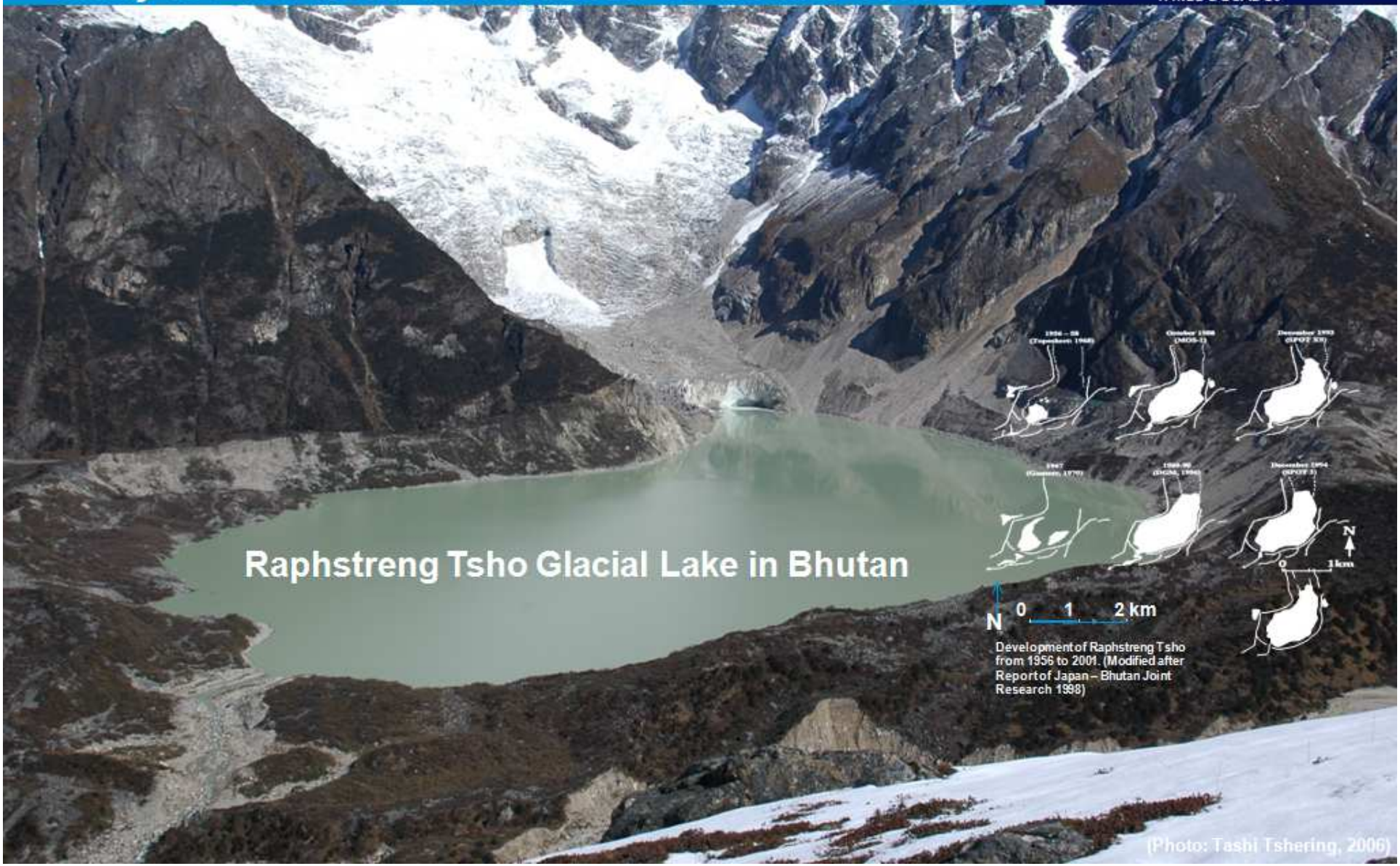
30
THREE DECADES



Development of Raphstreng Tsho from 1956 to 2001. (Modified after Report of Japan – Bhutan Joint Research 1998)

Melting of Glaciers in Himalaya and formation of glacial lakes
(Trans-boundary issue)

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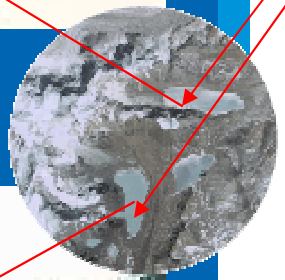
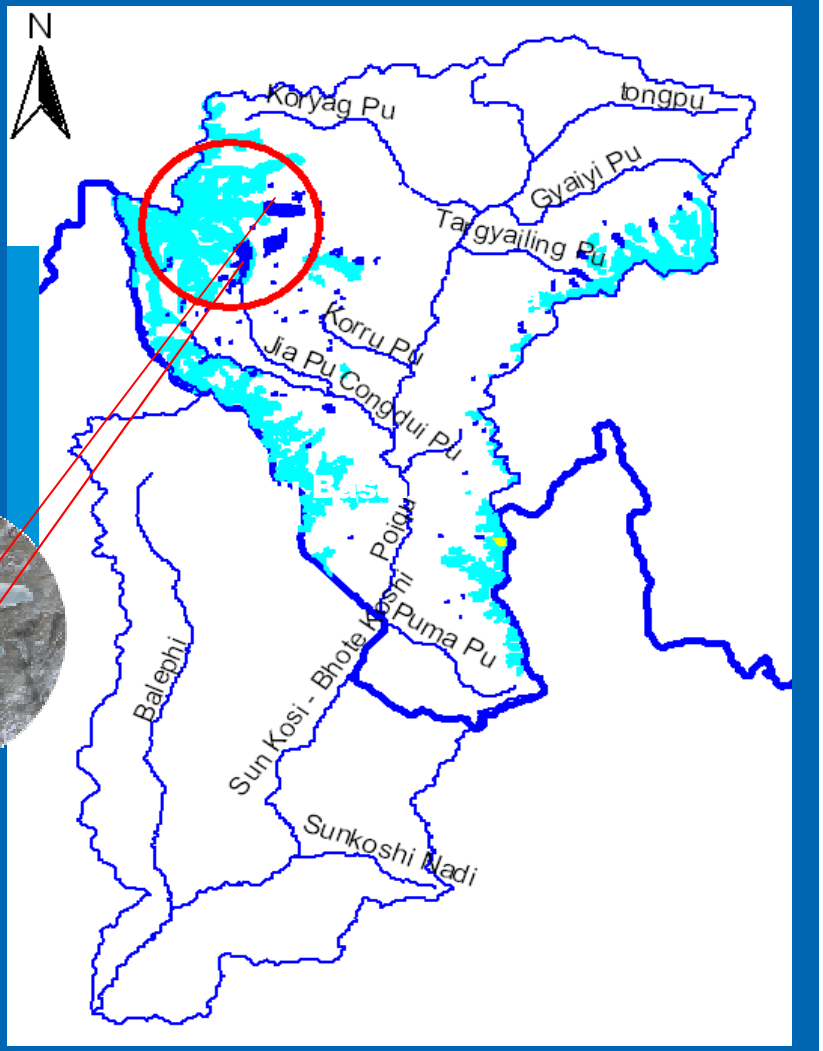
Gangxi Co lake at the tongue of Glacier 50191C0009 in 1987



Lumu Chimi lake at the tongue of Glacier 50191B0029 in 1987



Past GLOF events

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The Programme design

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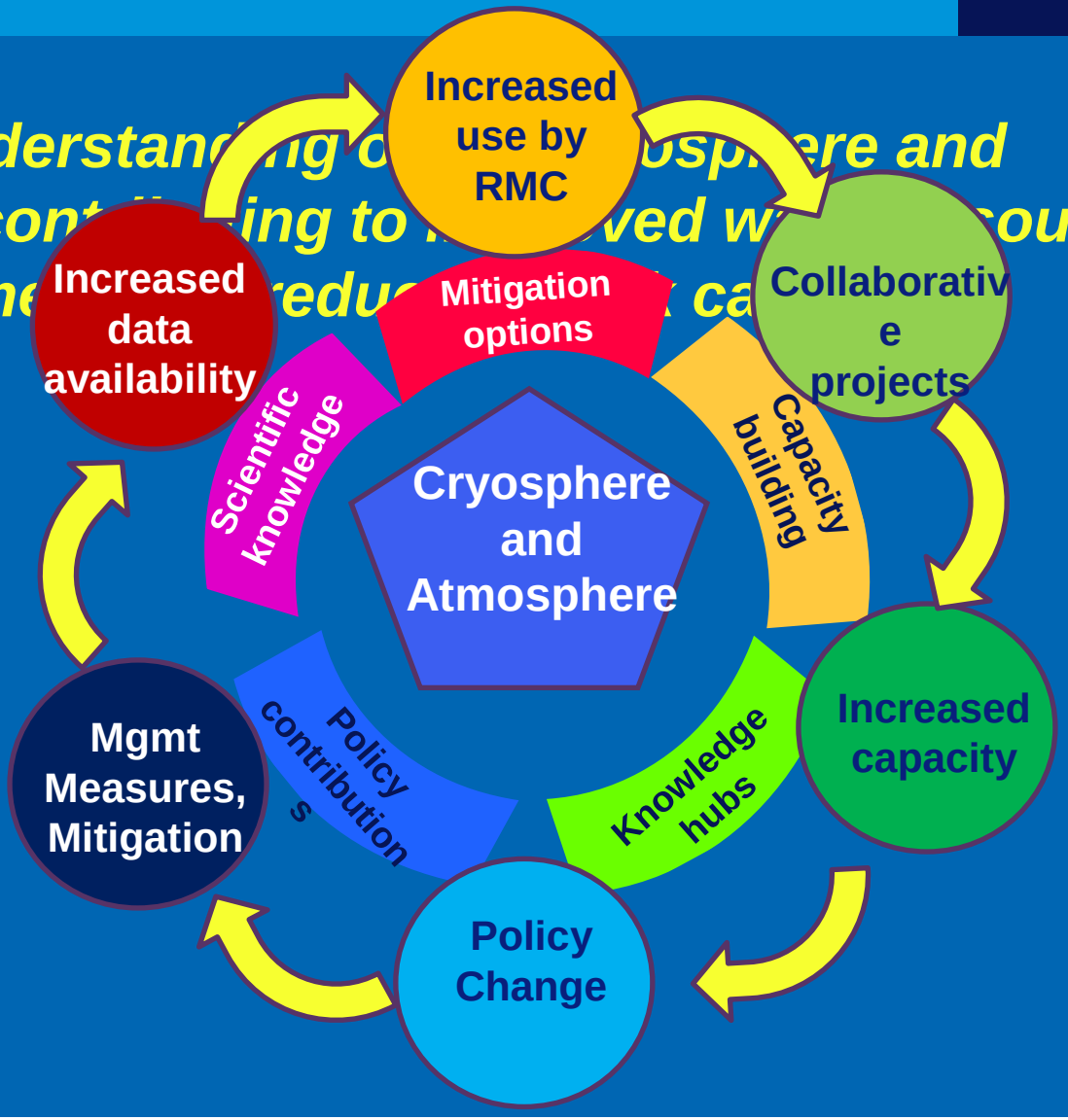
Increased understanding o… osphere and atmosphere cont… ing to … ved w… ource and risk manageme… redu… ca…



HKH Cryosphere Monitoring

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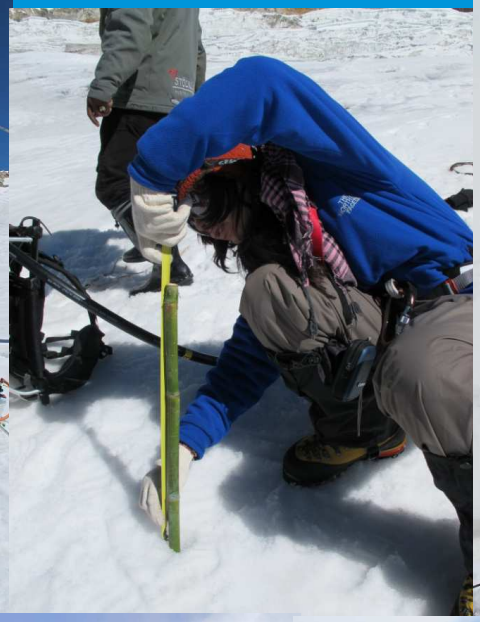

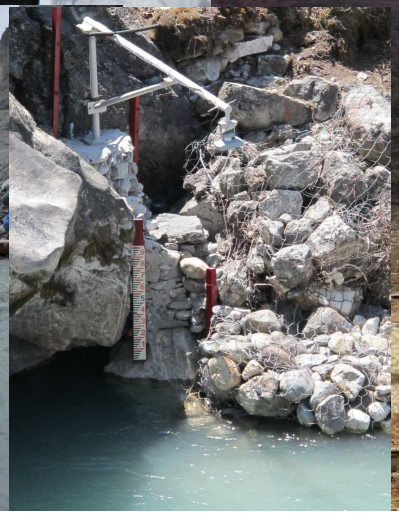

Monitoring and assessment of changes in Glaciers, Snow and Glacio-hydrology in the Hindu Kush Himalayas with a special focus on strengthening the capacity of Nepalese organizations (The HKH Cryosphere Monitoring Project) (2010-2015)

Implemented by

International Centre for Integrated Mountain Development (ICIMOD)

Supported by

Norwegian Ministry of Foreign Affairs

Partners:

Water and Energy Commission Secretariat, Govt. of Nepal (WECS/GoN)
Department of Hydrology and Meteorology, Govt. of Nepal (DHM/GoN)
Tribhuvan University, Kathmandu (TU)
Kathmandu University, Kathmandu (KU)

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NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

WECS DHM TU KU

The three pillars of the cryosphere monitoring are in-situ measurements, modelling and remote sensing, which are methods that complement each other for calibration and validation.

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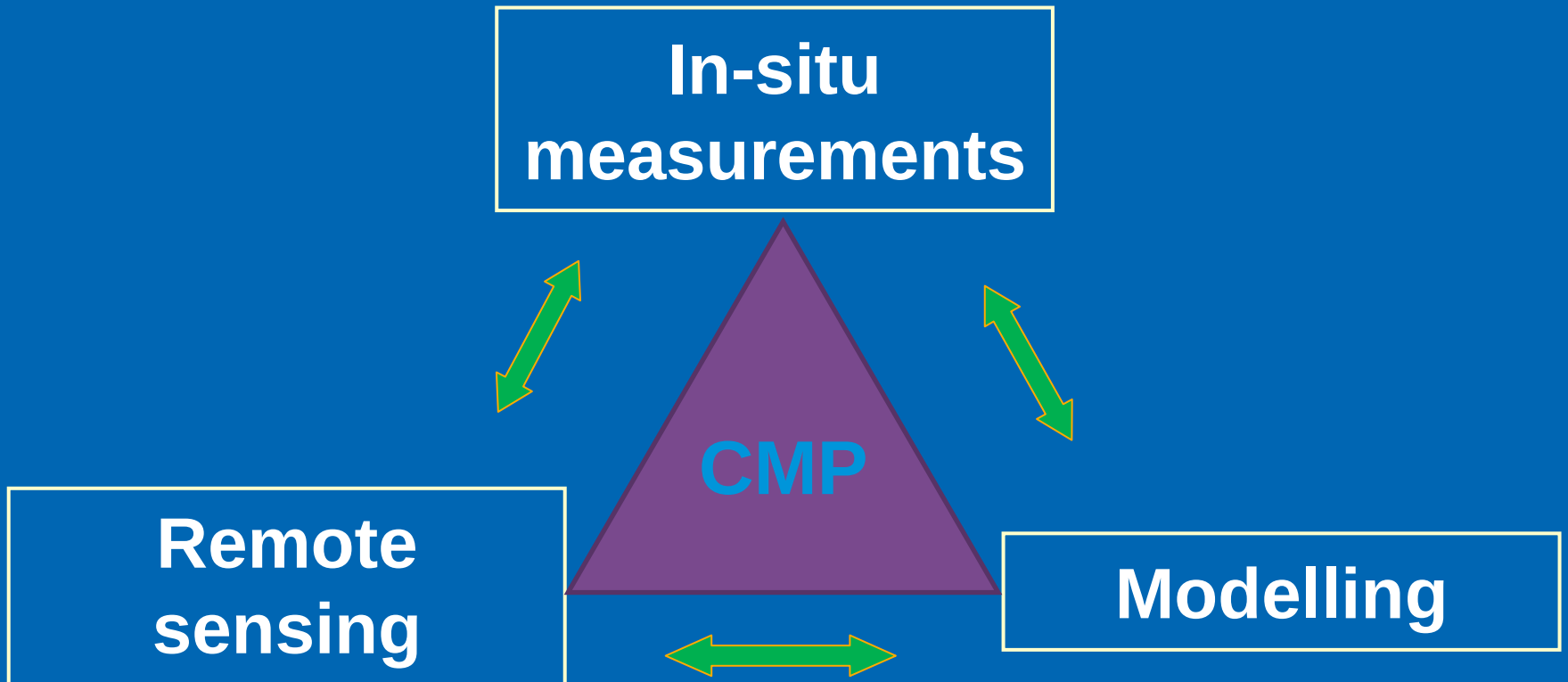

Cryosphere Monitoring Programme

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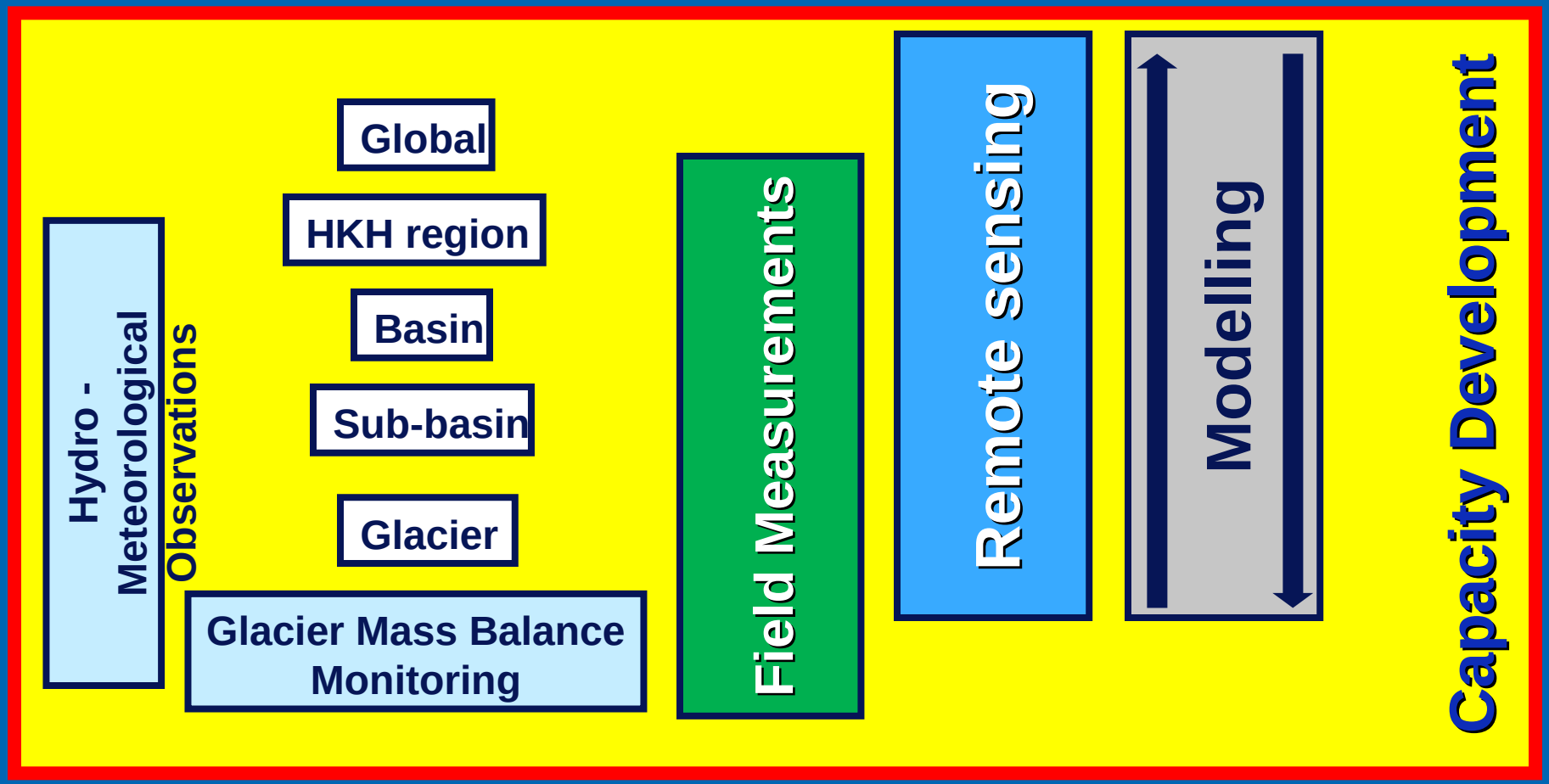

Regional Cryosphere Knowledge Hub

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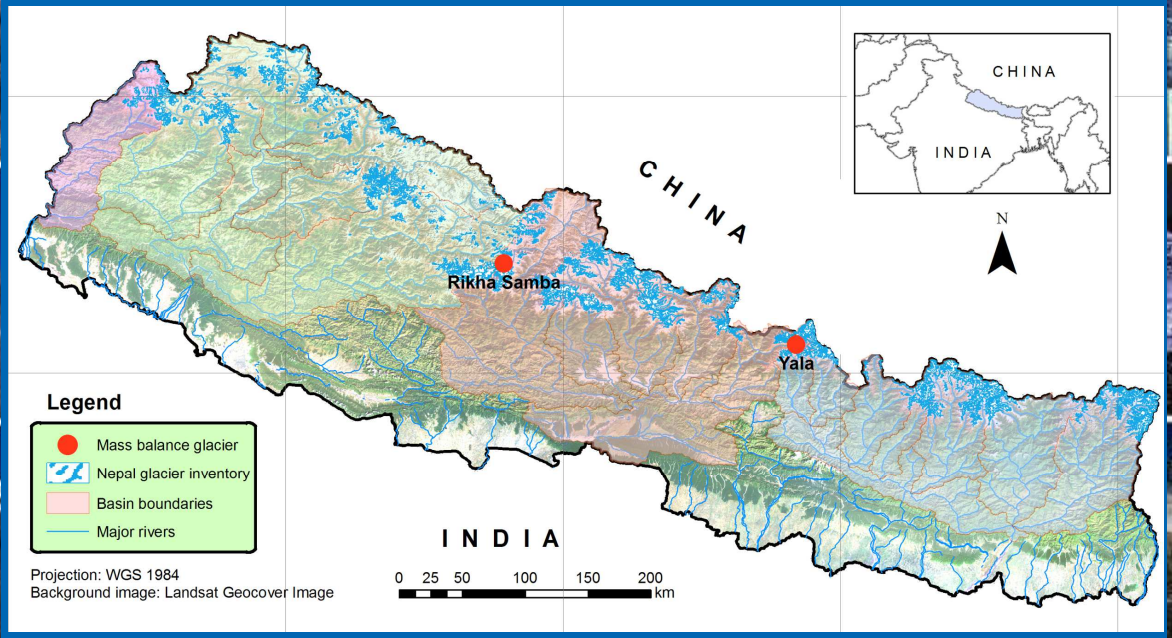
Selected glacier catchments for monitoring



Glacier name	Coordinates	Elevation (m asl)	Area
Yala, Langtang Valley	28°15’ N / 85°37’ E	5174 – 5746 m	2.8 km^2
Rikha Samba, Hidden Valley,	28°50’ N / 83°30’ E	5250 – 5985 m	4.8 km^2

Photo Source: Y. Fuji (1974) and K. Fujita (1994, 1998, 2010).

Photo Source: S. Kohshima (1982) and K. Fujita (1996, 2008, 2009)

Field based glacier mass balance measurements

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Glacio-hydrological modelling and water resources scenario analysis

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Upgrading of existing facilities

Upgrading of the Kyangjing Hydrological and Meteorological Station in Langtang Valley, Nepal

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Remote sensing based snow and glaciers monitoring

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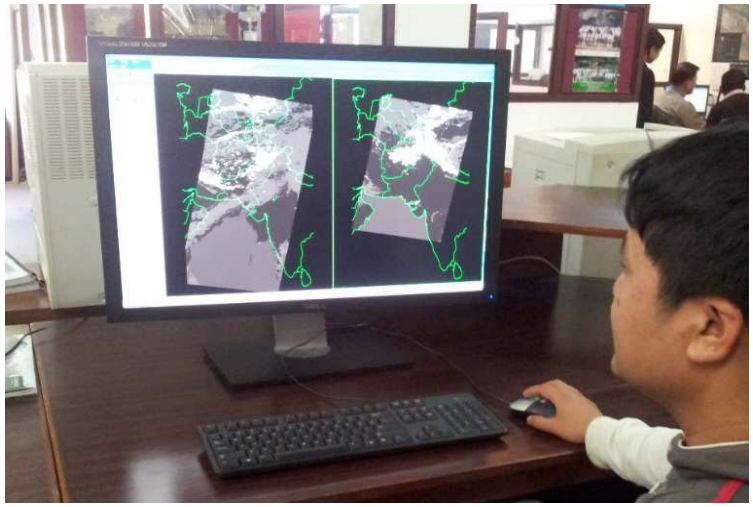
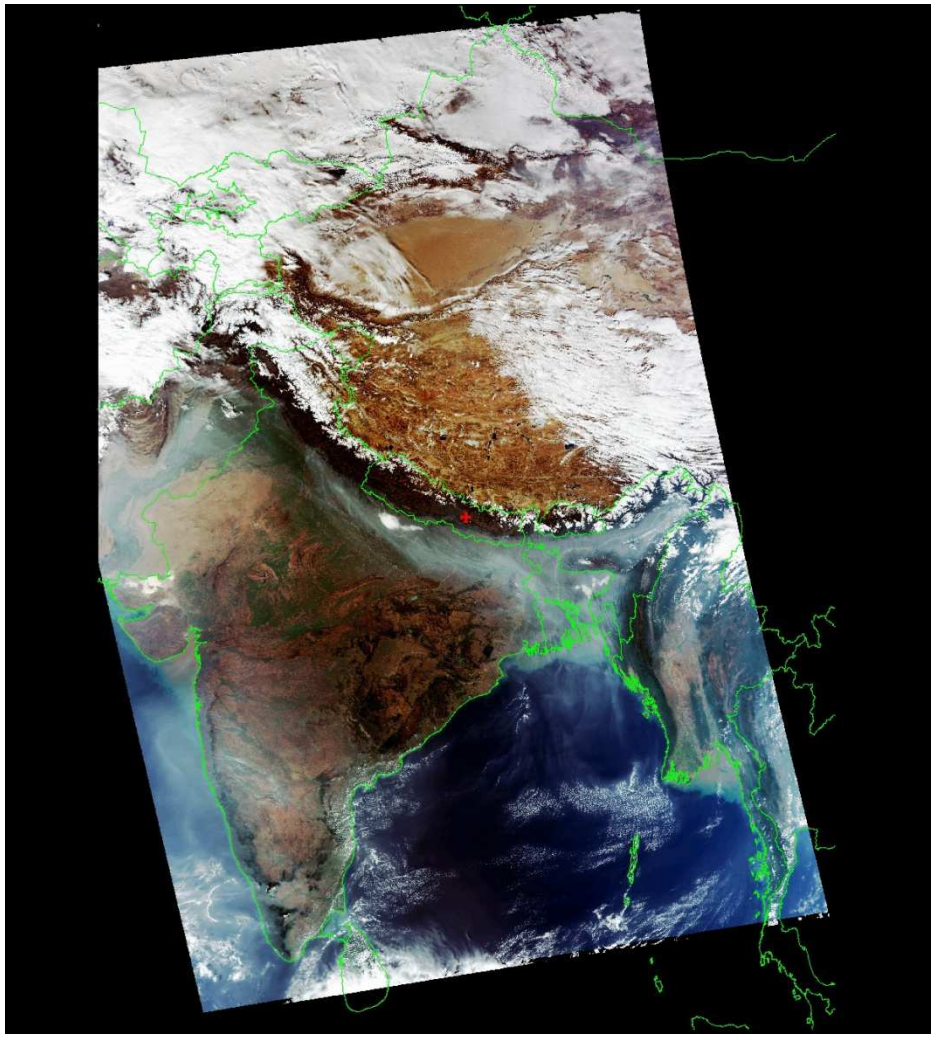
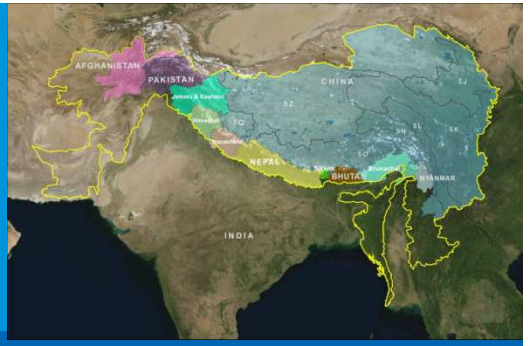
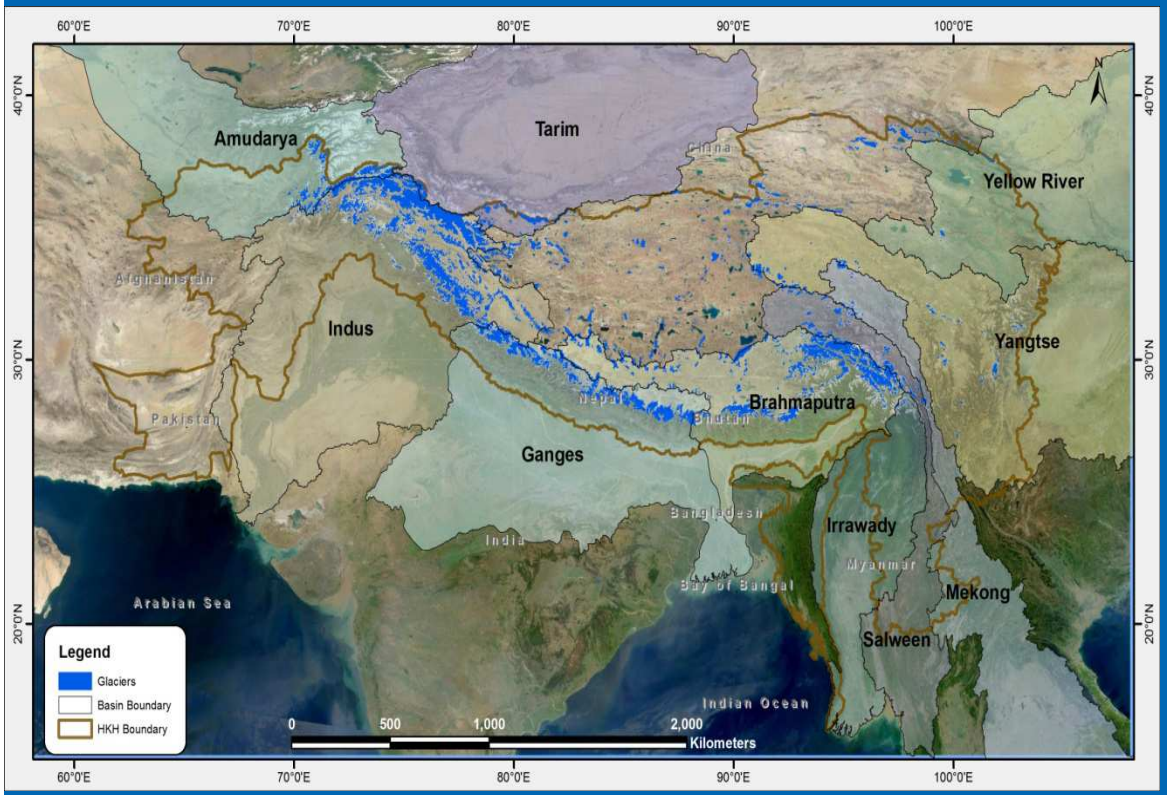




Glaciers in the HKH region



Glacier Area in HKH: about 60,000Km²



Basins	Number	Area (km²)
Amu Darya	3,277	2,566.18
Indus	18,495	21,192.67
Ganga	7,963	9,011.53
Brahmaputra	11,497	14,019.84
Irrawaddy	133	35.46
Salween	2,113	1,351.76
Mekong	482	234.61
Yangtze	1,661	1,659.85
Yellow	189	137.43
Tarim	1,091	2,310.26
Interior	7,351	7,534.64
Total	54,252	60,054.23

Bajracharya et al. (2011)

Snow cover in the HKH region

HKH had 18.2% (0.76 million sq. km.) of snow cover area (2000-2010)

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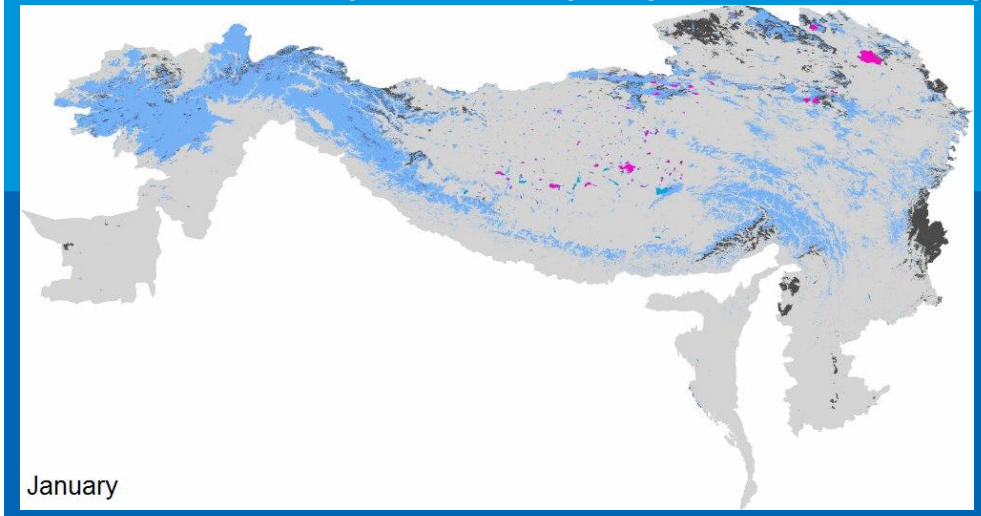
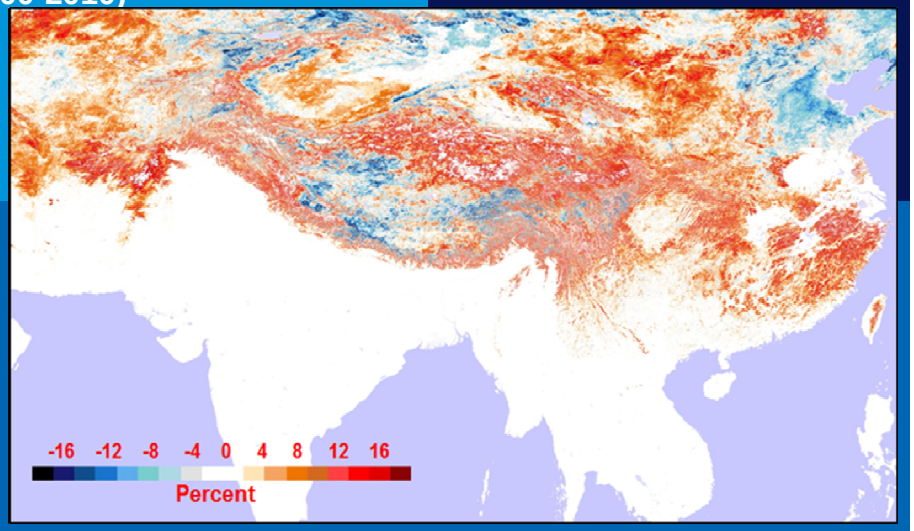
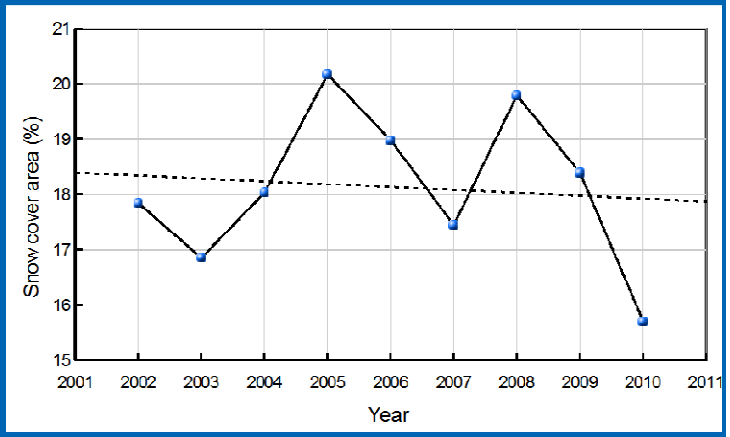


Temporal variation of snow cover area of HKH



Snow cover variation over last decade (2002-2010) across the Himalayas.

Basin	Total land area (sq.km)	Average snow cover area	
		(sq.km)	(%)
Amu Darya	645,895	9,918	1.6
Brahmaputra	528,082	107,121	20.4
Ganges	1,001,087	47,742	4.8
Indus	1,116,347	167,992	16.7
Irrawaddy	426,393	9,511	2.4
Mekong	841,337	23,534	3.0
Salween	363,898	38,571	10.7
Tarim	929,254	167,061	15.9
Yangtze	2,066,050	193,304	9.4
Yellow River	1,073,443	95,193	9.4



(ICIMOD 2011)

Inter-annual variation in snow cover area for the ten major river basins (2002 – 2010)

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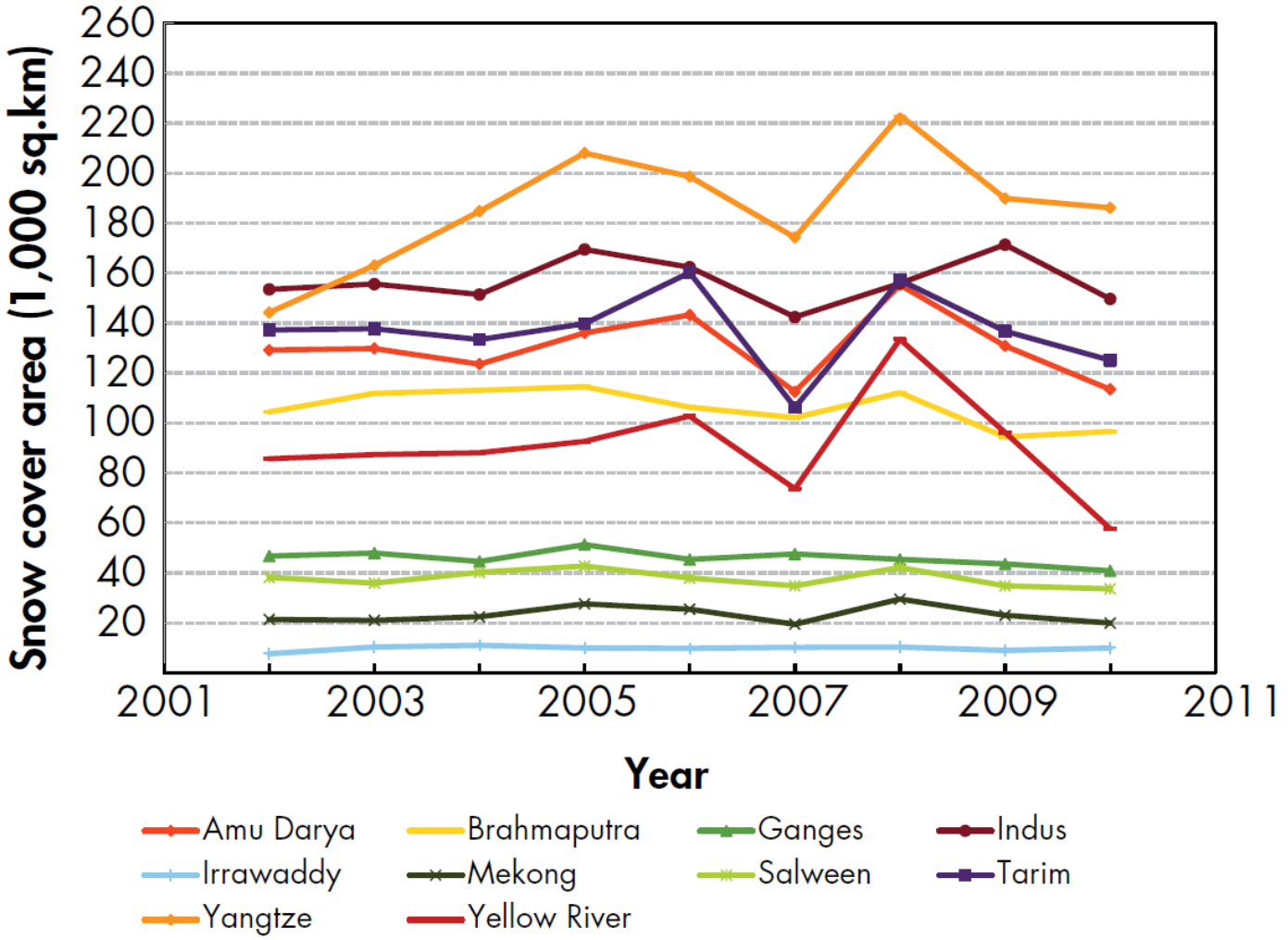

ICIMOD 2011

Capacity building

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MS Glaciology programme at Kathmandu University

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2011 -2013 batch: Four students (1 female and 3 male) completed the M. S. by Research in Glaciology

2012 -2014 batch: Four students (4 male) continuing the M. S. by Research in Glaciology

2013 – 2015: Four students (2 female and 2 male) started the M. S. by Research in Glaciology

Supported by CHARIS Project:
2012 – 2014: 2 students from Afghanistan (Kabul University faculty members)
2013-2015:1 from Nepal

Study tour to glaciers monitored by Norwegian Water Resources and Energy Directorate (NVE) in Norway (10 – 23 August 2013)

- Participation from PMD Pakistan and WIHG India
- Participant from CAREERI China could not attend
- Participation from WECS, DHM, TU, KU and ICIMOD

Svartisen glacier, Norway
19 August 2013

Regional Cryosphere Knowledge Hub

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International Conference on the Cryosphere of the Hindu Kush Himalayas: State of the Knowledge

and

Workshop on Hindu Kush Himalayan Cryosphere Data Sharing Policy

14–18 May 2012, Kathmandu, Nepal

Development of Regional Cryosphere Knowledge Hub

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Way forward

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In **future**, the programme initiated for the cryosphere monitoring and capacity development to the partner institutions, need to expand to other parts of the HKH region and link with other regional and international programmes.

Thank you

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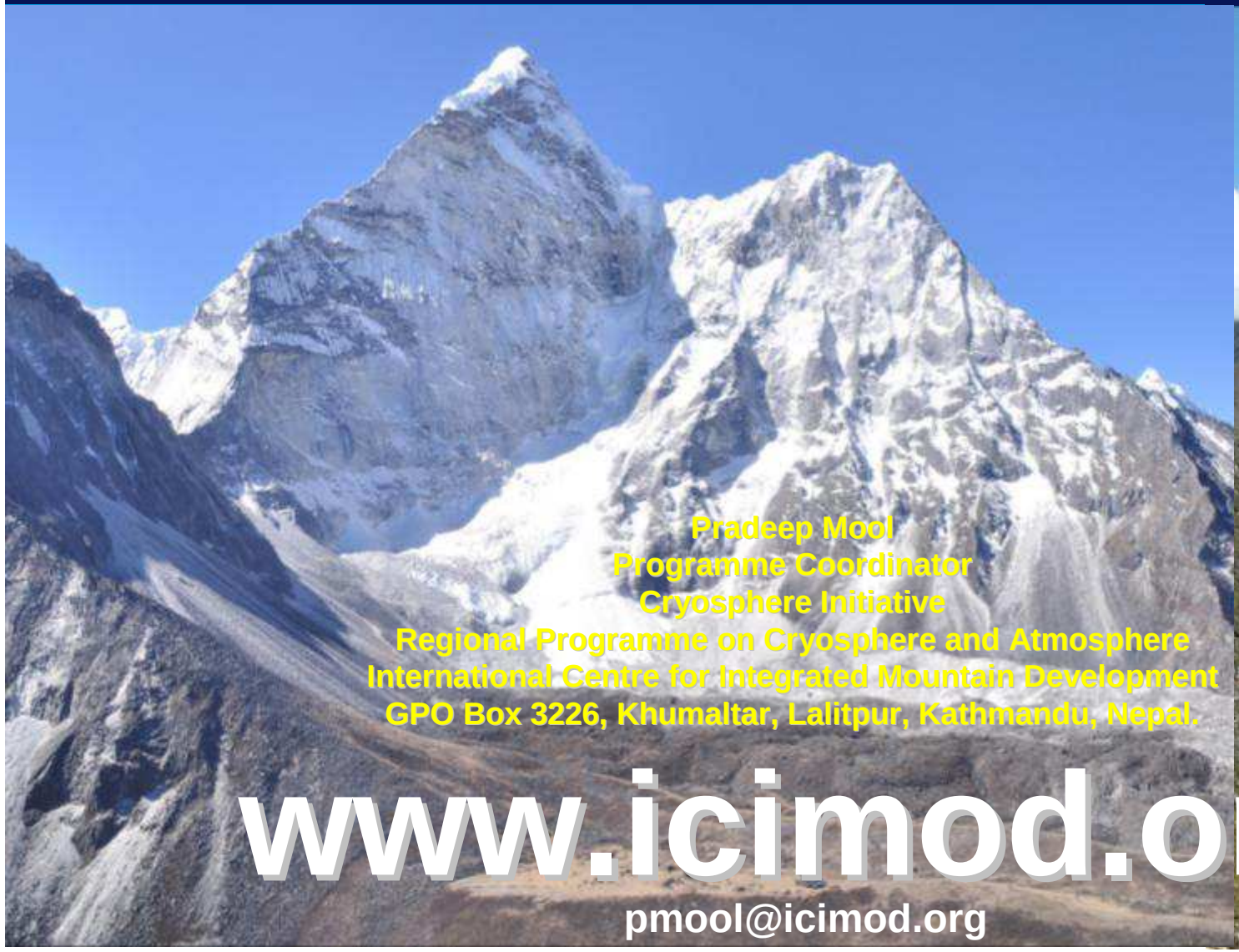

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