

Remote sensing inputs for snow melt runoff modeling and glacial lakes mapping

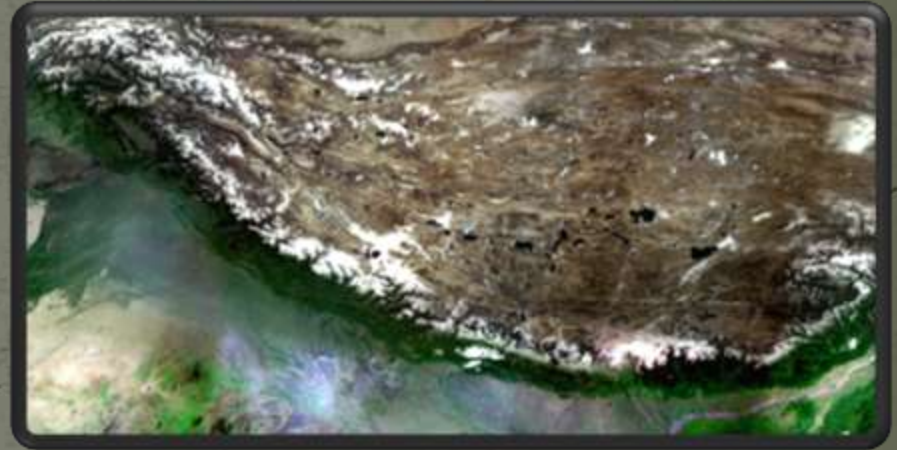
K. Abdul Hakeem

**National Remote Sensing Centre
Indian Space Research Organisation**



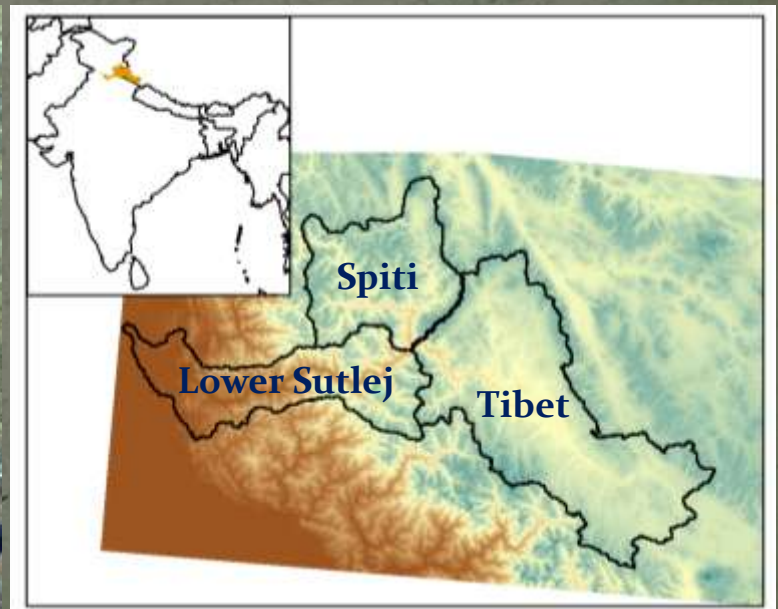
Snowmelt runoff modeling

- Mountains in India - 35% of the geographical area
- Himalayas account for 58% of this
- 22 major river systems with about one million sqkm catchment area lying in the Himalayas
- Snow and glacier melt runoff of more than 50%
- Dependable source of water for irrigation, hydroelectric power and drinking water supply
- Hydropower generation contributes about 26% of total installed capacity in India
- Himalayan river systems contribute 78% of the total Indian hydropower potential



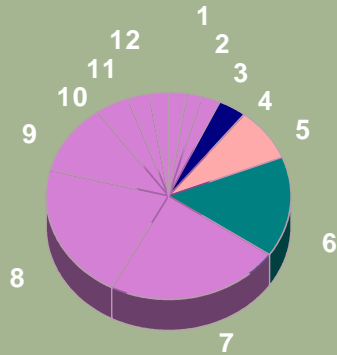
Snowmelt runoff forecast in Sutlej basin

- Objective
 - Issue of seasonal forecast in the first week of April
 - Revised forecast in the last week of May



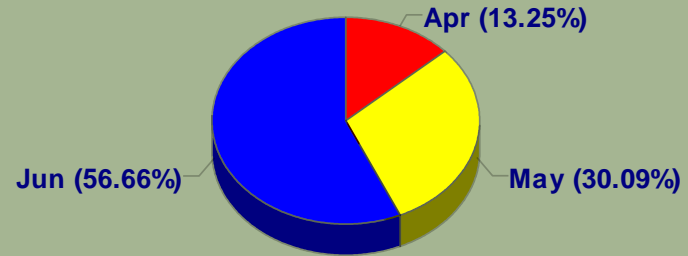
Distribution & Variation in Discharge

Annual Distribution of Q



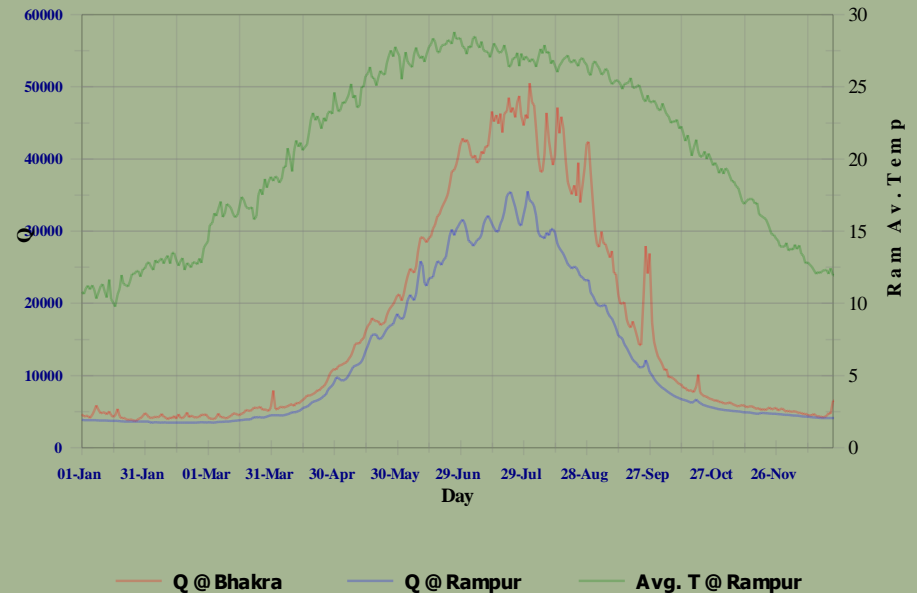
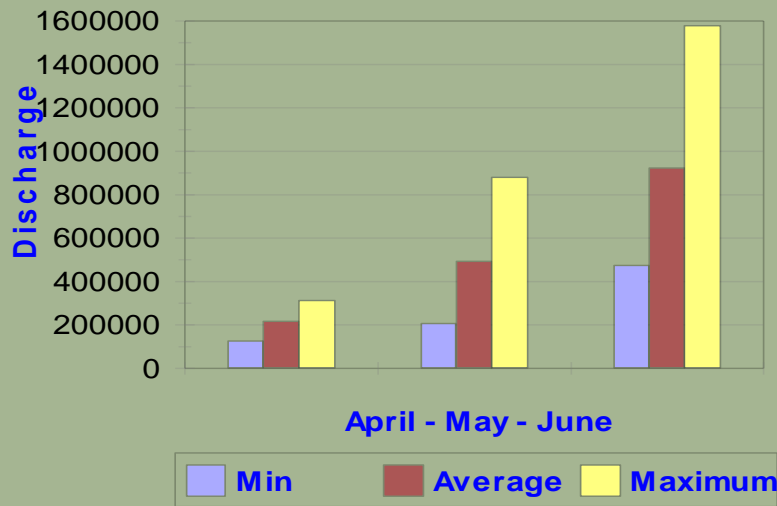
AMJ contribute to 27% of Annual inflows

Distribution of 3MQ

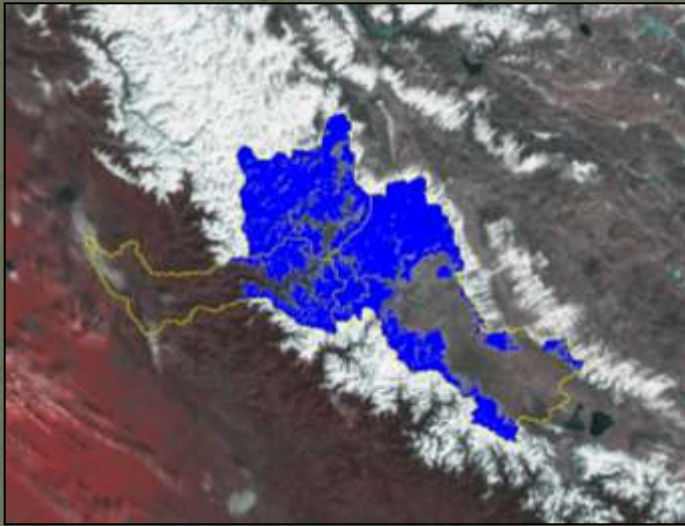


Daily Average Discharge (cusecs)

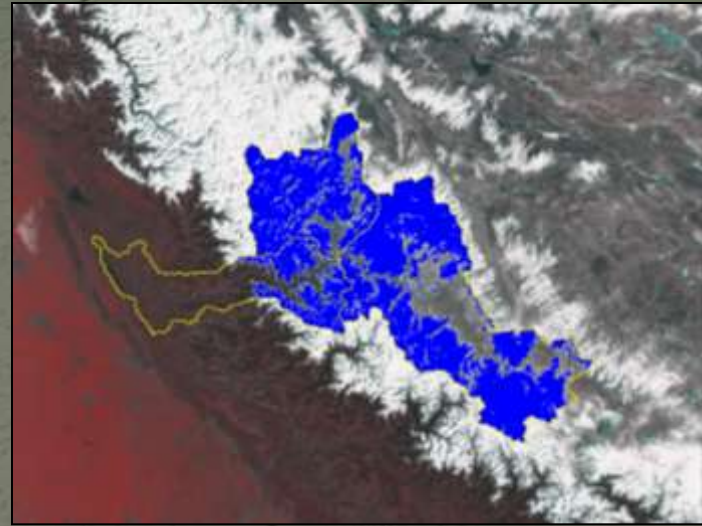
Variation of Q



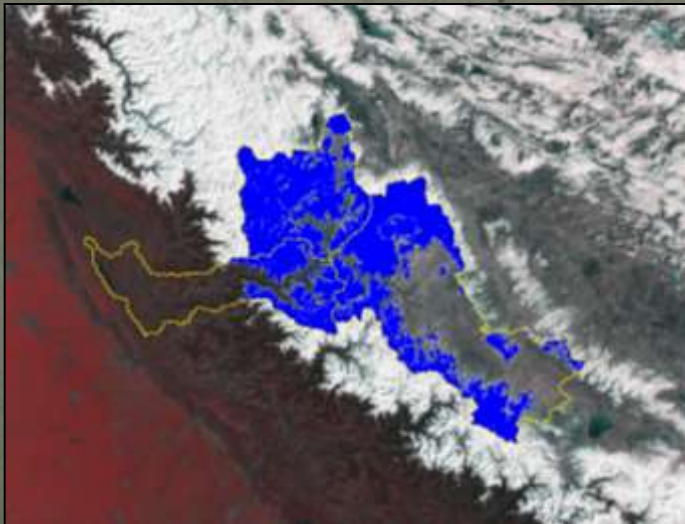
Snowcover Accumulation & Depletion



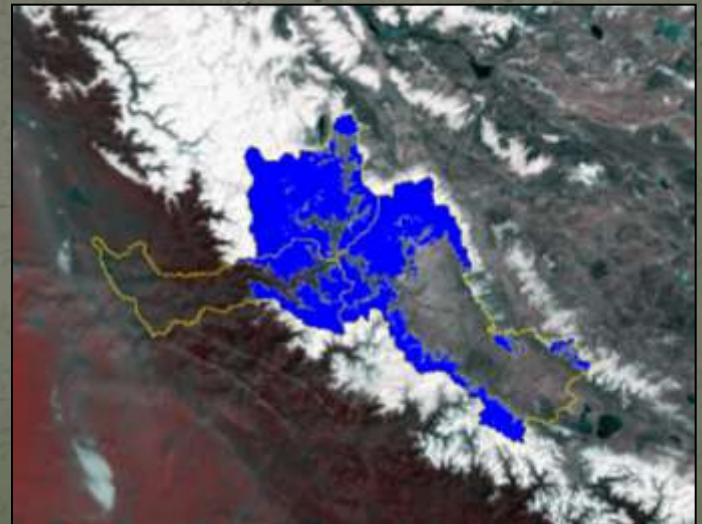
02 Feb 2009



19 Feb 2009

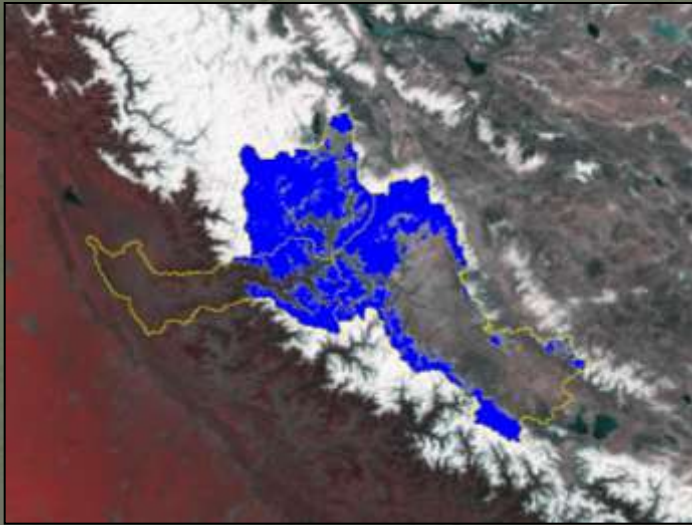


28 Feb 2009

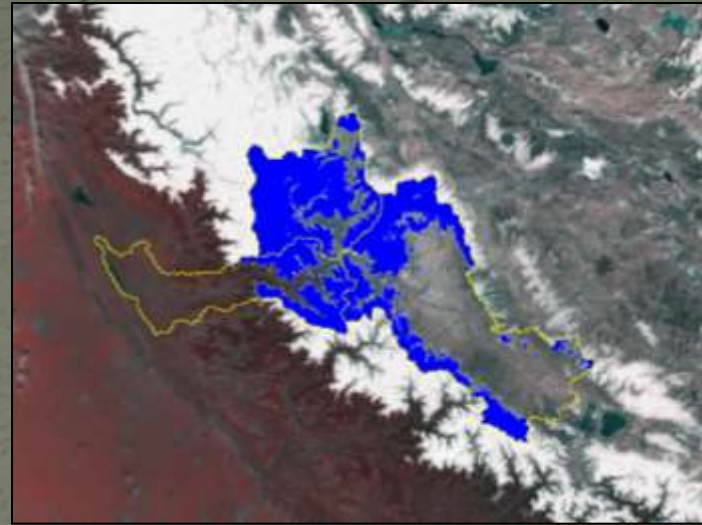


05 Mar 2009

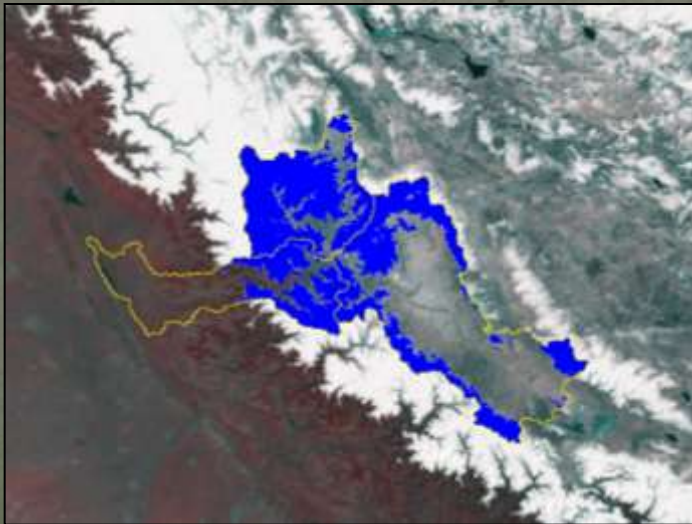
Snowcover Accumulation & Depletion



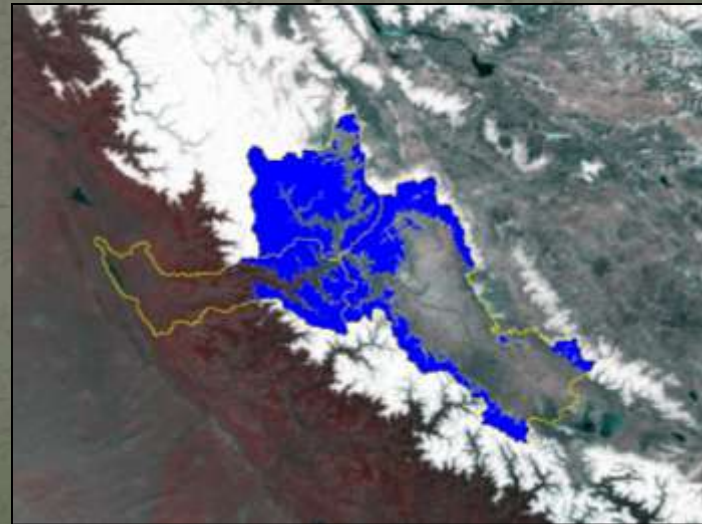
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18 Mar 2009

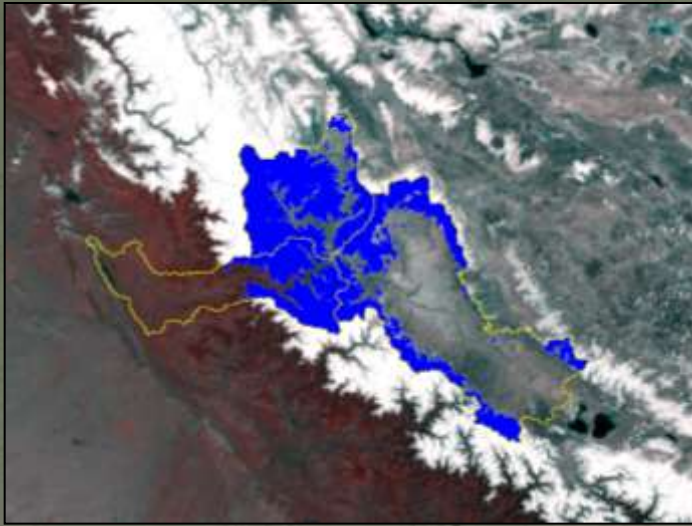


31 Mar 2009

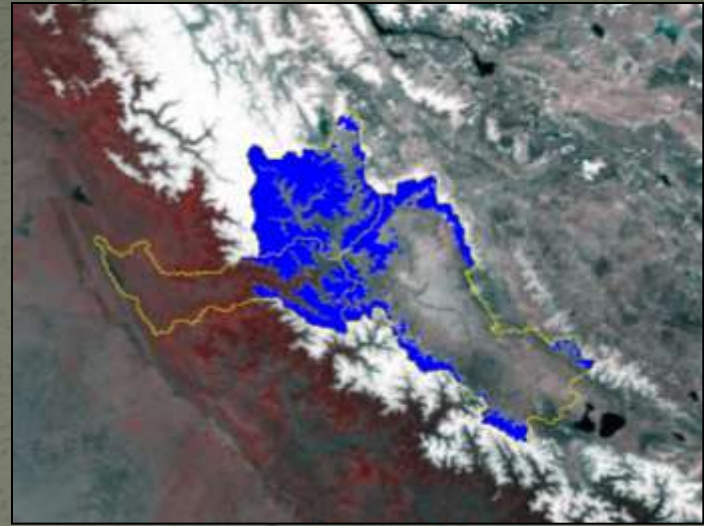


04 Apr 2009

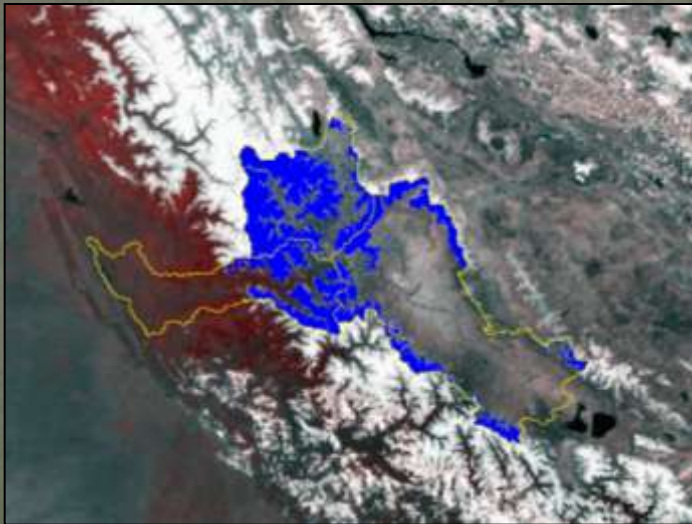
Snowcover Accumulation & Depletion



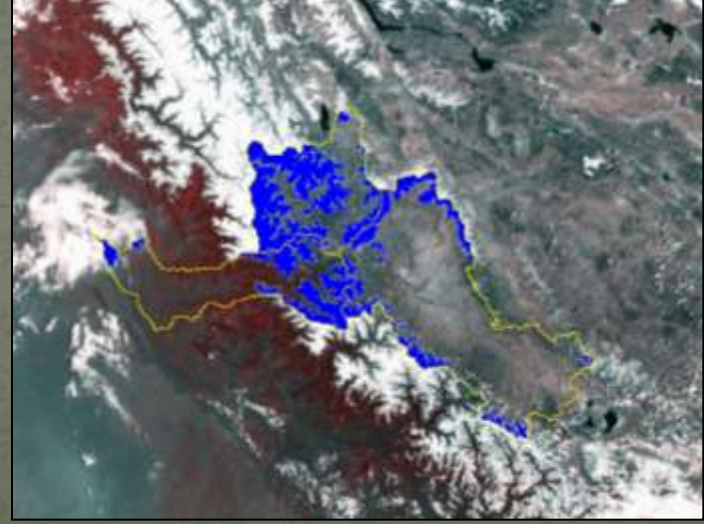
17 Apr 2009



30 Apr 2009



17 May 2009



21 May 2009

Snowmelt Runoff Model

Initial Forecast (April first week)

Revised Forecast (May last week)

$$Q = c * A * (C_1 S_1 W_1 + C_2 S_2 W_2 + C_3 S_3 W_3)$$

Q - Inflows between the date of SCA computed and 30th June in cusec-days
C₁, C₂, and C₃ - Runoff coefficients for three regions

S₁ - SCA in Spiti region as % of the region area

S₂ - SCA in Tibet region as % of the region area

S₃ - SCA in Lower Sutlej as % of the region area

W₁ - Average snowfall in Spiti region measured till 31 March

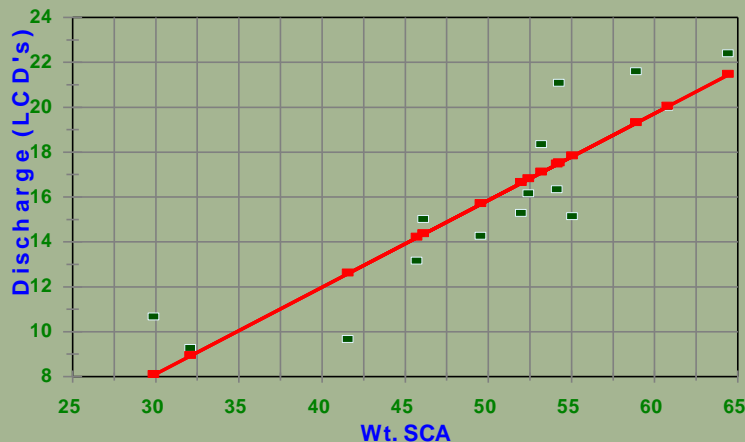
W₂ - Average snowfall in Tibet region measured till 31 March

W₃ - Average snowfall in Lower Sutlej basin measured till 31 March

A - Basin area

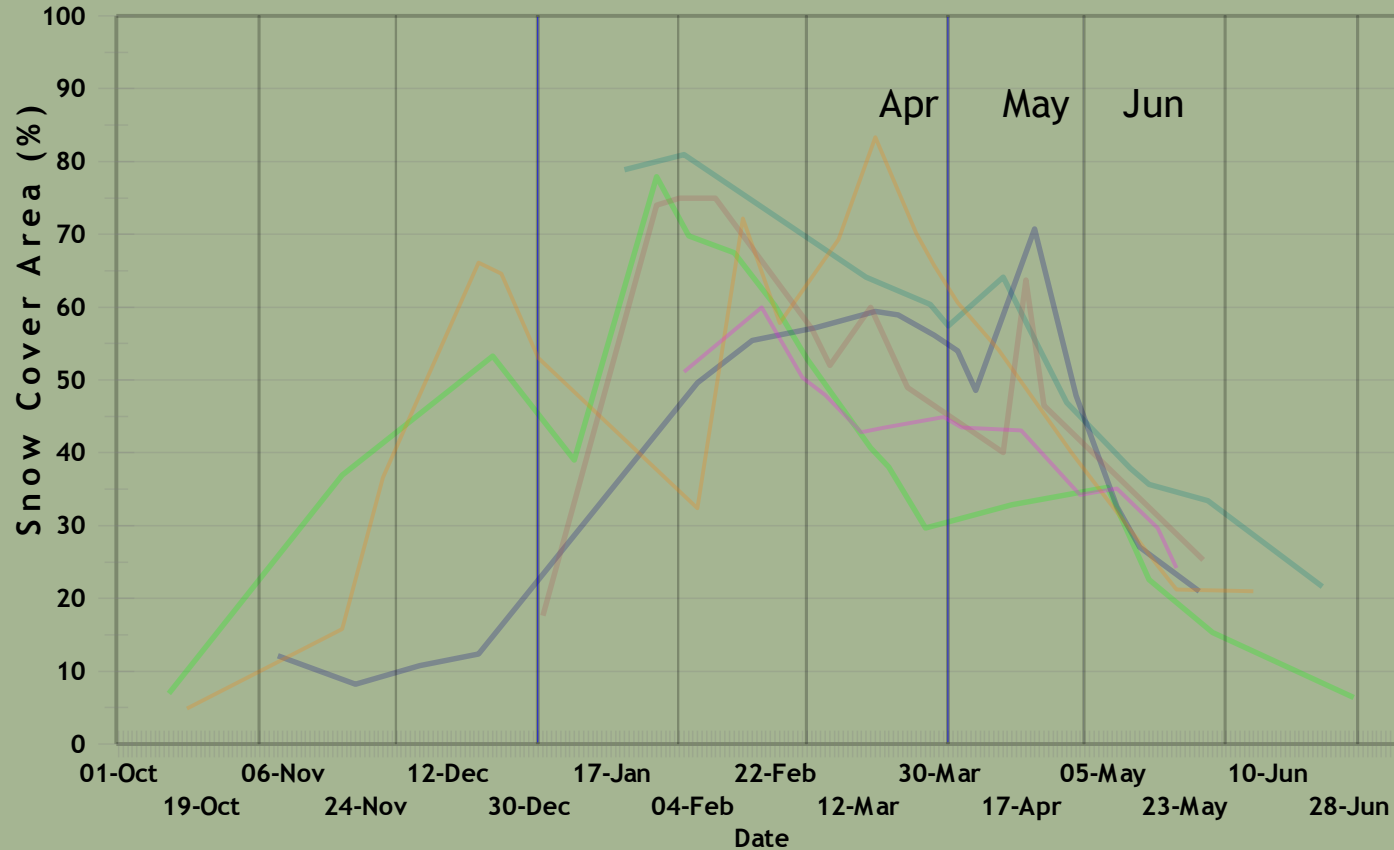
c - Unit conversion factor

Initial Forecast



Snowcover Depletion Curves

Snowcover Depletion Curves
Sutlej Basin

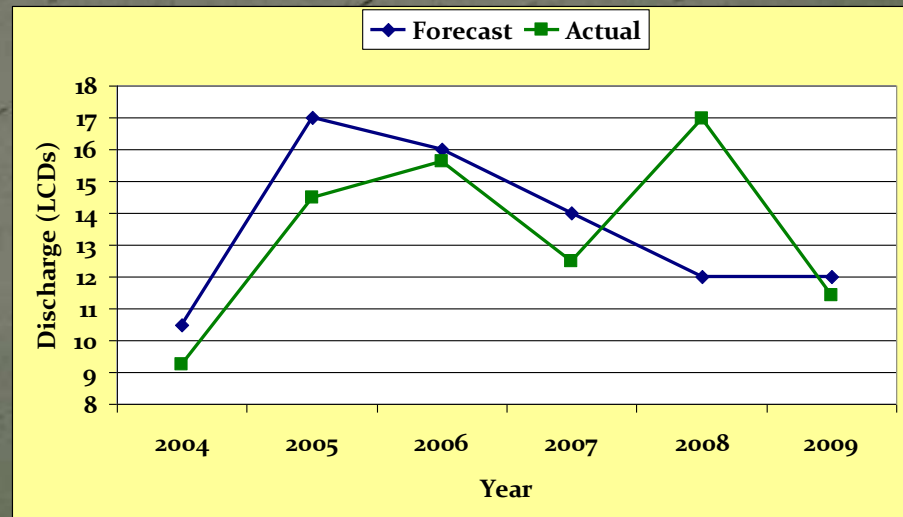


2004 - 9.24 LCD's 2005 - 14.5 LCD's 2006 - 15.62 LCD's
2007 - 12.48 LCD's 2008 - 16.94 LCD's 2009 - 11.15 LCD's

Forecast Results

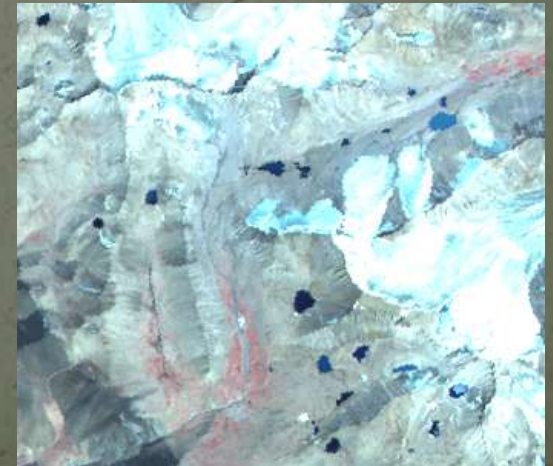
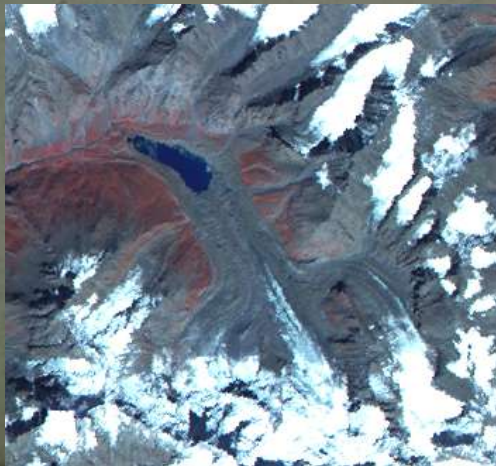
Date	Snow cover Area (% of Basin Area)
02-Feb-09	51.1
19-Feb-09	60
28-Feb-09	50.3
05-Mar-09	47.9
03-Mar-09	42.8
18-Mar-09	43.5
31-Mar-09	44.9
04-Apr-09	43.5
17-Apr-09	43.1
30-Apr-09	34.2
08-May-09	35.1
17-May-09	29.7
21-May-09	24.2

Year	Forecast		Actual	Deviation
	(in lakh cusec days)			
2007	Initial	16 +/- 10%	12.48	-28.0%
	Revised	14 +/- 10%		-12.1%
2008	Initial	12 +/- 10%	16.95	-29.0%
	Revised	12 +/- 10%		-29.0%
2009	Initial	12 +/- 10%	11.14	+7.7%
	Revised	12 +/- 10%		+7.7%

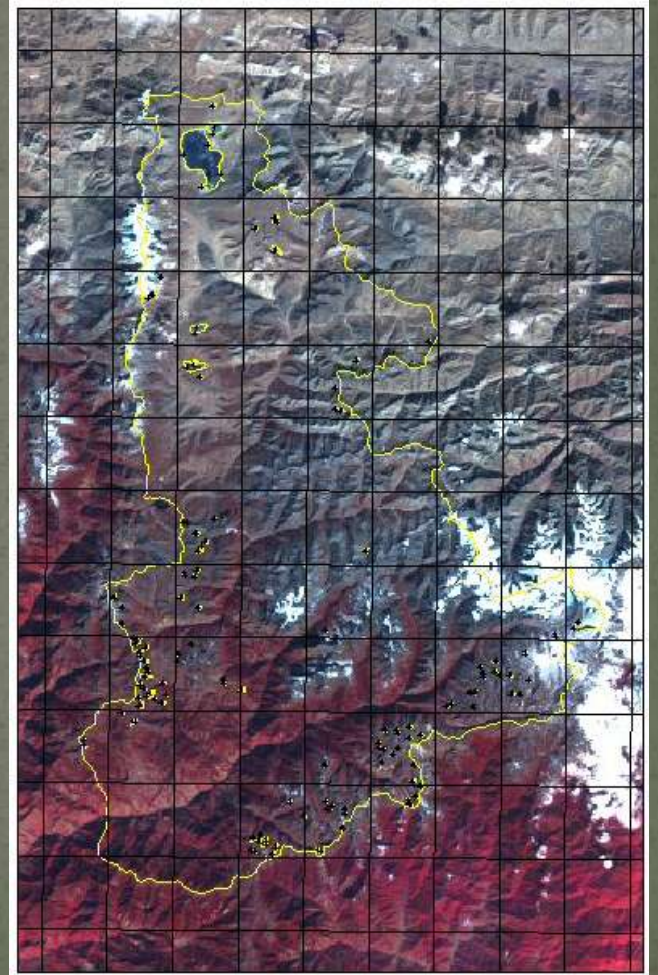
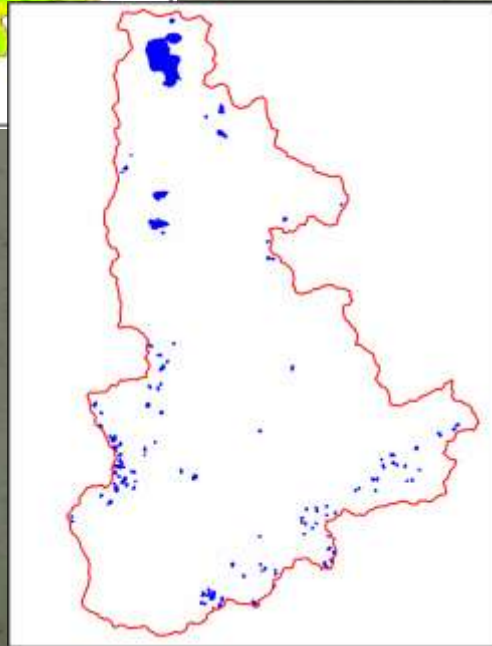
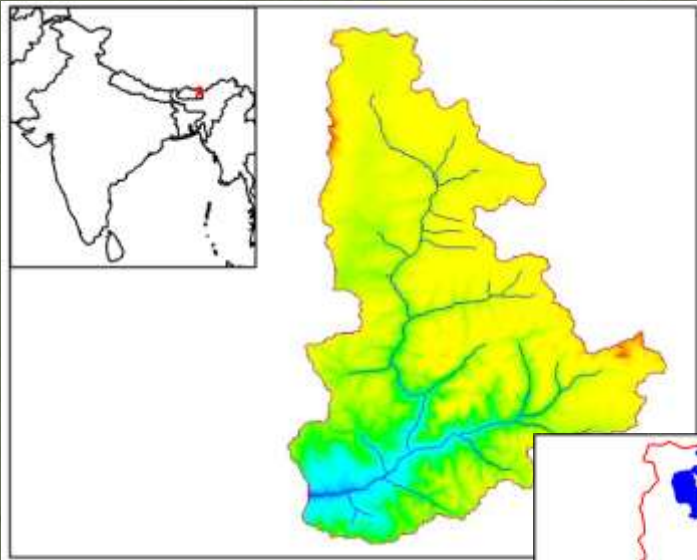


Glacial Lakes & Water Bodies

- GLOFs have been regular phenomena in different parts of the Himalayas
- New lakes are formed in Himalayas due to glacier retreat
- Most of these lakes are formed by the accumulation of vast amounts of water from the melting of snow and by blockade of end moraines located in the down valleys close to the glaciers



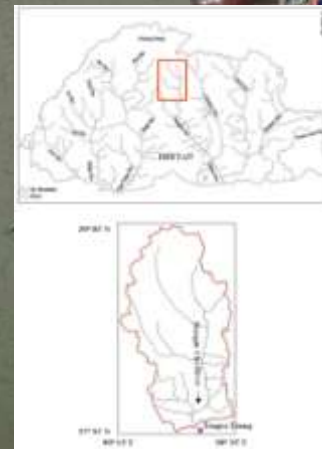
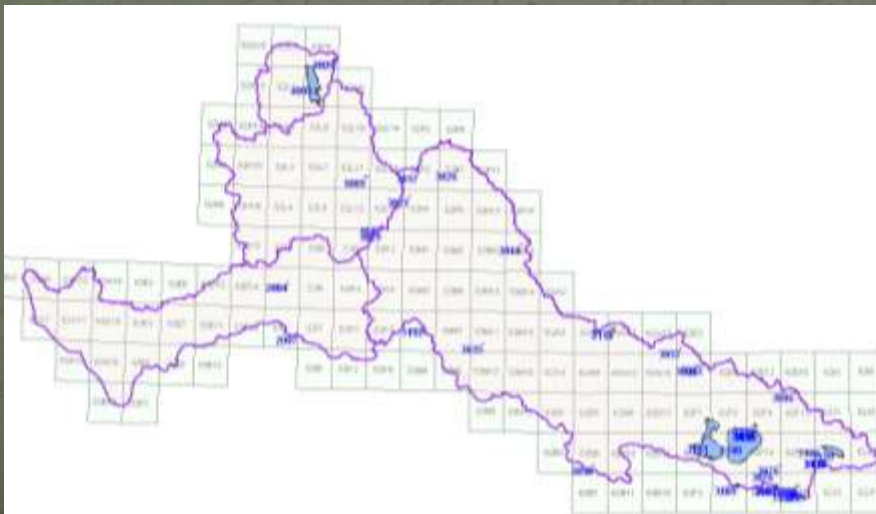
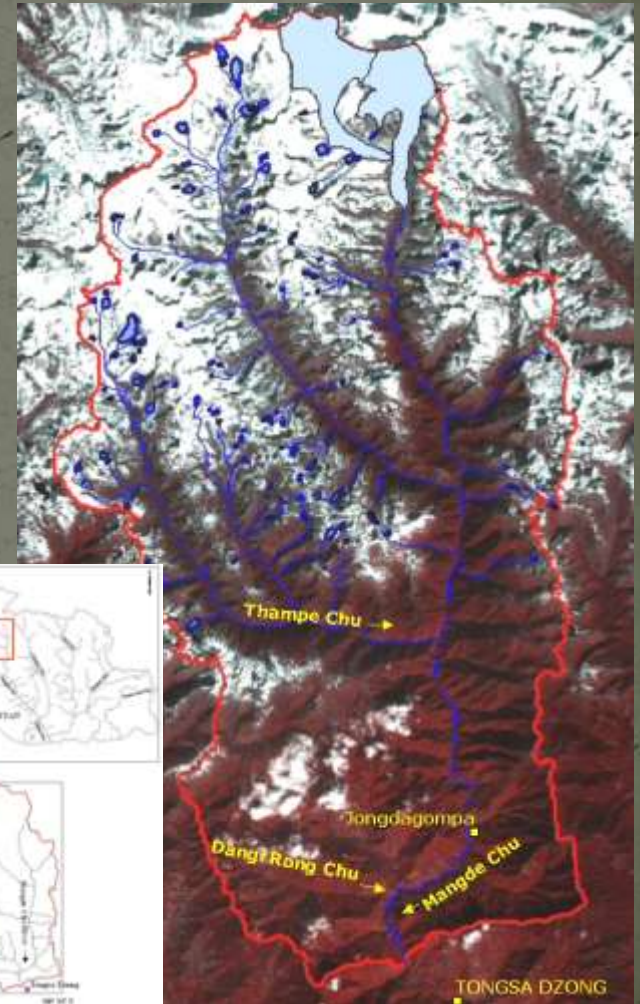
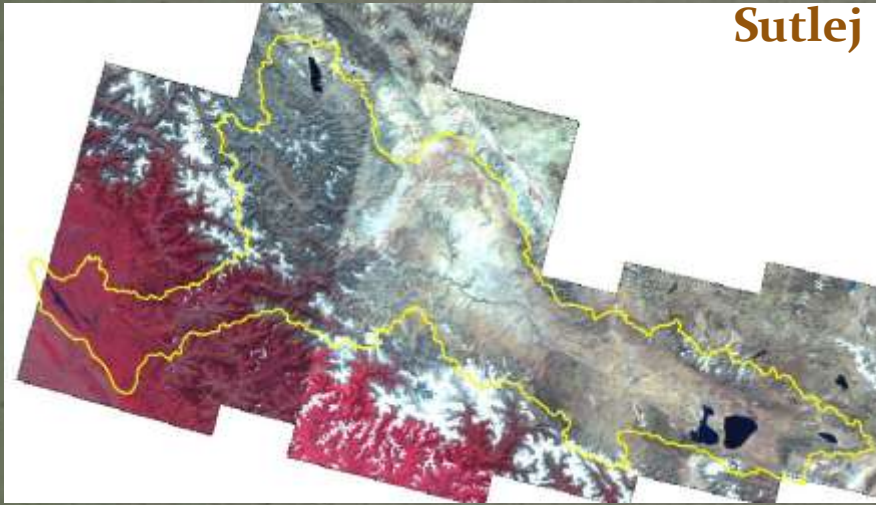
Inventory of glacial lakes and water bodies in Tawang basin



Inventory of glacial lakes and water bodies in other basins

Mangdechhu

Sutlej





*Thank
You*



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