Mass Balance Status of Glaciers of Bhutan

As Observed on Gangju La and Thana Glacier

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What is a Glacier ?

A glacier is a persistent body of dense ice that is constantly moving under its own weight. The term "glacier" comes from the French word glace (glah-SAY), which means ice.

Why are Glaciers Important?

Glaciers are important because:

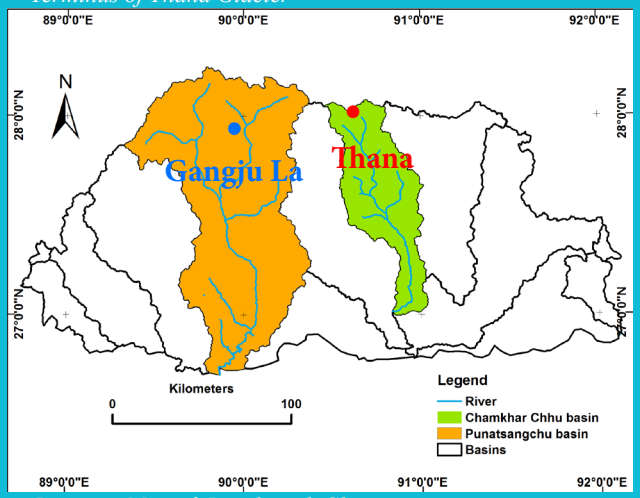
- Glacial ice is the largest reservoir of fresh water on earth.
- Sailent feature of Earth's water and weather cycle.
- Glacial melt water are essencial for the livelihood & all ecosystem residing downstream.
- Excellent climate indicator.

What is a benchmark glacier? Does Bhutan have benchmark glaciers?

Benchmark glaciers refers to those glaciers that have been selected for long-term glacier monitoring that investigates climate, glacier geometry, glacial mass balance , its dynamics and stream runnoff.

Bhutan has a total of 700 glaciers (BGI 2018). In an attempt to understand the behaviour of those glaciers in the face of global climate change and water resource, two benchmark glaciers were identified.One of the long-term bench marked glacier is Gangju La Glacier in the head water of Pho chhu sub-basin and another one is Thana Glacier, in the head water of Chamkhar chhu sub-basin, which are monitored on an annual basis.

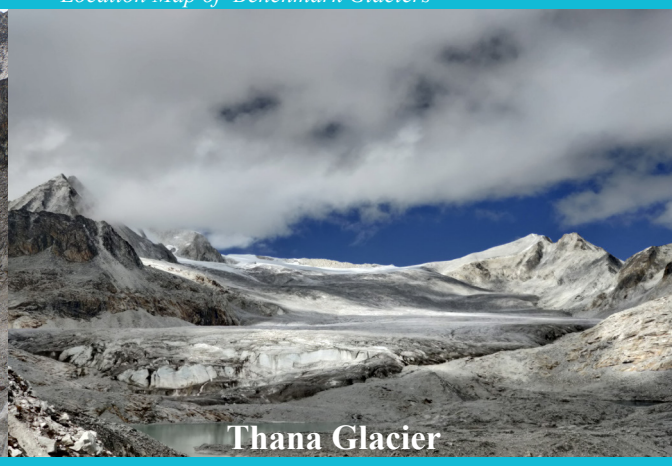
Terminus of Thana Glacier



Location Map of Benchmark Glaciers

Gangju La Glacier

Area: 0.215 km^2
Location: 27.94^0 N, 89.95^{o}E
Altitude: (4800-5100) m.a.s.l
Glacier Type : Clean ice glacier
Terminus retreat : 182 meters (2004-2020)
Glacier Mass Balance :-1655.85 mm w.e.a^{-1} (2019-20)
Max Thickness: 96.44 meters (2019)
Basin : Pho chhu sub-basin



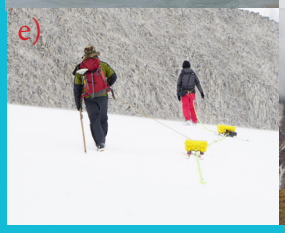
Thana Glacier

Area: 3.71 km^2
Location: 28.020 N, 90.61oE
Altitude: (5100-5700) m.a.s.l
Glacier Type : Clean ice glacier
Terminus retreat rate : 726 meters (1980-2020)
Glacier Mass Balance : -2907.2 mm w.e.a^{-1} (2019-20)
Max Thickness: 228.86 meters (2018)
Basin : Chamkhar chhu sub-basin

What activities are carried out for long term monitoring of Benchmark Glaciers?

The following activities have been adopted for long term monitoring of benchmark glaciers:

- Direct Method/ Glaciological method(Stake method) and In situ Geodetic methods (differential Global Positioning System) for calculating Glacier Mass Balance.(a & b)
- Ice Radar Survey for estimating glacier thickness(d).
- UAS survey for glacier areal mapping(f).
- Discharge measurement at downstream.(c)
- Snow Pit measurement to determine snow density(d).



What is the current status of the Benchmarked Glaciers of Bhutan?

Gangju La Glacier

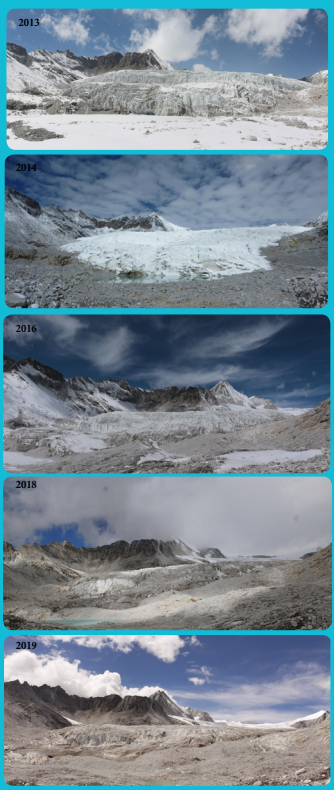
Studies on Gangju La Glacier has been carried out since 2003 and over the past two decades. It has suffered mass loss over the entire glacier surface leading to negative mass balance ranging from -1110±160 mm w.e. a^{-1} to -2390 mm w.e. a^{-1}. Gangju La glacier lies below the equilibrium line altitude (ELA) which is also the reason why the glacier is losing mass drastically every year. Such overall thinning of the glacier surface and losing more mass over the years can be seen from the increased terminus retreat rate (10.4 m.a^{-1} from 2004 – 2014, 13.3 m.a^{-1} from 2014 – 2020).

Thana Glacier

Thana Glacier has been monitored since 2012. Although Thana glacier shows a bit of accumulation towards the upper reach, it exhibits net negative mass balance ranging from -660 to -2645 mm w.e. a^{-1} through direct method and -930 to -2910 mm w.e. a^{-1} through geodetic method. Such annual mass loss is validated by surface area loss of approximately 2,76,790 m^2 which accounts to 7% decrease in area from 2016 to 2020. The cumulative mass balance is -6530 mm.w.e. from 2016 to 2020 revealing a total loss of approximately 24 million tons of ice.

What are the plans for the future?

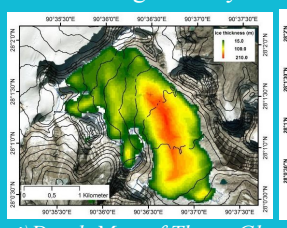
- Carry on with annual Mass Balance measurement on the two benchmarked glaciers.
- Identify new Benchmark glacier(s) for better geographical representation.
- To quantify the total glacial contribution to the river runoff regime.
- To incorporate Bhutan Glacier monitoring system into World Glacial Monitoring Services(WGMS) for compiling and disseminating standardized data on glacier dynamics.



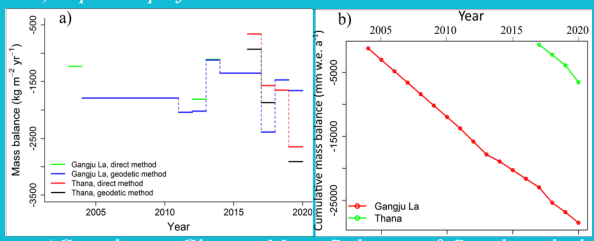
g) Thana Time series terminus

h) Gangju La time series change

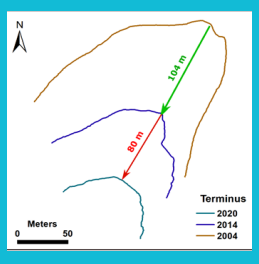
i) Thana terminus change



i)Depth Map of Thana Glacier



j)Cumulative Glacier Mass Balance of Benchmarked glacier



k)Gangju La terminus change

Contact us at