GEODESY
PROJECT REPORT

On

Climate change and Samudra Tapu lake expansion since 1970.

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CANDIDATE'S DECLARATION

We hereby declare that the project entitled **"Climate change and Samudra Tapu lake expansion"** submitted in partial fulfillment for the award of the course CE302 degree of Bachelor of Technology in Civil Engineering completed under the supervision of **Dr. Mohd. Farooq Azam,** Professor IIT Indore is an authentic work.

Further, we declare that we have not submitted this work for the award of any other degree elsewhere.

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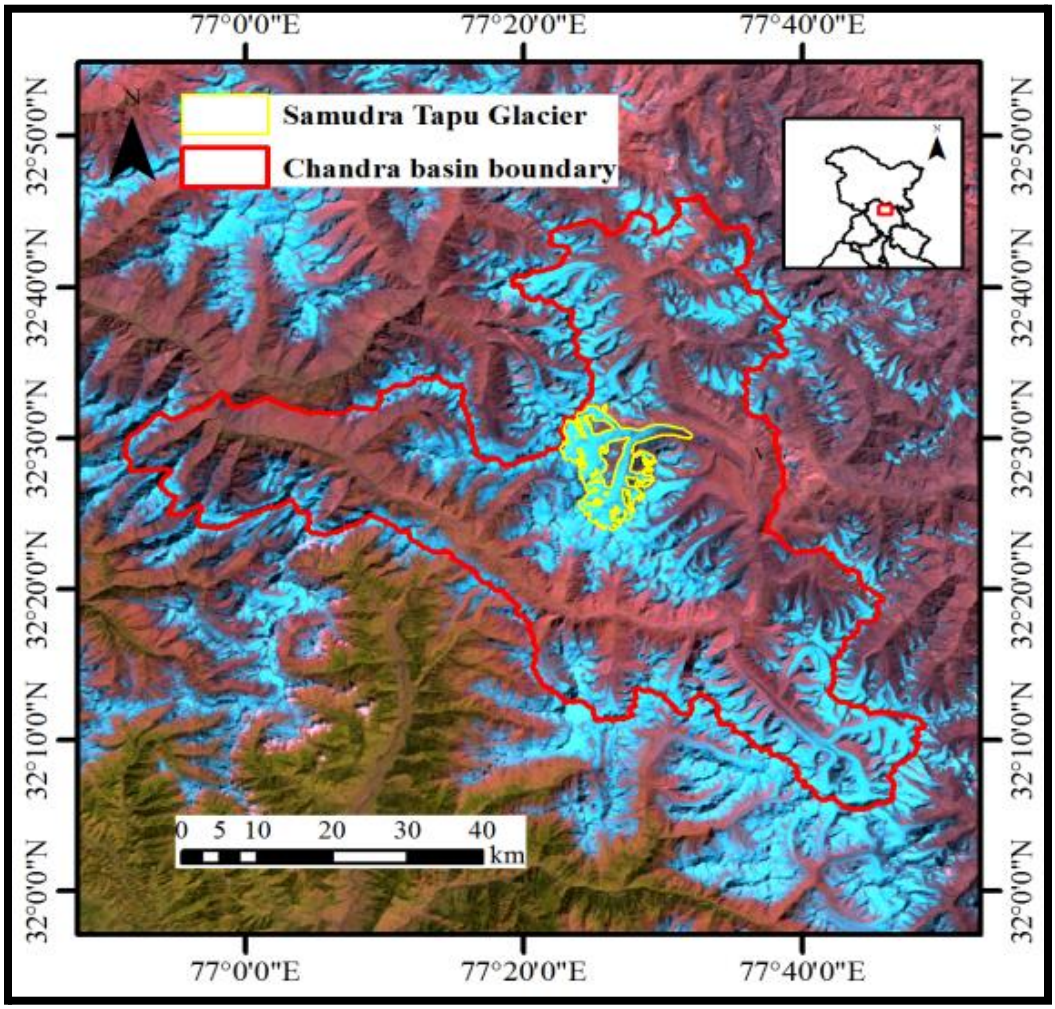
Abstract

The Himalayas have one of the most extensive reservoirs of snow,
ice, and glaciers, which serve as a massive freshwater reservoir. Monitoring glaciers is critical for determining the overall reservoir health of the Himalayas. Samudra Tapu is one of the major glaciers in the Chandra basin in the Himachal Pradesh districts of Lahau and Spiti. Field studies and remote sensing techniques were used to map features such as lake areas. The then calculated areas will give us an insight into the current state of expansion/depression of the lake, which in either way affects the environment.



1. Introduction

Our aim is to analyze the expansion of the Samudra Tapu Lake over the past 47 years (i.e since 1975). The lakes tend to increase their size over time occupying surrounding land and increasing water content that flowed down to the lakes by the melting of icebergs and glacial snow. This study shows us how big the lake has expanded in every decade until 2019.

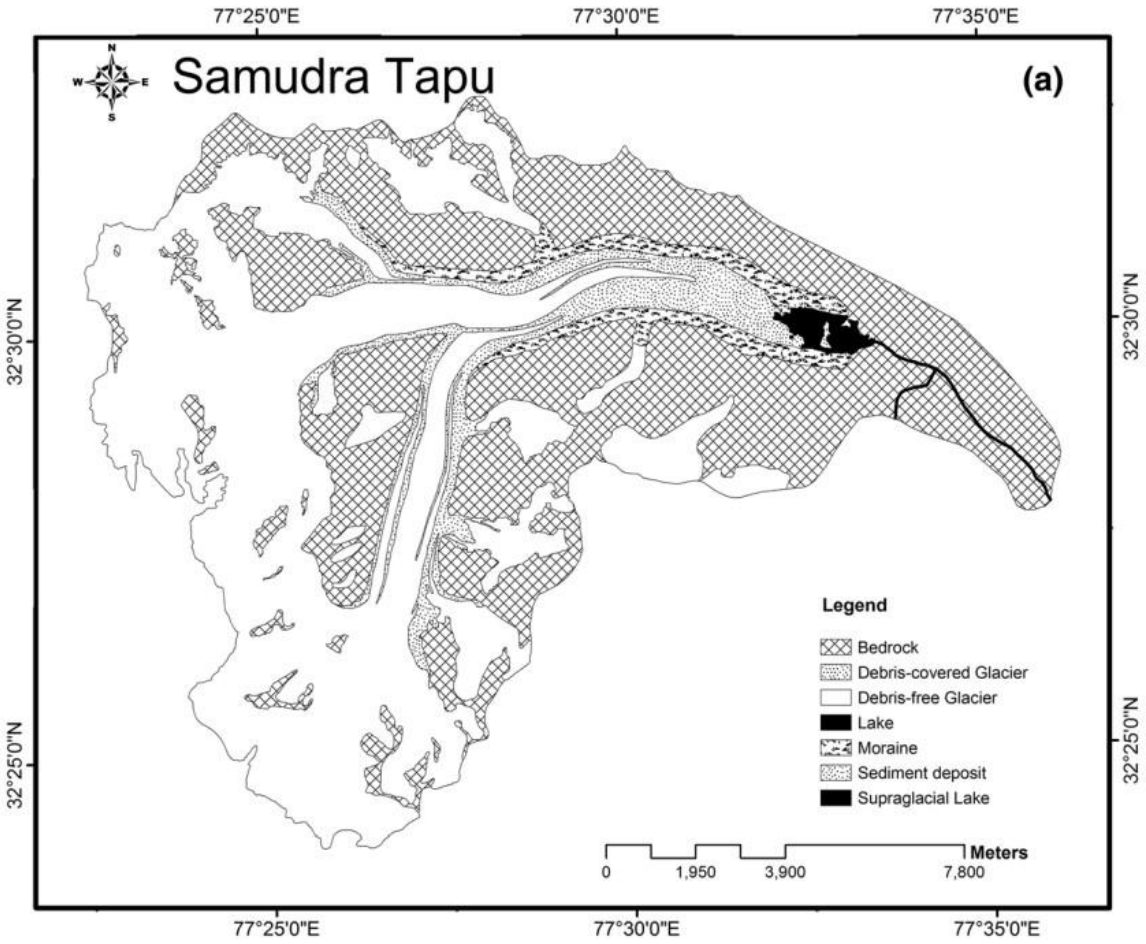
Glacier: A glacier is a mass of snow, rocks, and sometimes water that forms on land and flows slowly down a slope due to the gravity of its own weight. The accumulation of the snow is done every year and the new heaps of ice compress the ones that are previously there forming volumes of ice getting crystallized and compacted into sheets of ice.

Glacial lake: A glacial lake is a water body formed from the activities of glaciers. The glacier melts and fills the land occupied by the snow with water and thus becomes a glacial lake. For millions of years, the glaciers have been melting and turning into glacial lakes. But, the end of the Ice Age that happened around 10,000 years ago did make a boost to the number of glacial lakes that formed from the glaciers, as the melting of ice was rapid. It is observed that after the Ice Age, the earth lost almost 50% of the glaciers. The characteristics of these glacial lakes change from place to place. Glacial lakes serve as a fresh water source for people nearby and can be potentially used in hydropower.

2. Study area

Samudra Tapu Lake is a glacial lake located in Himachal Pradesh. The lake is present in the Samudra Tapu Glacier. The glacier is one of the largest glaciers located in the Chandra basin of district Lahaul and Spiti in Himachal Pradesh. The lake is around 1.6 square kilometers(as of 2019) whereas the glacier is around 62.5 square kilometers.

The glacier extends from latitude 32.40° N to 32.55° N and longitude 77.37° E to 77.61° E. The Geospatial studies carried out in Samudra Tapu Lake showed significant expansion in the area and volume of the lake in the last 40 years. The linear expansion of Samudra Tapu Lake is around 1700 meters and the aerial expansion of the lake is around 1 square kilometer. This increase is due to climate change which in turn increased the melting of glacial snow. This rate of melting raises concerns as the Himalayan glaciers are prone to natural disasters.



3. Data Source & Input Parameters

The analysis is based on maps from USGS and Google Earth Explorer.
The USGS offers scientific information on the natural dangers that endanger people's lives and way of life, the water, energy, minerals, and other resources we rely on, the health of our ecosystems and environment, and the effects of climate change and land use change.

3.1 Landsat Satellites

Landsat satellites have been continually collecting space-based pictures of the Earth's land surface since 1972, providing continuous data to enable land managers and policymakers to make educated choices about our natural resources and the environment. The Landsat Missions are eight Earth-observing operational satellites that work with the U.S. Geological Survey to gather data and take pictures of our globe. (USGS).

The USGS provides us with TIF-formatted maps of specific locations at various points in time. Following the instructions provided, these TIF files were exported to QGIS and created as shape files.
Click LAYER > ADD LAYER > ADD VECTOR LAYER after starting QGIS.

3.2 Google Earth Pro

Landsat 8 is the name of the satellite that Google Earth makes use of. It is an ongoing earth imaging satellite that was launched in 2013. Compared to Landsat 7, it takes pictures with higher quality and more frequently.

4. Factors affecting lake expansion

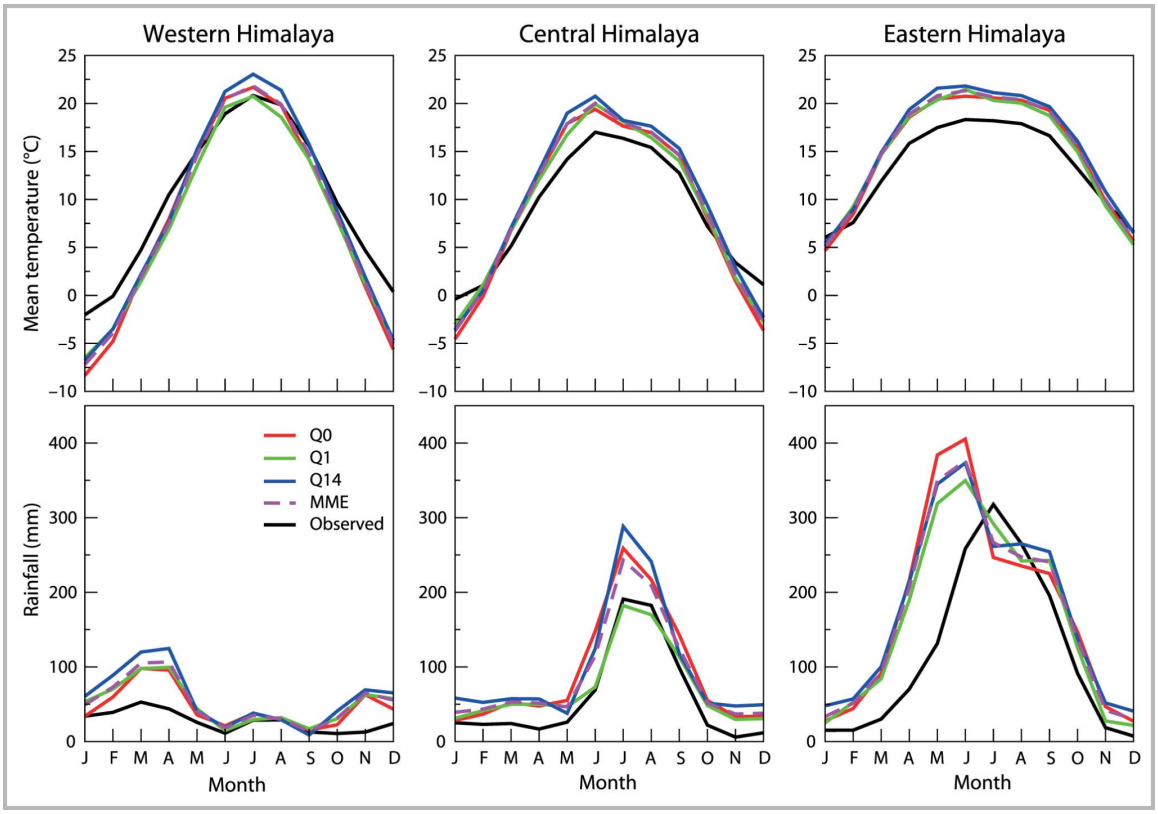
This issue is a consequence of human actions. Carbon dioxide and other greenhouse gas emissions, in particular, have elevated temperatures, even more near the poles, and as a result, glaciers are fast melting and retreating.
Climate warming, which is more evident across the high mountains than in lowland areas, has led to unprecedented negative glacier mass balances worldwide. Several studies have observed rapid glacier melting and mass loss in Himachal Pradesh. The meltwater from these glaciers coalesces and accumulates, forming new glacial lakes or expanding existing ones.

Table 1. Data Area

Year of Study	The area found in QGIS	Link for TIF File (from USGS)	Link for Shape Files
1975	417410	TIF Files (from USGS)	Shape Files
1989	642627		
1994	766822		
1999	1280552		
2003	1285979		
2014	1589866		
2019	1593312	NA	

Since the 1990s, there have been more and larger glacial lakes in High Mountain Asia, according to an analysis of Landsat series photos. One of the main climatic risks brought on by warming in high-altitude places is the possibility of glacial lake outburst floods (GLOF) or debris floods, which can occur as a result of lake expansion. GLOFs can be incredibly destructive and can strike with little forewarning, resulting in considerable loss of life and damage to property, infrastructure, and agricultural land.

The greenhouse effect is the primary cause of climate change.
Many of these greenhouse gases are produced naturally, but due to human activity, some of them are becoming more abundant in the atmosphere, most notably carbon dioxide (CO2), methane, nitrous oxide, and fluorinated gases.

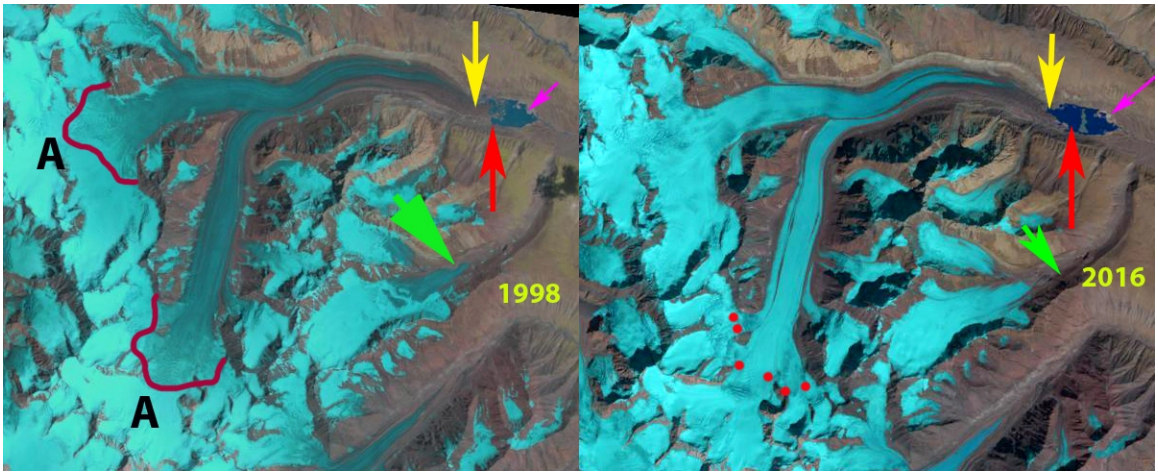


5. Data and Methodology

Samudra Tapu and Gepang Gath are two proglacial lakes of Chandra Basin at an altitude of 4200 m above mean sea level (MSL). As one of the largest glaciers in Chenab Basin, India, it terminates at 4150 m and is 16 km long, and has an area of 62.5 square kilometers.

The geospatial analysis of Samudra Tapu Lake was made using panchromatic and multispectral satellite data with minimal snow and cloud cover and Advanced Spaceborne. Images from July-September were selected, because during this period snow cover is at its minimum and glaciers are fully exposed. Glacier boundary was delineated using topographic maps and then it was digitized using the Quantum Geographic Information System(QGIS). The glacial boundary was mapped on satellite imagery using a standard combination of bands. A detailed description of the satellite data used is given in Table 1.

The image below offers us a general picture of how Samudra Tapu Lake has expanded or grown.



6. METHODOLOGY

- **QGIS-based lake expansion and data collection**

Lakes area changes were a comprehensive result of many external factors, but our research focuses on the factor of melting of glaciers and addresses general lake changes in Samudra Tapu Lake. Our main aim was to analyze arial change in the lake. We organized images taken during the period from 1975 to 2019. We chose images such that their cloud coverage was less than 10% and the lake was not frozen.

All of the remote sensing photos used in this paper were gathered from Landsat satellites, and the data were either downloaded from Google Earth Explorer or a cloud-based geographic information database from the website of the United States Geological Survey (USGS).

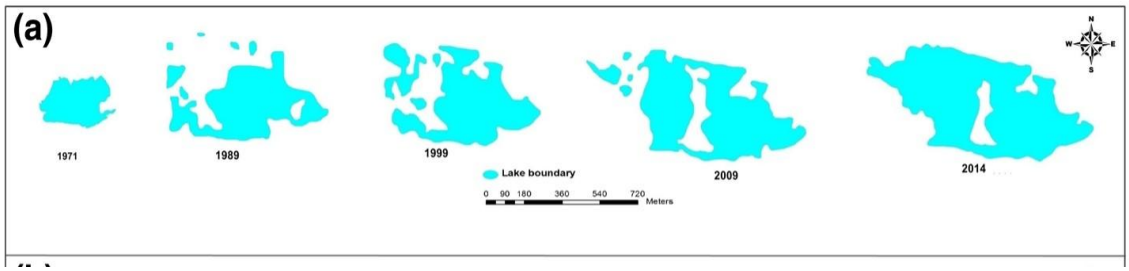
Then these images were imported as raster data to QGIS for further analysis and further, in QGIS polygons were made on boundary of lake in different layers which are called shape files (a vector file format used in geographic information systems (GIS) mapping to represent physical objects by recording details about their position, shape, and characteristics of geographic elements on a map.) indicates Samudra Tapu Lake in a different time period. For further analysis we calculated areas of different shape files which gives us detailed information of how the lake is expanding.
The link for QGIS file is provided here: LINK

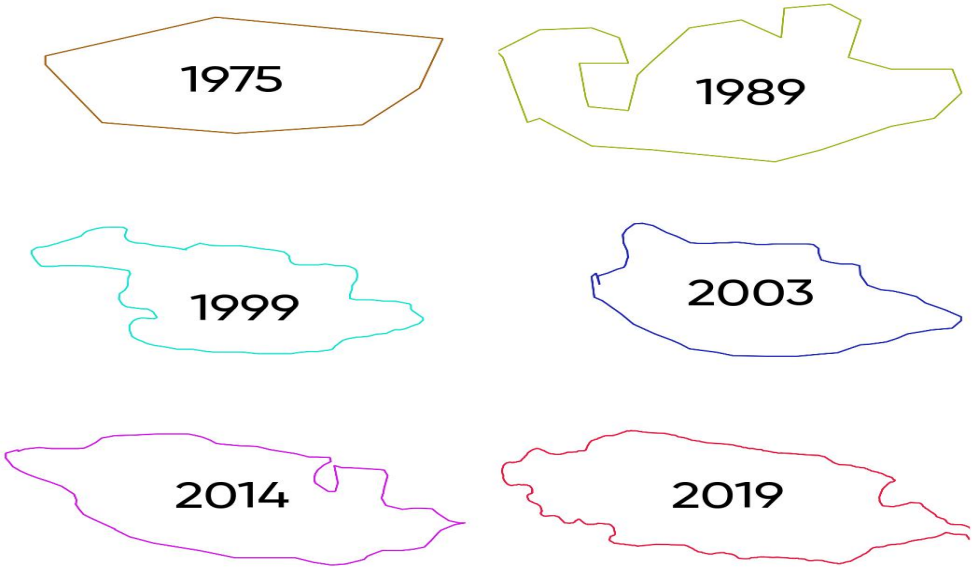
- **<u>Making Shape File from Google Earth Pro</u>**

A 3D rendering of Earth is produced by Google Earth, a computer program that largely uses satellite imagery. In order to give users the ability to view cities and landscapes from different perspectives, the program maps the Earth by superimposing satellite photos, aerial photographs, and GIS data onto a 3D globe.

In place of USGS, Google Earth Explorer was used to create shape files for the 2019 data, which were then imported into QGIS for processing and determining its properties. Currently, Google Earth is using Landsat 8 which gives more resolution and more frequency than Landsat 7.

The given image shows us how the shape of our lake looks in different time periods.





Shape Files created in QGIS

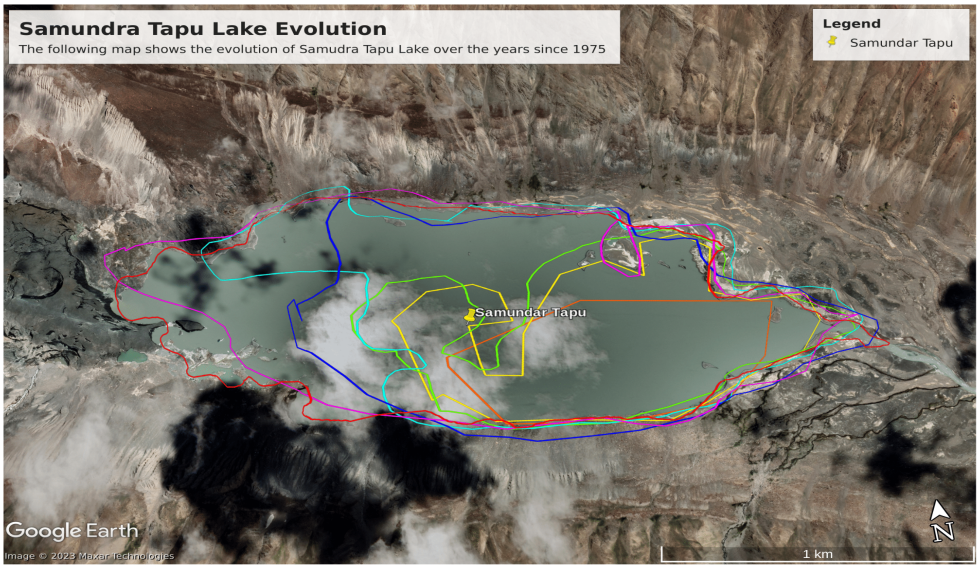
8. RESULTS

We took different raster data from USGS for the year (1975 to 2014) and then made shape files from them after opening them into QGIS. Also for the year 2019, we made shape files from Google Earth Pro. All the shape files attributes like area and perimeter were analyzed in QGIS and results are presented in Table No. 2.

Table 2: Represents the analysis of area generated from shape files

Year	Area (square meters)	Increase (square meters)	Percentage Increase (%)	Cumulative Increase (Since 1975)
1975	417410	-	-	-
1989	642627	225217	53.96	225217
1994	766822	124195	19.33	349412
1999	1280552	513730	66.99	863142
2003	1285979	5427	0.42	868569
2014	1589866	303887	23.63	1172456
2019	1593312	3446	0.22	1175902

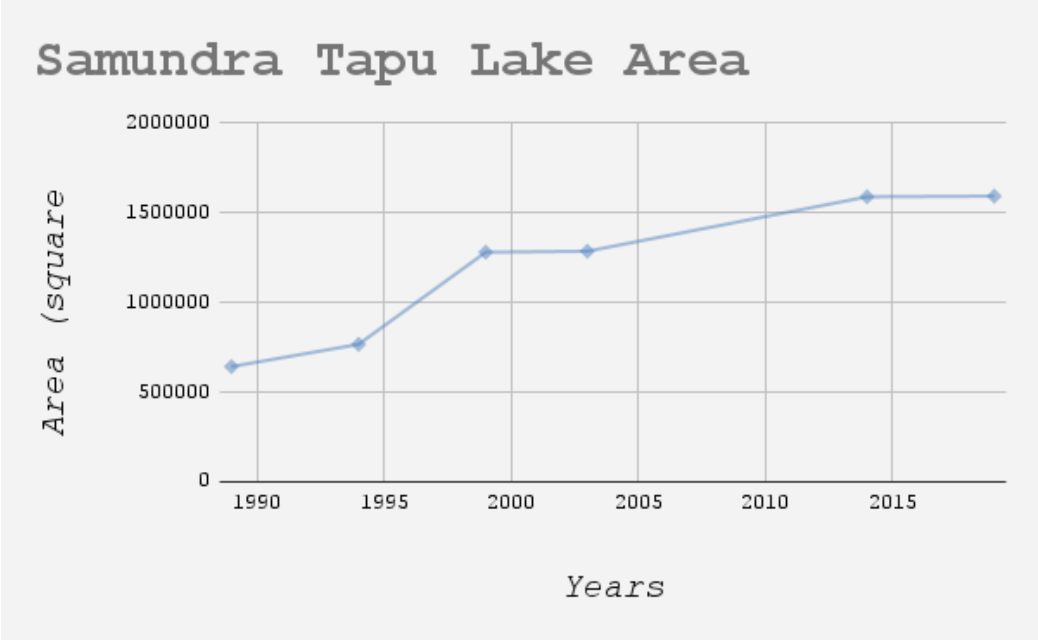
The above result shows the gradual increase in the area of Samudra Tapu Lake. It is in correspondence with the gradual decrease in the area of Samudra Tapu Glacier. For better visualization of the increase in area, all the shape files were imported into Google Earth Pro over Samundra Tapu and the file was exported in PNG Format. The image is shown below.

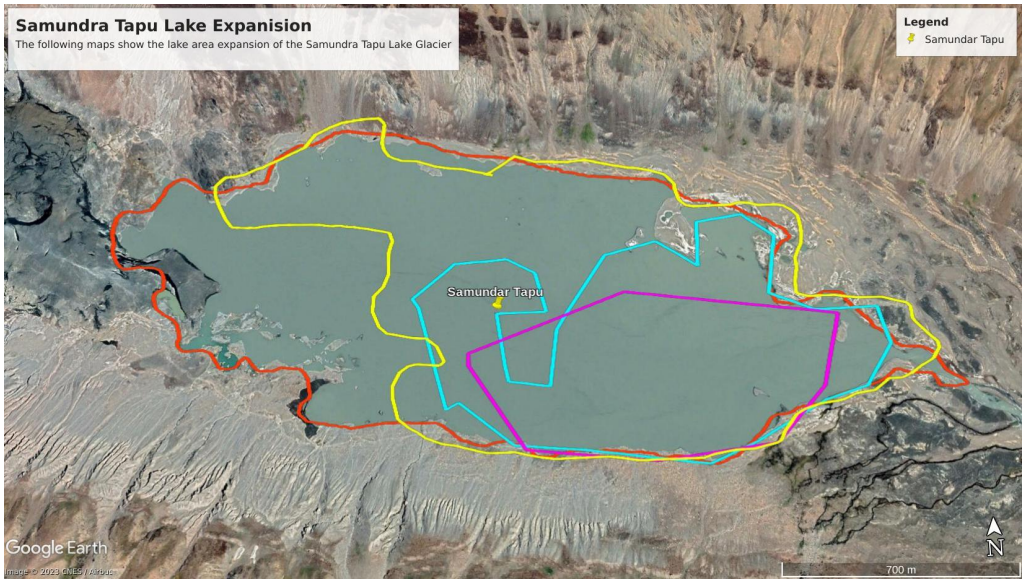


Red: 1975
Yellow: 1989
Green: 1994
Cyan: 1999
Dark Blue: 2003
Pink: 2014
Red: 2019

9. CONCLUSION

Overall analysis of the data shows that the Samudra Tapu Lake is constantly expanding due to the continuous melting of the Samudra Tapu Glacier. The data from USGS was taken and then analyzed using QGIS and Google Earth Pro. The yearly increase in data is shown in Table 2. All of the progress on the topic is recorded in the DRIVE





Pink: 1975
Cyan: 1989
Yellow: 1999
Red: 2019

10. REFERENCES

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