Measures to Restore Damages from Drainage of Lake Lago Greve, and Develop Stratifies to Prevent Further Drainage of Freshwater Lakes

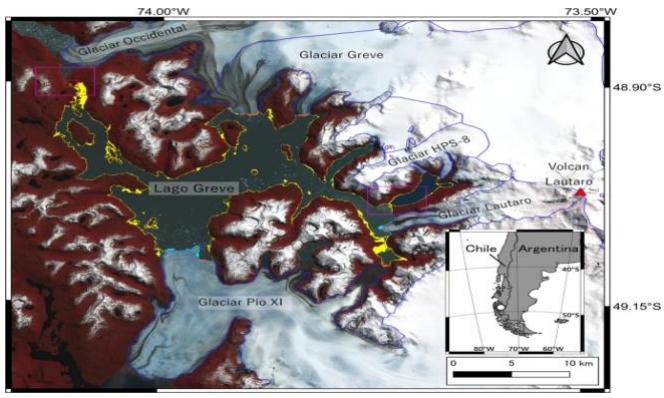
Forum: Environment Commission
Student Officer: HeeEun Kim, Deputy Chair

Introduction

The rapid technological development that has occurred over the past few decades has increased the dependence of humans on technology. This has resulted in the environment becoming severely damaged due to increased carbon dioxide emissions. According to the NOAA, in 2021, carbon dioxide contributed almost two-thirds of the total heating effect of greenhouse gases produced by humans. The effects of climate change on the freshwater ecosystem are severe. It causes low oxygen demands, thermal stratification, and acidic conditions. Apart from this, the depletion of water level from lakes is seriously impacted by deforestation and over-pumping of groundwater. Since, soil holds the capacity of water, through deforestation, the movement of water from the soil surface into the ground is reduced, which results in a decrease in the groundwater level. Additionally, deforestation affects the water quantity by the increased runoff which can accelerate soil erosion and increase the sediment load and turbidity of water sources. Besides, groundwater depletion is also defined as the long-term cause of water level depletion. Groundwater is a valuable resource throughout the world where groundwater is the source of drinking water for more than half of the human population and provides over 50 billion gallons per day for agricultural needs. Sustained groundwater pumping is a key issue associated with water level declines.

Background

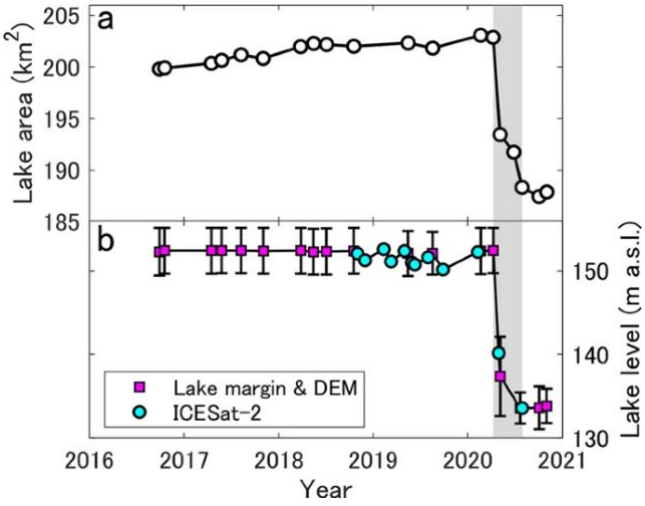
In April 2020, one dissertation reported a sudden retreat of the shoreline of Lago Greve, which is a large proglacial lake in Chilean Patagonia. In November 2022, the lake covered approximately about 187.9 km2 and became the fourth largest proglacial lake in the world. Although accurately measuring the depth of the lake was not possible, scientists estimated it as approximately 150m based on the observations before the formation of the lake. This lake includes Glaciar Pio XI the largest glacier in Patagonia and had a various number of outlet glaciers of the Southern Patagonia Icefield (SPI). From 1945 to 1962, Glaciar Pio XI advanced and blocked a Río Greve stream and formed Lago Greve as an ice-dammed lake. Through several types of satellite data,



Satellite image of Lago Greve

scientists analyze that a large amount of water has been released from the lake in a short period. This case is egregious because from 2016 to 8 April 2020, the area of the lake gradually enlarged resulting increment. However, on 8 April and 5 May 2020, the sudden retreat of the shoreline was observed from the satellite data which was followed by further retreat and lake area reduction from 8 April to 29 July 2020. Furthermore, the lake area experienced a 7.2% reduction on the lake area from 1 November 2020 to 8 April 2020. According to the lake area and the change in water level, water volume released from 8 April to 29 July 2020, which is equivalent to annual ice mass loss for 0.01 mm of sea level rise.

Beyond statistics regarding Lake Lago Greve, in general, according to the study, globally the extensive retreat of glaciers has been associated with the increase in the number and size of proglacial lakes. Many ice-dammed lakes are shrinking in absolute areas, and while most proglacial lakes are growing, also the number of proglacial lakes is increasing. However, one research paper reported that the average area decreases of 17% among their studied ice-dammed lakes are slightly lower but broadly similar to the estimates of Wolfe et al. (2014), who found a 28% decrease in Alaska ice-dammed lake area between 1971 to 2000. Noting that the lake area is large with the lake volume.



Changes in lake area and water level of Lago Greve

Places of High Concern

Chile

Image of the Aculeo Lake on May 4, 2013, and the dried-out lake on April 15, 2019

Since 2010, Chile began to experience a severe drought to the extent that the Aculeo Lake located southwest of Santiago become a symbol of the region's unending drought. Five years ago, Aculeo Lake was an expansive and pristine lake that attracted tourists to camp and swim in the clear water. As the water in the lake began to evaporate, the tourism industry has been devastated. The consequences caused a reduction in traffic into the lake region on weekends and holidays and over 500 people lost their jobs. Furthermore, Chile's abundant glacier reserves are increasingly threatened by climate change and rising temperatures from human activity, such as mining. According to the Chilean Antarctic Institute, the precipitation in the Metropolitan Region's (MR) Andes mountains has decreased by 3 cm every 10 years.

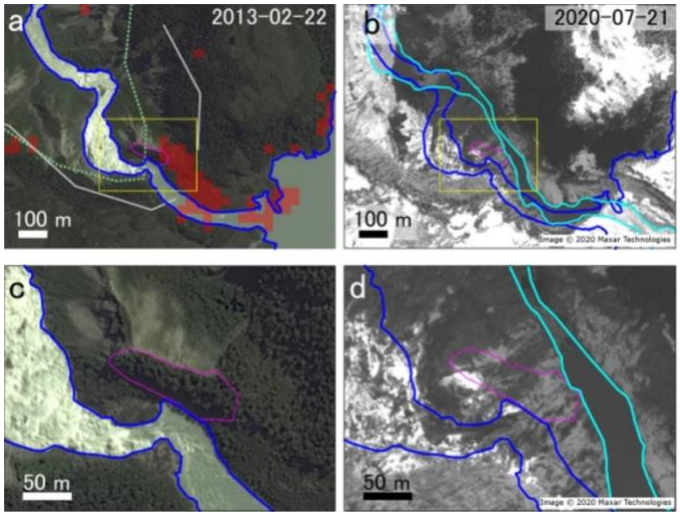
Egypt

Egypt is situated in northeastern Africa and the Sinai Peninsula in western Asia with five natural lakes, including Lake Idku. Particularly, the lake contributed to about 8.8% of the total national agricultural income since 2014. After the construction of the Aswan High Dam, change in water characteristics and biotic composition have been observed in the northern lakes. Moreover, the gradual shrinkage of Lake Idku due to the land reclamation and overgrowth of aquatic vegetation reduces the entrance of open seawater into the lake and accelerates the process of land transformation. Pollution of Lake Idku and other shallow water ecosystems is an international issue that strongly impacts the national economy and the health of communities. As lake production exponentially declined, according to the General Authority for Fisheries Resources Development (GAFRD), the annual fish production at Lake Idku decreased by more than 40%.

Problems Raised

Shifted Stream

Before the event (undiscovered) that caused the drainage in Lake Lagos Greve, in February 2013, the Satellite data show that the northward water stream was bent towards the west with a bump covered with vegetation at the top of the waterfall. Unfortunately, after the event, on 21st July 2020, the stream shifted northeastward by several hundred meters from the origin and vegetation disappeared from its region. The northern bank of the stream was eroded while the flow migrates. Before the event, the stream was running along the lowland which was relatively low-lying ground to the south in the valley. Because the surface elevation on the northern bank of the stream dropped by 20~30m, the depression shifted to the north, which led to the change in lake surface elevation after the lake drainage.



Surface elevation changes in the lake outlet region

In addition to the collapse of the bump at the top of the waterfall and the change in the flow, erosion started to spread to the northern bank of the stream. As the erosion proceeded upstream and gradually shifted to the north, the surface of the water dropped. After the event of stream shift, the vegetation located at the top of the waterfall disappeared from the region bounded by the stream flowlines before and after the event.

Climate Change

Illustration of Earth's surface after the climate change

As the human population increased, the production of climate emissions has significantly increased. Due to climate change, Earth's average temperature has risen by at least 1.1 °C (1.9 °F) since 1880, according to the analysis from scientists at NASA's Goddard Institute for Space Studies (GISS). Furthermore, a half-a-degree increment in the average global temperature has a huge know-on effect on the ecosystem. Because of the warm air temperature, the earth experiences more evaporation and transpiration which increases the risk of drought not only by evaporating water from soils, rivers, streams, and water, but also water from freshwater lakes, which remains dry soils.

Especially, the immediate drought increases the amount of carbon dioxide in the atmosphere, including by decreasing land productivity, which reduces the amount of vegetation storing carbon dioxide and also impacts lowering water levels in lakes and reservoirs. Moreover, as a long-term impact, drought has impacted seawater intrusion and damage to the ecosystem which causes public health problems including shortages of drinking water and poor-quality drinking water.

Possible Solutions

As there are many aspects to this problem, many solutions can be proposed. Among the many problems that exist within this issue, three of the gravest are the following:

1. The fact that international laws on carbon emission have not yet been established in the United Nations,
2. The fact that the Paris Agreement, which is a legally binding international treaty on climate change, where is not successful enough to prevent the global average temperature from rising,
3. The fact that restoration of lakes and the awareness about the increment of the average global warming is exceedingly low. Moreover, the nation's movement towards the increment of the global average temperature is less active and less cooperative.

Therefore, it is especially necessary to mediate negotiations between countries and organizations to construct an effective international law relating to the emission level of carbon dioxide. Limiting the total amount of carbon emissions can effectively reduce the world's total carbon emissions. Moreover, it is essential to reinforce the Paris Agreement to be more successful and gain the power of influence to prevent the global average temperature from rising to 1.5°C. Finally, raising public awareness of global average temperatures for both governments and citizens can operate effectively on lake restoration methods and solutions.

Glossary

pH: is a quantitative measurement of the acidity or basicity of aqueous or other liquid solutions.

Satellite: man-made machine orbiting the Earth that collects reflected radiation from the Earth's

surface

Remote Sensing: is the process of detecting and monitoring the physical characters of an area by measuring the reflected and emitted radiation at a distance

Metropolitan Regions (MRs): city regions meeting criteria which ideally 'fit for purpose' in the era of globalization or applicable across the world.

General Authority for Fisheries Resources Development (GAFRD): is a biodiversity and environmental management institution in Egypt; research and innovation toward the sustainable development outcomes

NASA Goddard Institute for Space Studies (GISS): is a laboratory in the Earth Sciences Division (ESD) of the National Aeronautics and Space Administration's Goddard Space Flight Center (GSFC).

Ice-dammed Lakes: lakes which form where glaciers block the flow of water in either a trunk or tributary valley

Sources

"Biodiversity." Population Matters, 5 Jan. 2023, https://populationmatters.org/biodiversity/?gclid=Cj0KCQiAq5meBhCyARIsAJrtdr4ir9ATIu_iwDPYY7O1ruAuwRGQR3HM1A4XHR7a5uGjlAiNzjQ1fkoaAipzEALw_wcB.

"Environmental Assessment of Drainage Water Impacts on Water Quality and Eutrophication Level of Lake Idku, Egypt." Environmental Pollution, Elsevier, 17 June 2016, https://www.sciencedirect.com/science/article/abs/pii/S0269749116304523.

"General Authority for Fish Resources Development." GFAR, https://www.gfar.net/organizations/general-authority-fish-resources-development.

Hata, Shuntaro, et al. "Abrupt Drainage of Lago Greve, a Large Proglacial Lake in Chilean Patagonia, Observed by Satellite in 2020." Nature News, Nature Publishing Group, 26 Aug. 2022, https://www.nature.com/articles/s43247-022-00531-5#Fig2.

"Lakes, Rivers, and Streams." Environmental Resilience Institute, Indiana University , https://eri.iu.edu/erit/implications/lakes-rivers-streams.html.

Libretexts. "Freshwater Lakes." Geosciences LibreTexts, Libretexts, 27 July 2020, https://geo.libretexts.org/Courses/University_of_California_Davis/GEL_109%3A_Sediments_and_Strata_(Sumner)/Textbook_Construction/Freshwater_Lakes.

"NASA GISS: About Giss." NASA, NASA, https://www.giss.nasa.gov/about/.

panelGuoqingZhangabPersonEnvelopeTandongYaoabHongjieXiecWeicaiWangaWeiYangab, Author links open overlay, et al. "An Inventory of Glacial Lakes in the Third Pole Region and Their Changes in Response to Global Warming." Global and Planetary Change, Elsevier, 1 June 2015, https://www.sciencedirect.com/science/article/abs/pii/S0921818115001101?via%3Dihub.

"The Paris Agreement ." Unfccc.int, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement?gclid=CjwKCAiAzp6eBhByEiwA_gGq5ICpeFjsvAbht_2ZBfAD1dEEK-i6lsngqXQkt4xvMu86_INQWLjhFhoC-eQQAvD_BwE.

"Ph." Encyclopædia Britannica, Encyclopædia Britannica, Inc., https://www.britannica.com/science/pH.

"Proglacial Lakes: Character, Behaviour and Geological Importance." Quaternary Science Reviews, Pergamon, 25 Aug. 2013, https://www.sciencedirect.com/science/article/abs/pii/S027737911300293X.

"Protecting One of the World's Largest Sources of Freshwater." National Geographic Society, https://education.nationalgeographic.org/resource/protecting-one-worlds-largest-sources-freshwater.

Publishing, Canadian Science. "Climate Change and Catastrophic Lake Drainage: What Does This Mean for Arctic Ecosystems?" Medium, Arctic Science, 14 May 2018, https://medium.com/arctic-science/climate-change-and-catastrophic-lake-drainage-what-does-this-mean-for-arctic-ecosystems-815739d09e00.

September 09, 2019 Carolina Herrera. "Chile's Ongoing Water Crisis: Threats and Needed Actions." NRDC, 12 Feb. 2020, https://www.nrdc.org/experts/carolina-herrera/chiles-ongoing-water-crisis-threats-and-needed-actions.

University of California Museum of Paleontology, https://ucmp.berkeley.edu/exhibits/biomes/freshwater.php.

University, Hokkaido. "What Caused the World's Fourth-Largest Proglacial Lake to Suddenly Drain? Scientists Finally Have an Answer." SciTechDaily, 2 Nov. 2022, https://scitechdaily.com/what-caused-the-worlds-fourth-largest-proglacial-lake-to-suddenly-drain-scientists-finally-have-an-answer/.

"What Is Climate Change? A Really Simple Guide." BBC News, BBC, 2 Nov. 2022, https://www.bbc.com/news/science-environment-24021772.

"What Is Remote Sensing and What Is It Used for? - USGS." What Is Remote Sensing and What Is It Used for? , https://www.usgs.gov/faqs/what-remote-sensing-and-what-it-used.

"World of Change: Global Temperatures." NASA, NASA, https://earthobservatory.nasa.gov/world-of-change/global-temperatures.