IMPACT OF THE ECOLOGICAL FOOTPRINT

IN THE LOSS OF ICE AND GLACIERS

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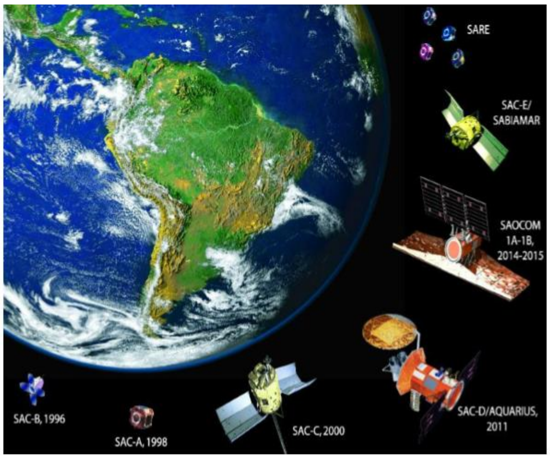

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Abstract:

The loss of snow due to snowmelt is a serious problem worldwide that progresses year after year and is attributed to the global warming generated by the pollution caused by climate change. In our area, it directly affects the availability of water in ecosystems and productive systems, increasing the risk of fires.

The warming causes the melting affect the poles and in the mountains causes the loss of the thickness and extension of glaciers. Excess water generates floods due to sea level rise; shortage of fresh water and droughts and fires in areas dependent on melting in summer.

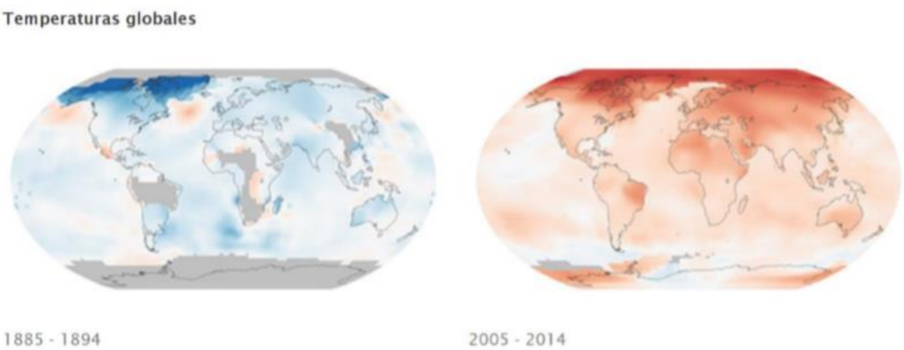
To analyze the loss of glaciers in the Patagonia region, Argentina, two sites were compared using Landsat 5 and 8 images corresponding to the years 2005 and 2017. The Landsat 8 images were validated with samplings in the terrain using the GLOBE Protocols. The NDVI, NDWI and NDSI indices were calculated using the QGIS software.

Ice loss was detected in both sites, which can produce an increase in drought, due to lower availability of water, particularly in the summer (which is the dry season and the melting of the available water resource)

The loss of snow due to snowmelt is a serious problem worldwide that progresses year after year and is attributed to the global warming generated by the pollution caused by climate change. To analyze the loss of glaciers in the Patagonia region, Argentina

1. Introduction

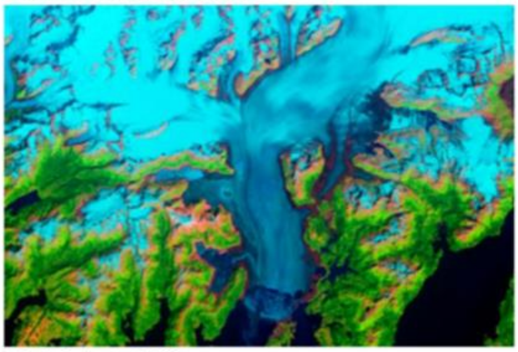
The loss of snow and melting worldwide is a problem that progresses year by year and is attributed to global warming, climate change and pollution.



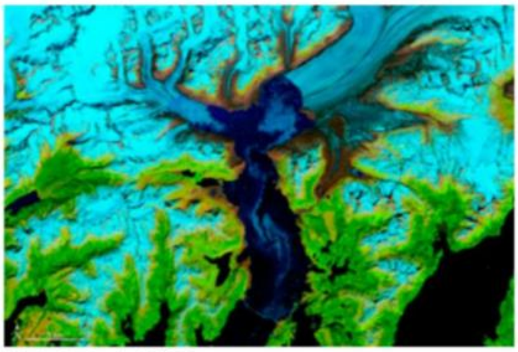
El mundo se está calentando, sea cual sea la causa. De acuerdo con un análisis realizado por científicos de la NASA, la temperatura global promedio ha aumentado aproximadamente 0.8 ° Celsius (1.4 ° Fahrenheit) desde 1880. Dos tercios del calentamiento se han producido desde 1975.

This loss of snow and ice in our area is very important because it directly affects the ecosystem and production systems, and it is also important to contextualize these changes on a global scale, comparing what happens in this region with other regions of the world.

Glaciar Columbia, Alaska



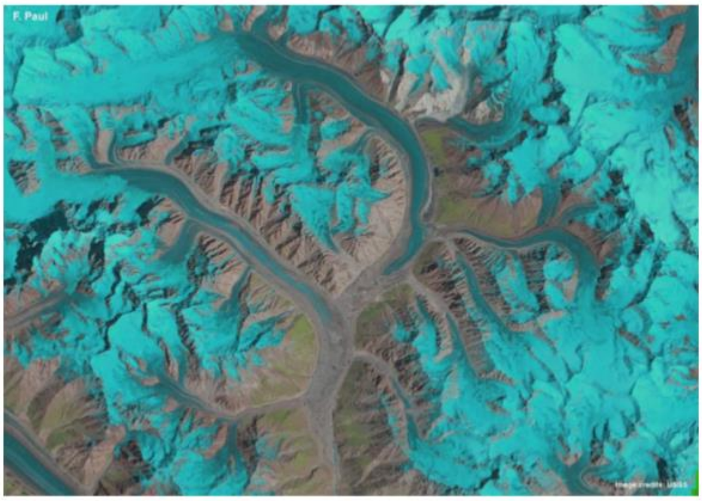
29 de julio de 1986



15 de junio de 2017

Desde 1980, el volumen de este glaciar que se derrama en Prince William Sound se ha reducido a la mitad. El cambio climático puede haber impulsado el proceso, pero las fuerzas mecánicas han jugado el papel más importante en la pérdida de hielo.

Glaciares en movimiento

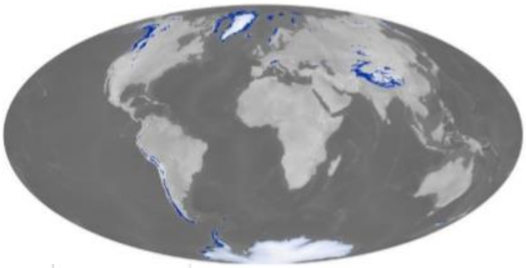


25 años de imágenes por satélite comprimidas en un solo minuto, revelan el complejo comportamiento y flujo de los glaciares en la cordillera de Karakórum, en Asia.

https://goo.gl/cvSt4c

This loss of snow and ice has as consequences, the melting of the glaciers at the poles and in the mountains; the loss of the thickness and extent of the glaciers; floods due to sea level rise; shortage of fresh water and droughts and fires in areas dependent on melting in summer.

Glaciares y capas de hielo



Las ubicaciones de los glaciares están marcadas en azul. El mapa incluye unos 198,000 glaciares que cubren aproximadamente 726,800 kilómetros cuadrados (280,600 millas cuadradas).

http://www.glims.org/

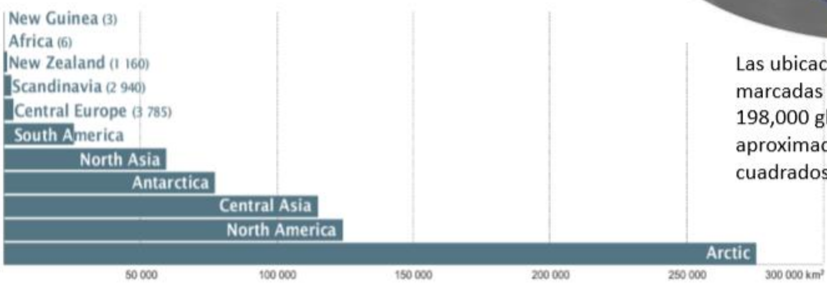
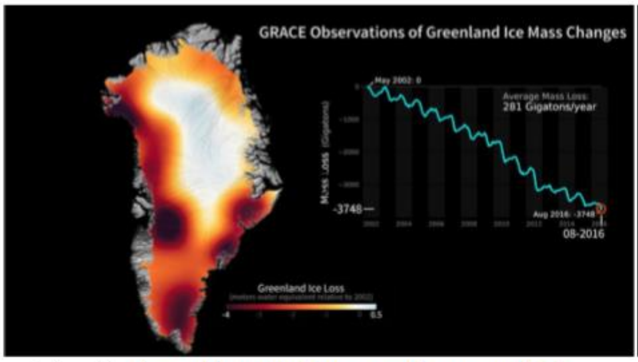


Fig. 3.7 Regional overview of the distribution of glaciers and ice caps

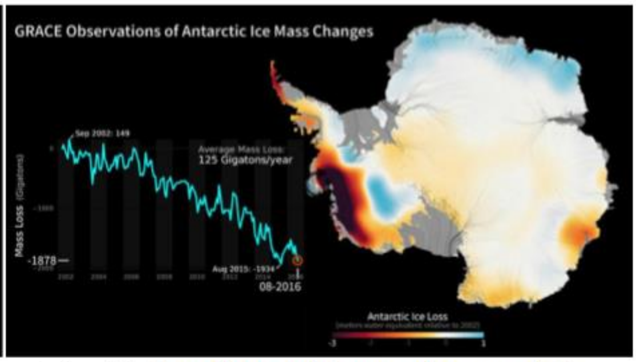
http://www.grid.unep.ch/glaciers/

In order to analyze these snow and ice losses, satellite images were observed showing the thickness and coverage of the ice and the impact of that melting, as well as quantifying the affected areas and observing changes in the ecosystem.

Pérdida de hielo en los polos

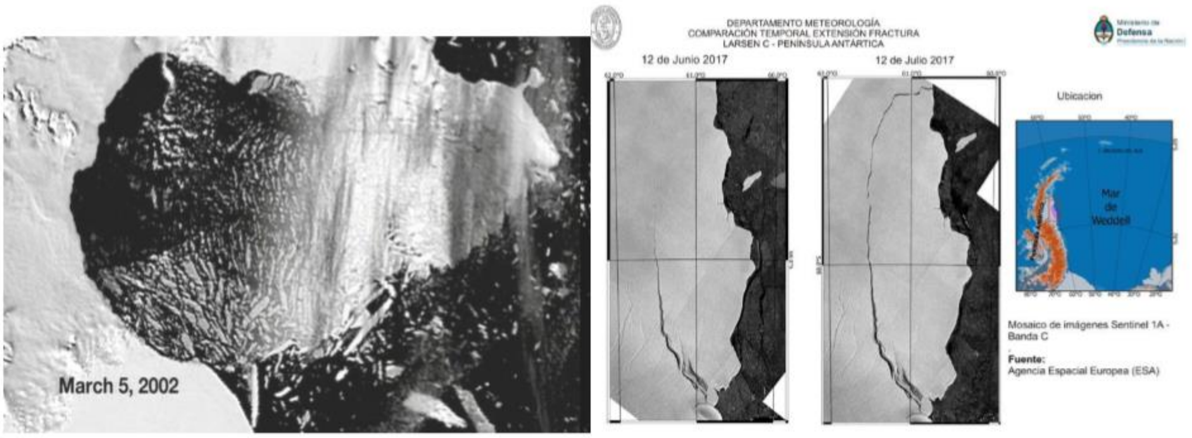


Animación: https://gracefo.jpl.nasa.gov/resources/33/



Animación: https://gracefo.jpl.nasa.gov/resources/34/

Antártida: Barrera de Hielo Larsen



Fuente: "La verdad incómoda". Documental.

To develop the research project, Landsat 5 and 8 images were used to compare changes in a period of time and the Landsat 8 images were validated with samplings in the terrain using the GLOBE Protocols, also calculating the green index, the water index and the snow index.

For this work two sites were taken, the Upsala Glacier in the Province of Santa Cruz, Argentina and the Lanín Volcano in the Province of Neuquén, Argentina. To make this choice, we considered the availability of images and the good visibility of them

The project has as an initiative to answer some questions such as: What is the impact of the ecological footprint on the loss of ice and glaciers and how is this impact in our region compared to other places in the world?

We also ask ourselves if satellite images can be used as tools to observe this impact.

2. Research Questions

The loss of snow and melting worldwide is a problem that progresses year by year and is attributed to global warming, climate change (it rains instead of snowing) and pollution (dark ice melts faster).

This loss of snow and ice in our area is very important because it directly affects the ecosystem and production systems, it is also very important to contextualize these changes on a global scale, comparing what happens in this region with other regions of the world.

This loss of snow and ice has as consequences, the melting of the glaciers at the poles and in the mountains; the loss of the thickness and extent of the glaciers; floods due to sea level rise; shortage of fresh water and droughts and fires in areas dependent on melting in summer.

In order to analyze these snow and ice losses, satellite images were observed showing the thickness and coverage of the ice and the impact of that melting, as well as quantifying the affected areas and observing changes in the ecosystem.

The main questions that this investigation tries to answer are:

What is the impact of the ecological footprint on the loss of ice and glaciers?

How is this impact in our region compared to other places in the world?

Can satellite images be used to observe this impact?

3. Hypothesis

There is a tendency to decrease ice and snow precipitation over time and this trend can be monitored through satellite images.

4. Materials and Method:

Landsat 5 and 8 images were used to compare changes over a period of time.

The Landsat 8 images were validated with samplings in the terrain, using GLOBE Protocols.

The green index, the water index and the snow index were calculated.

The following software was used:

- ✓ QGIS and Multispec (to analyze Landsat images)
- ✓ Google Earth to locate environmental problems
- ✓ CmapTools to map concepts
- ✓ Office to process information and present the investigation

Two sites were taken to compare:

Upsala Glacier (Province of Santa Cruz, Argentina), with a Landsat 5 satellite image of the year 2005 compared to a Landsat 8 image of the year 2017.

Lanín Volcano (Province of Neuquén, Argentina) with a Landsat 5 satellite image of the year 2010 compared to a Landsat 8 image of the year 2017.

To make this selection, the availability of images (of the same month) and good visibility (no clouds, dust or other phenomena of atmospheric disturbance) were considered.

To carry out the validation of the Landsat 8 images, samples were taken in the field, using GLOBE Protocols in three different sites within the San Ignacio CEI, which is located in the San Cabao Valley at 800 meters above sea level, in Junín de los Andes, where Sites had three different types of vegetation coverage (Bosque, Estepa and Mallín).

The description of the vegetation coverage of each site was applied, applying the GLOBE protocols of site selection, GPS, manual mapping, computerized mapping and Biometrics (GLOBE, 2005), which allowed assigning MUC codes to each study site.

Resultados del muestreo de cobertura terrestre

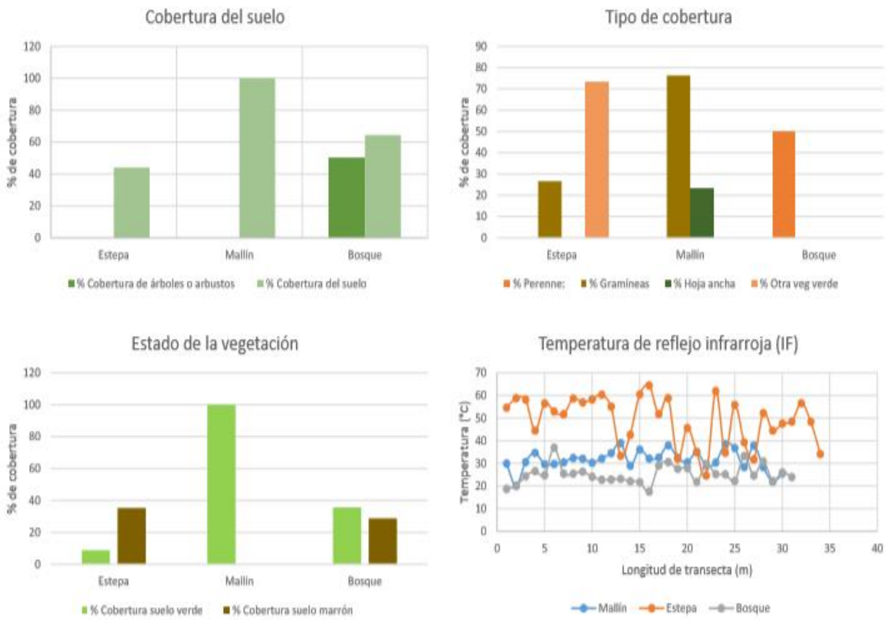
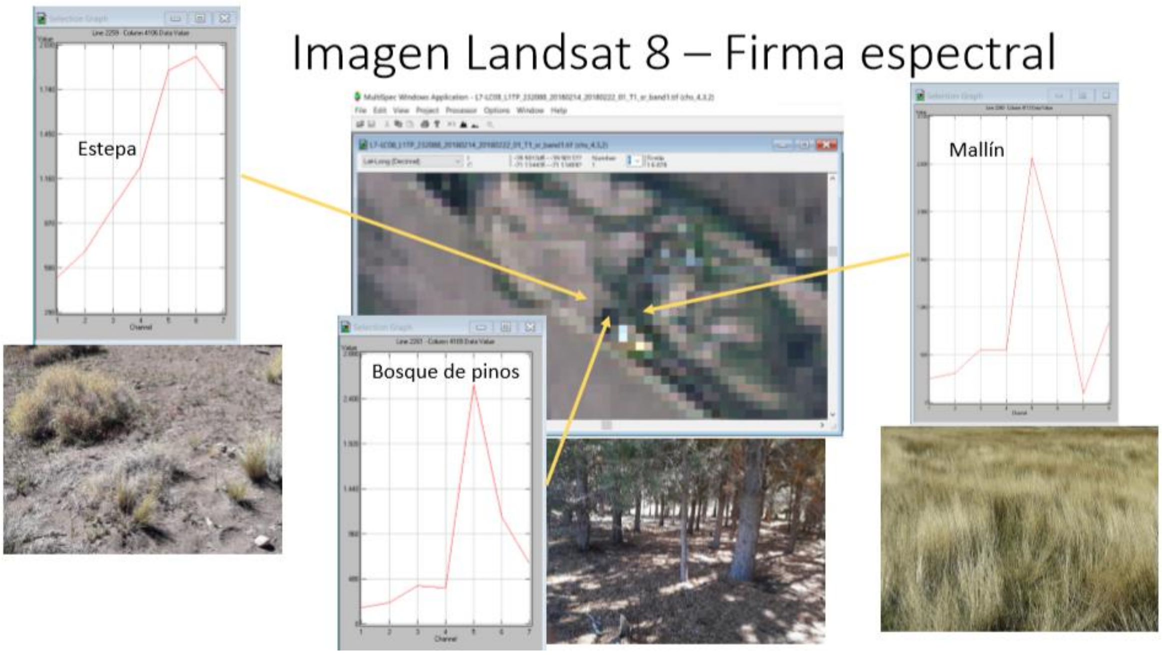


Imagen Landsat 8 – Firma espectral

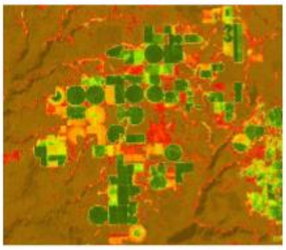


Calculation of indexes

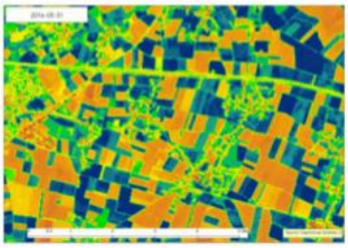
NDVI (Normalized Diference Vegetation Index) - Vegetation index

NDWI (Normalized Diference Water Index) - Water Index

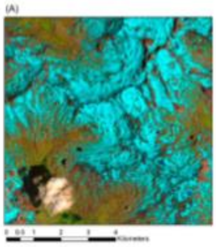
NDSI (Normalized Difference Snow Index) - Snow Index



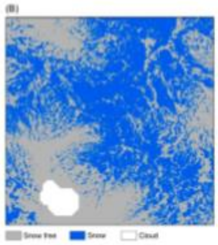
NDVI



NDWI

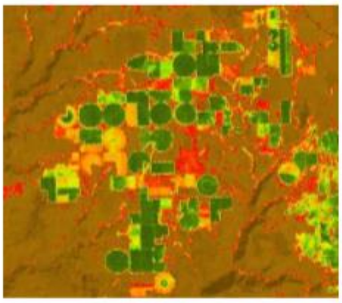


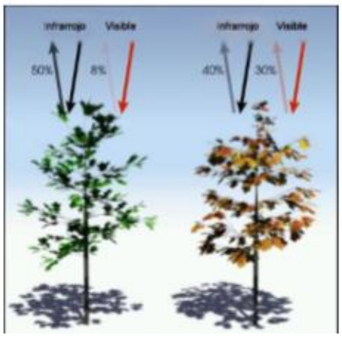
Imagen



NDSI

NDVI (Normalized Diference Vegetation Index) - Vegetation Index: Used to estimate the quantity, quality and development of vegetation Based on the measurement of the intensity of the radiation of certain bands of the electromagnetic spectrum that the vegetation emits or reflects.





Banda 5 → NIR, Banda 4 → Red

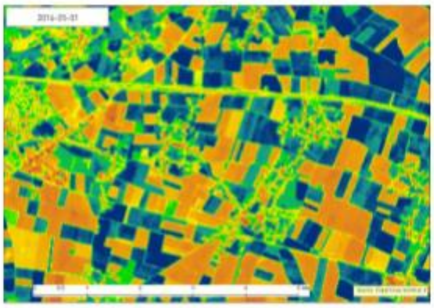
$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

Landsat 8		
Banda	Ancho (µm)	Resolución (m)
Band 1 Coastal	0.43 – 0.45	30
Band 2 Blue	0.45 – 0.51	30
Band 3 Green	0.53 – 0.59	30
Band 4 Red	0.64 – 0.67	30
Band 5 NIR	0.85 – 0.88	30
Band 6 SWIR1	1.57 – 1.65	30
Band 7 SWIR2	2.11 – 2.29	30
Band 8 Pan	0.50 – 0.68	15
Band 9 Cirrus	1.36 – 1.38	30
Band 10 TIRS1	10.6 – 11.19	100
Band 11 TIRS2	11.5 – 12.51	100

NDWI: (Normalized Diference Water Index) - Water Index

It is used as a measure of the amount of water the vegetation has or the level of moisture saturation that the soil possesses.

It is calculated from satellite images that provide reflectance information of a certain area in different frequency bands of the electromagnetic spectrum.



Banda 5 Banda 6

$$NDWI = \frac{(NIR-SWIR)}{(NIR+SWIR)}$$

Landsat 8		
Banda	Ancho (µm)	Resolución (m)
Band 1 Coastal	0.43 – 0.45	30
Band 2 Blue	0.45 – 0.51	30
Band 3 Green	0.53 – 0.59	30
Band 4 Red	0.64 – 0.67	30
Band 5 NIR	0.85 – 0.88	30
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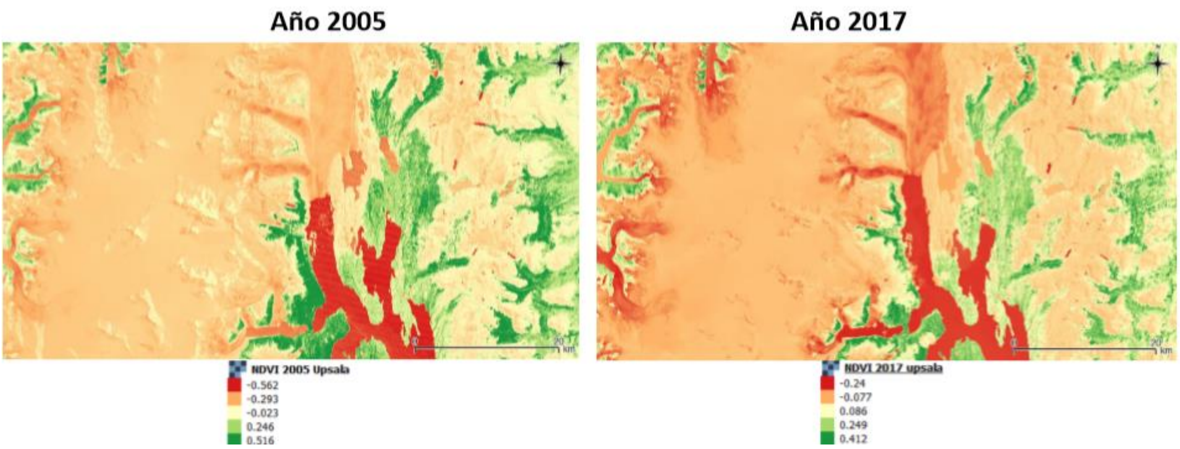
Band 8 Pan	0.50 – 0.68	15
Band 9 Cirrus	1.36 – 1.38	30
Band 10 TIRS1	10.6 – 11.19	100
Band 11 TIRS2	11.5 – 12.51	100

NIR: Infrarrojo cercano

SWRI: infrarrojo de onda corta

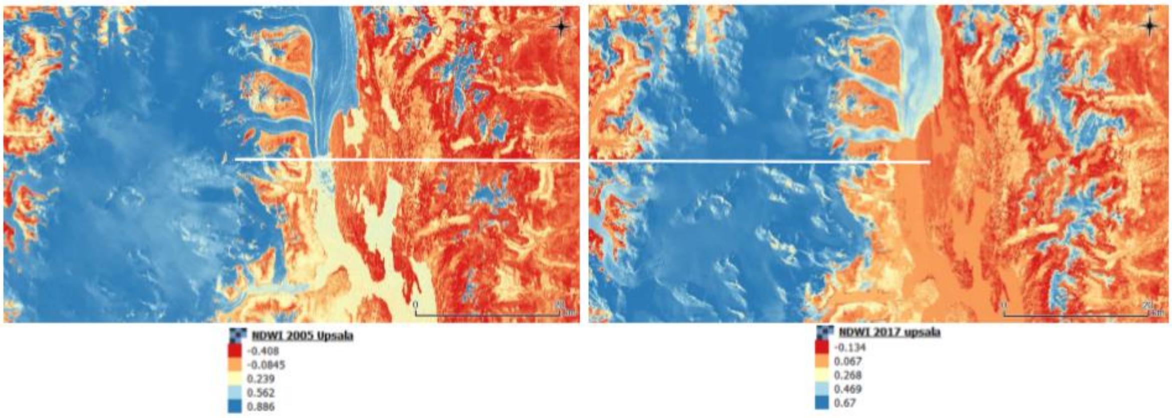
5. Results and analysis:

1) NDVI (Índice de verde) – **Glaciar Upsala**



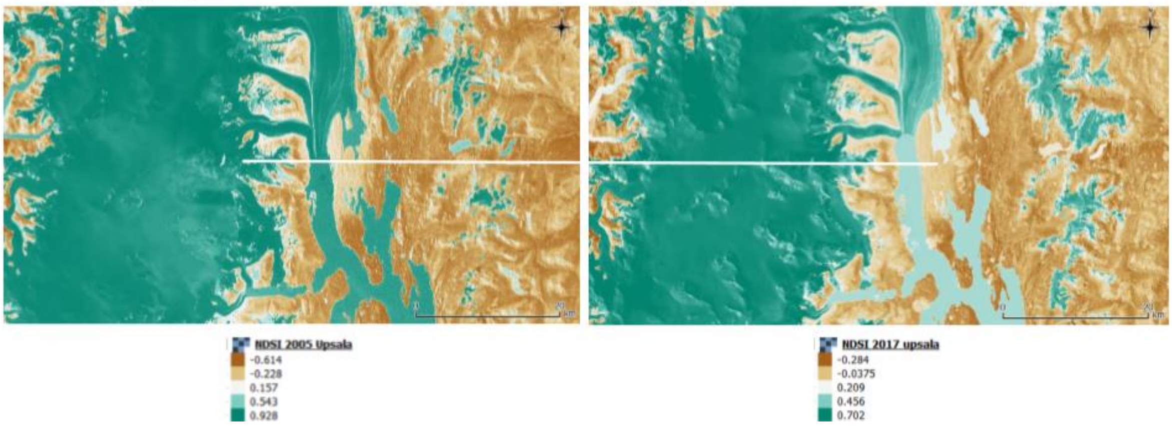
2) NDWI (Índice de agua) – **Glaciar Upsala**

Año 2005 **Año 2017**



3) NDSI (Índice de nieve) – **Glaciar Upsala**

Año 2005 **Año 2017**

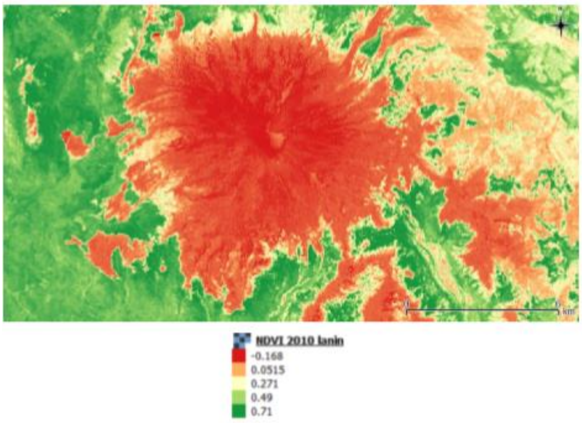


These two images illustrate the retreat of the Patagonian Upsala glacier. It is estimated that between 1997 and 2003, 13, 4 square km of ice melted on that site.

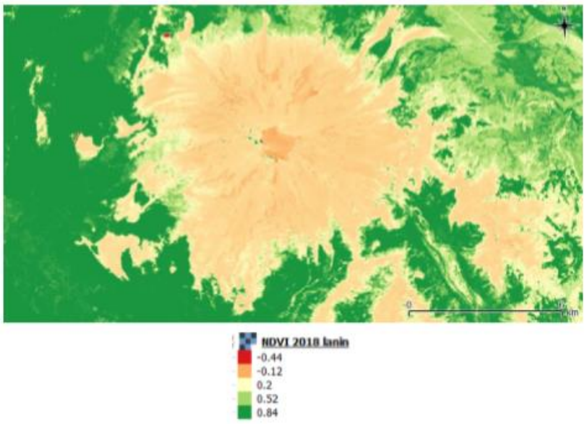
Fuente: "La verdad incómoda". Documental.

1) NDVI (Índice de verde) – **Volcán Lanín**

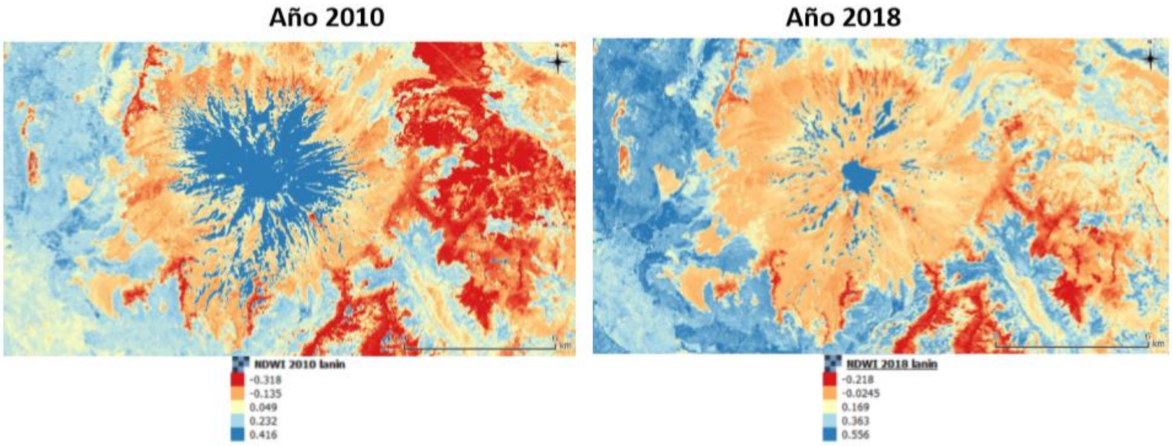
Año 2010



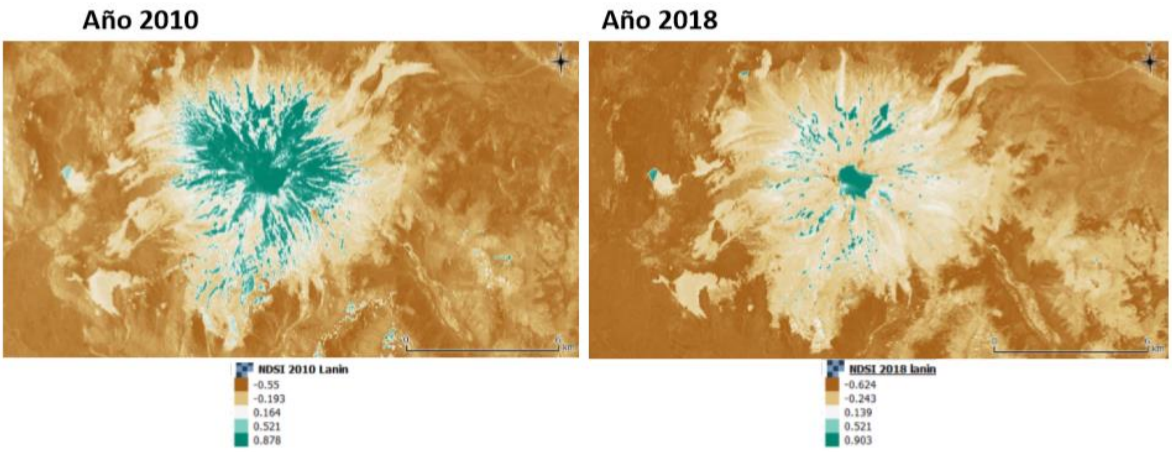
Año 2018



2) NDWI (Índice de agua) – **Volcán Lanín**



3) NDSI (Índice de nieve) – **Volcán Lanín**



According to the analysis of these satellite images, the Lanín Volcano has also suffered a significant setback in its surface covered with ice and snow, which is clearly detected in the calculations of the water and snow indexes.

6. Conclusions

In both sites an important loss of ice is detected, which can have as consequence an increase of the drought, a smaller availability of water, in particular in the summer (because it does not rain and both regions depend on the thaw as a source of water resource), Negative impacts on ecosystems and loss of moisture can affect vegetation and increase the risk of fires.

7. Discussion

The satellite images show the decrease of ice over time. This analysis by satellite images could be used to monitor some periods of the year since the satellite passes every 14 days through the site. Although it is not possible to see the origin of the loss of ice in the satellite images, the tendency of the loss of ice can be monitored.

Some recommendations to try to keep the ice and avoid the recoil of the surface covered with snow and ice are: Do not deforest, since the forests capture CO2 and help to reduce the greenhouse effect. Recycle as much material as possible to reduce pollution and the use of natural resources. Reduce the use of fossil fuels (reduce CO2 emissions). Decrease the emission of dust particles that are deposited in the ice and accelerates the thaw.

8. Acknowledgments:

We especially thank the students of CEI San Ignacio for dedicating many hours to the realization of the research plan and results analysis for this Project.

We would like to especially thank our mentor Professor Ana Prieto for helping us during the data analysis stage and in the preparation of the research report.

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