

United Nations/Brazil Symposium on Basic Space Technology
"Creating Novel Opportunities with Small Satellite Space Missions"
12/09/2018
Natal, Brazil.

ANALYSIS OF GLACIAL VOLUME CHANGE IN SNOW-CAPPED MOUNTAINS OF BOLIVIA AND PERU WITH THE USE OF A SMALL SATELLITE



UNITED NATIONS
Office for Outer Space Affairs

Natalia Indira Vargas Cuentas

September – 2018

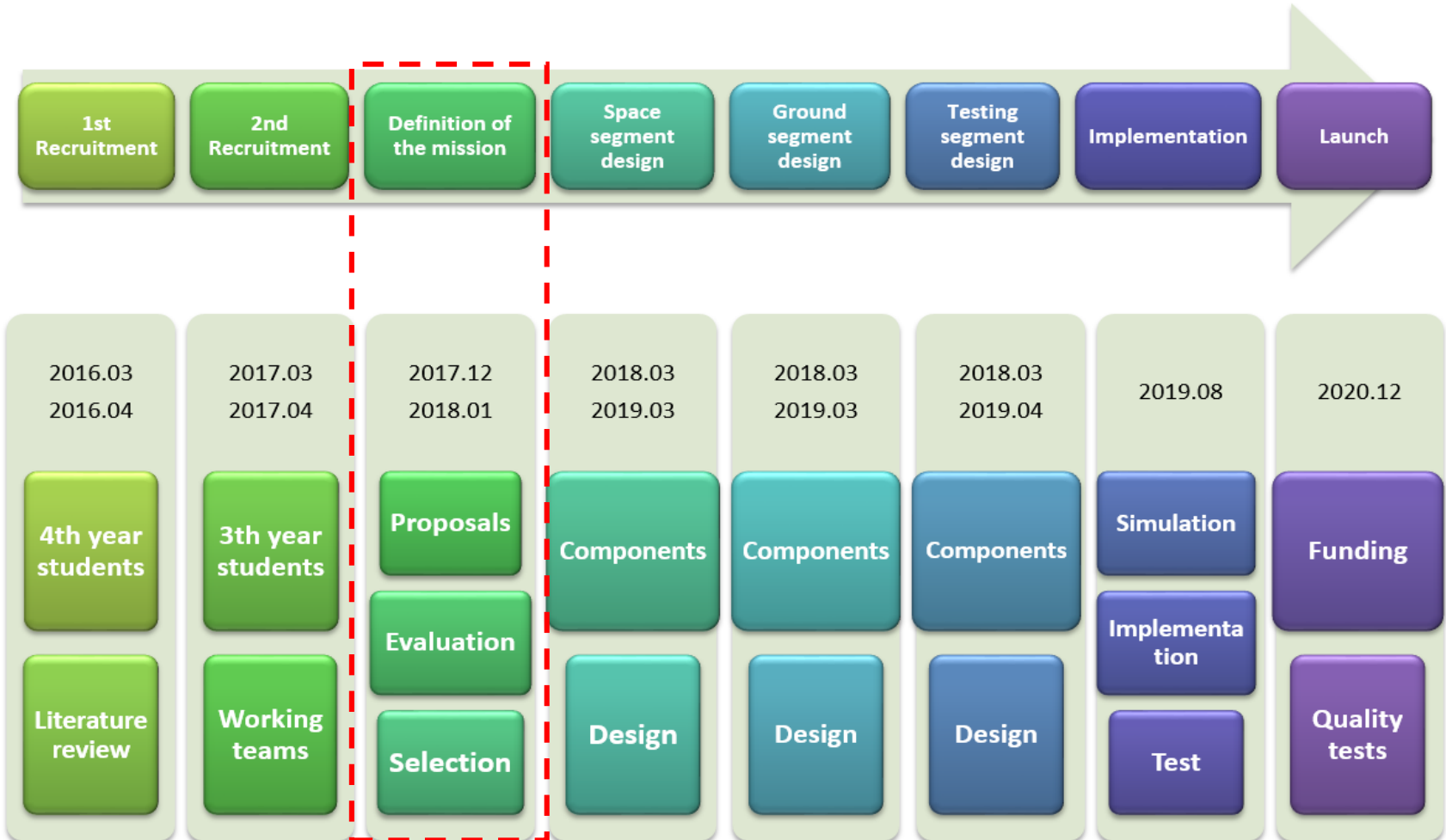


CONTENT

- Background
- Introduction
- Snow-capped of Bolivia and Peru
- Image processing system
- Results
- Conclusion

The INCA program

INvestigación en Ciencias Aeroespaciales, was created in March 2016 in the Universidad de Ciencias y Humanidades.



Design of the small satellite

A nanosatellite of 1U and 1 Kg of mass will be designed and implemented, consisting of seven main modules.



On-board computer



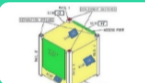
Power module



Thermal control module



Communication system



Attitude control system



Structure



Payload

Projects of the INCA program

- ✓ Initial design of the space segment.
- ✓ Application of the payload.
- ✓ Establishment of an amateur ground station.
- ✓ Small facility for test vibration.
- ✓ Indigenous 3D printer.



Introduction

A glacier is a large mass of compressed ice that is formed as a result of the snow remaining in one place.



The global warming and the progressive increase of the temperature have caused in the last years the phenomenon known as retreat of the glaciers.



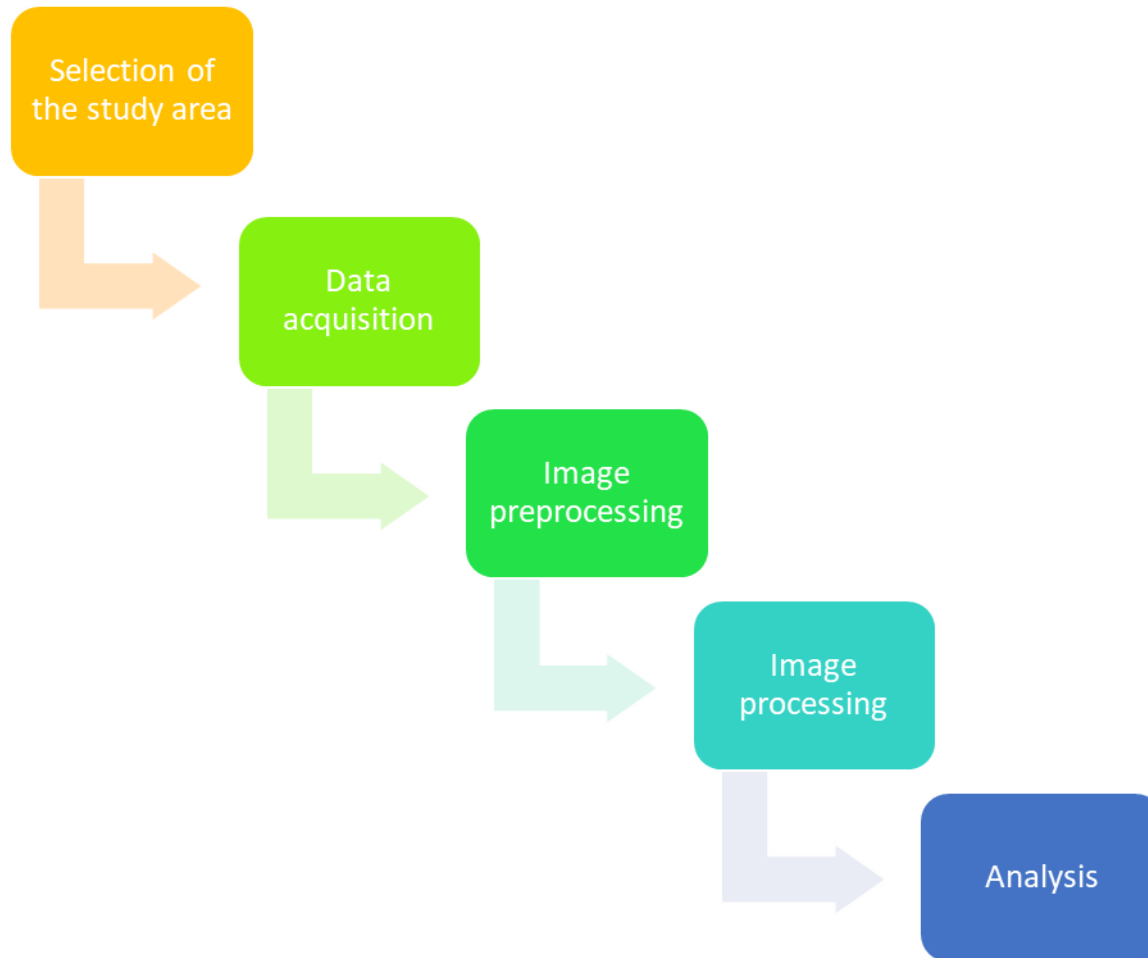
Snow-capped of Bolivia and Peru

- The National Institute of Glacier and Mountain Ecosystem Research indicates that since 1962 Peru lost 57% of its ice reserves and 42% of its glaciers.
- The amount of drinking water that has been lost is at least 3,000 million cubic meters, enough to supply the city of Lima for 5 years.
- According to the International Water Organization in 2025, Peru will be the first country in the region to suffer water stress due to climate change.

Snow-capped of Bolivia and Peru

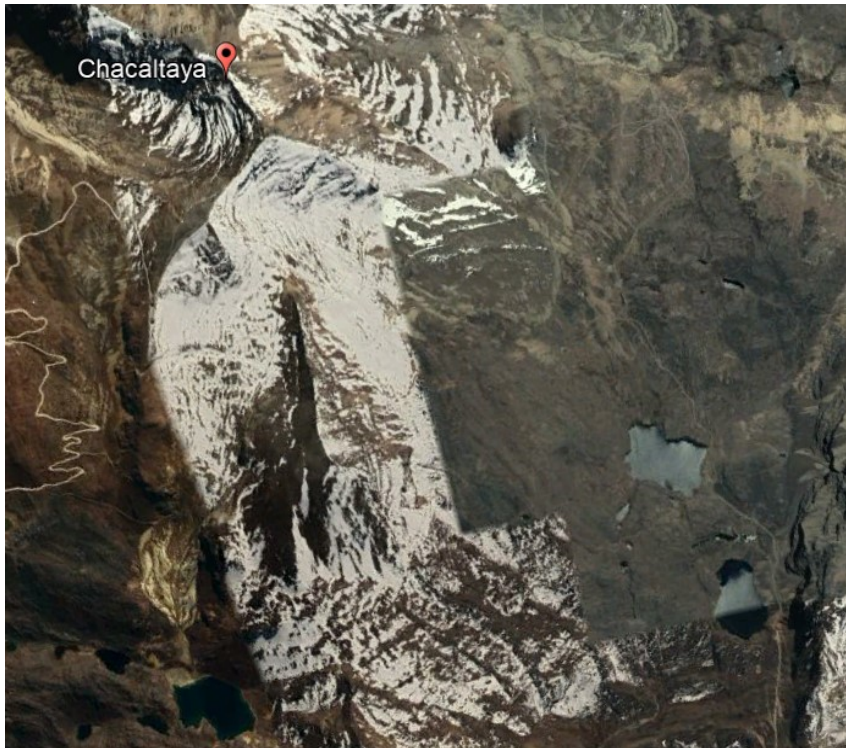
- According to the Institute of Geological and Environmental Research of Bolivia, the city of La Paz depends on 30% of glacial water throughout the year and this figure increases to 42% in the dry season.
- Some years ago in 2009 Bolivia witnessed the complete disappearance of Chacaltaya, which supplied 80% of La Paz's drinking.
- At the end of 2016, La Paz experienced a large shortage of drinking water that affected 177,000 families.

Image processing system



Study area

Snow capped	City	Country	Coordinates	Altitude (masl)
Chacaltaya	La Paz	Bolivia	16°19'S 68°10'O	5421
Yanamarey	Ancash	Peru	9°07'S 77°36'O	4856



Data introduction

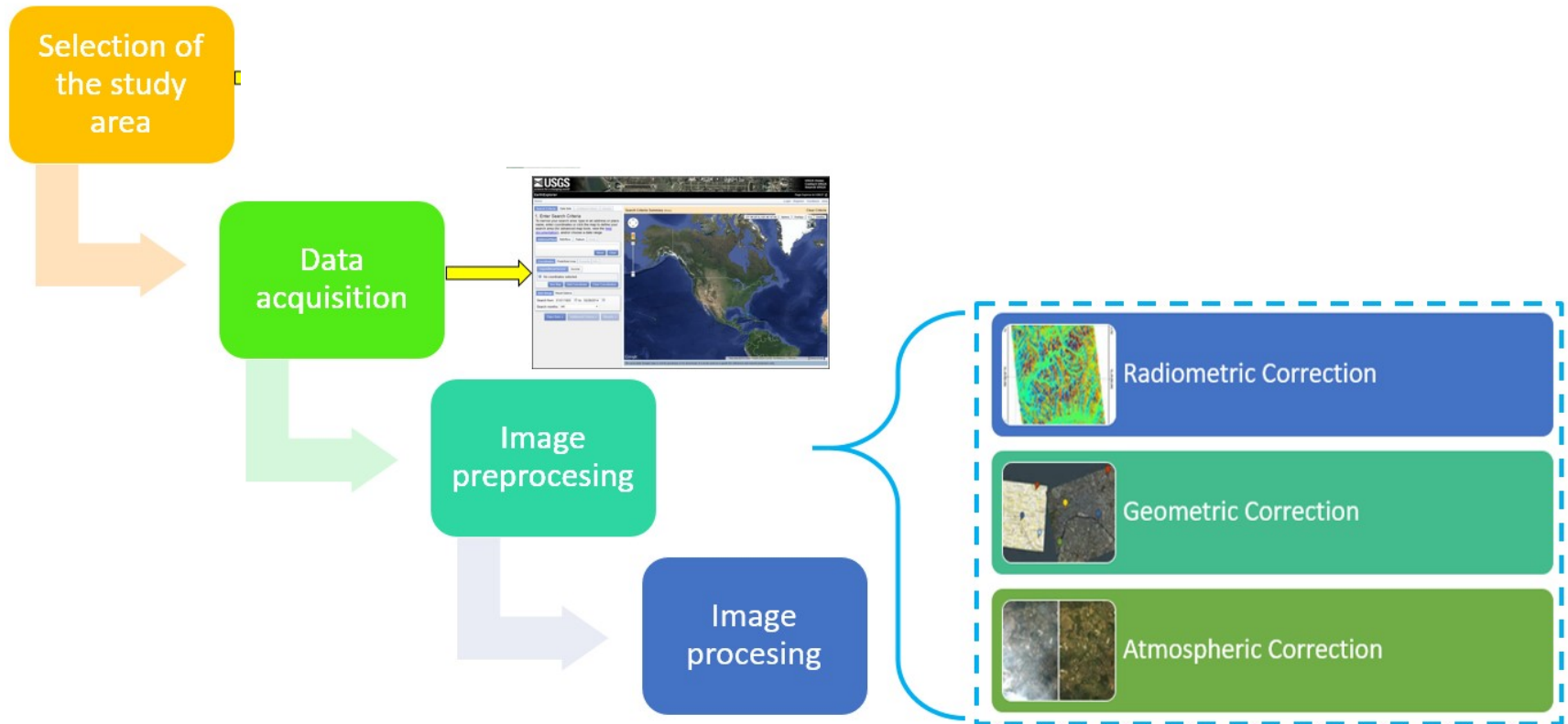
We use the satellite imagery from Landsat 8 satellite from 2013, 2015 y 2017.

Chacaltaya La Paz Bolivia					
Data set	Satellite	Sensor	Number of bands	Date acquired	%Cloud coverage
LC08_L1TP_001071_20130926_20170502_01_T	Landsat 8	OLI/TIRS	11	26/9/2013	<10%
LC08_L1TP_001071_20150831_20170404_01_T	Landsat 8	OLI/TIRS	11	31/08-2015	<10%
LC08_L1TP_001071_20170414_20170501_01_T	Landsat 8	OLI/TIRS	11	14/4/2017	<10%
Yanamarey Ancash Peru					
Data set	Satellite	Sensor	Number of bands	Date acquired	%Cloud coverage
LC08_L1TP_008066_20130927_20170502_01_T	Landsat 8	OLI/TIRS	11	27/9/2013	<10%
LC08_L1TP_008066_20150901_20170404_01_T	Landsat 8	OLI/TIRS	11	1/9/2015	<10%
LC08_L1TP_008066_20170618_20170629_01_T	Landsat 8	OLI/TIRS	11	18/6/2017	<10%

We complement this data with drone images of a selected area of 100x100 in each snow-capped:

Instrument	Sensor	Number of bands	Date
Drone	Multispectral	4	15/11/2017

Image pre-processing

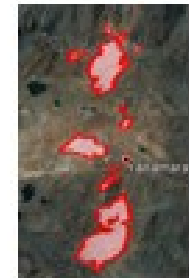
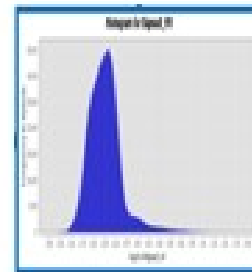


In order to acquire valid information from our satellite images, different types of corrections must be made in the pre-processing stage

Image processing



$$NDSI_{LB} = \frac{Band_3 - Band_6}{Band_3 + Band_6}$$



Results

We observe the following behavior in the snow-capps:

Chacaltaya La Paz Bolivia				
Year	Perimeter (km)	Area (km2)	Glacial retreat (km)	
2013	0,34	0,01	-1,65	-1,75
2015	1,99	0,16		
2017	3,74	0,69		
Yanamarey Ancash Peru				
Year	Perimeter (km)	Area (km2)	Glacial retreat (km)	
2013	7,56	1,62	2,14	1,98
2015	5,42	0,79		
2017	3,44	0,54		

We compare the NDSI in the satellite images and the drone images:

Chacaltaya La Paz Bolivia			Yanamarey Ancash Peru		
Data set	Max_NDSI	Min_NDSI	Data set	Max_NDSI	Min_NDSI
Satellite image	0,67	-0,07	Satellite image	0,83	0,29
Drone	0,78	-0,1	Drone	0,92	0,24



Conclusion

- With the development of this proof of concept we have trained and awakened the interest in new students that now are part of the project.
- Our students show more commitment in order to solve this real problem.
- The nanosatellite will be developed with the help of undergraduate students, so the main objective is educational, but we believe it is important to show how aerospace technology and its applications help to solve real problems.

Thank you for your attention!



natalia.i.vargascuentas@ieee.org