The 8th
Mission Idea Contest
for Multiple Nano-satellites

UNISEC GLOBAL
University Space Engineering Consortium

Monitoring the greenhouse gases on the terrains of Continental Collision Plates and warning system of glacial lake outburst floods over the Hindu Kush Himalayan range

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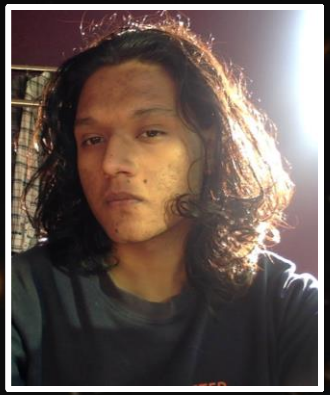

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Outline


INTRODUCTION
CONCEPT OF OPERATIONS
SATELLITE DESIGN
MISSION
KEY PERFORMANCE PARAMETERS
IMPLEMENTATION PLAN

INTRODUCTION

INTRODUCTION

- Climate change
- Increase in global mean temperature by $0.18°C$ per decade
- Climate change is sensitive to altitude.

- Mountains are particularly sensitive to climate change.
- Disasters like outburst floods and landslides can be attributed to climate change.

INTRODUCTION

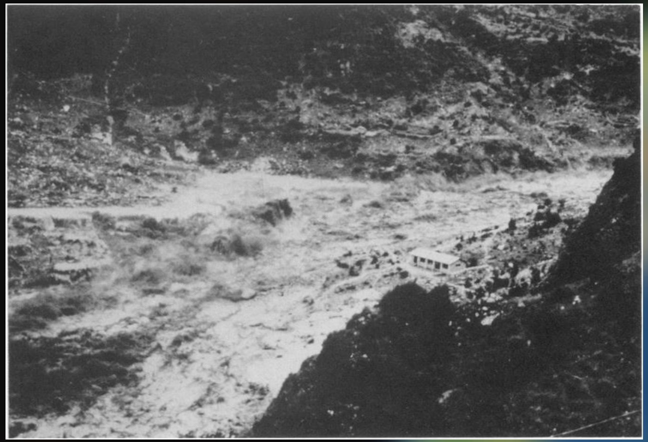

Fig 1: Flash-flood at the site of the Namche Small Hydel Plant, on August 4, 1985.

Fig 2: Massive mudflows in the mountains of Nelson County due to Hurricane Camille, 1969.

Fig 3: Imja Glacial Lake in 2007 (a) and in 2014 (b).

Fig 4: Avalanche in Galtur, Austria, 1999.

INTRODUCTION

Greenhouse gases

- Predominant indicators of atmospheric climate change.
- Tipping elements like loss of major ice sheets, disruption of tropical monsoons and ecosystem shifts can be directly or indirectly correlated.

Glaciers

- Another key indicator of climate change in continental collision terrain.
- Disastrous events like outburst floods, landslides and avalanches can be attributed to climate change in the region.

At present, there is a data gap relating the two phenomena, due to a lack of comprehensive and excessive data.

MISSION

MISSION

Remote sensing over the terrains formed by continental plates collision

HKH region as an early indicator of climate change

Reduce potential damage from glacial lake outburst floods

Possible relation between greenhouse gases and geographical terrain

MISSION

Primary Objective
To monitor greenhouse gas levels in terrains formed by continental plates collision.

Secondary Objective
To monitor and analyze glacial lakes in the areas of interest.

CONCEPT OF OPERATIONS

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SPACE SEGMENT

Constellation of 3 satellites in a hybrid SSO/LEO

- Satellite in LEO in 35° inclination will monitor data over the HKH region.
- Satellite in LEO 65° in inclination will monitor other continental collision plates terrain, as well.
- Satellite in dawn dusk SSO will capture data for auto correlation.

Fig 5: Constellation Orbit

LAUNCH SEGMENT

- The satellites will be launched from Polar Satellite Launch Vehicle (PSLV) and deployed from the Dhruva Space Orbit Deployer.
- After deployment, the satellite will start the detumbling mode, while sending beacons for communication.
- The satellites can be tracked using Two-Line-Element (TLE) set.

Fig 6: PSLV rocket

GROUND SEGMENT

- Ground station
  - The primary ground station selected for the mission is National Remote Sensing Centre (NRSC), India.
  - The ground station at Kyutech University which supports communication in S band, will be used to downlink the data.
  - The ground stations that are part of the BIRDS ground station network will be used to downlink data, if upgraded to X/S band.

Fig 7: NRSC, India

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GROUND SEGMENT

- Post-processing
  - Using Argus GSE, the captured greenhouse gas data will be analyzed.
  - The images, once downlinked, will be processed using ArcGIS to calculate the NDWI.
  - The data, raw and processed, will be made available via a web-portal for further processing or research.

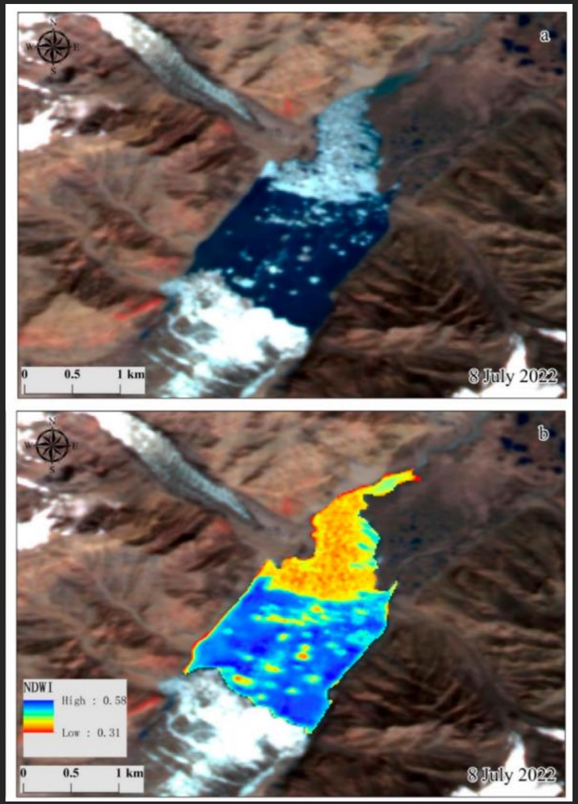

Fig: 8 Satellite image before and after calculating NDWI

Fig: 9 Food and Agriculture Organization

Fig 10: International Centre for Integrated Mountain Development

KEY PERFORMANCE PARAMETERS

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Constellation

Data Acquisition

Constellation

- The mission will have 2 6U satellites in Bender constellation with an additional satellite in 35° inclination.
- Due to greater spatial coverage, the Bender constellation was selected for this mission.

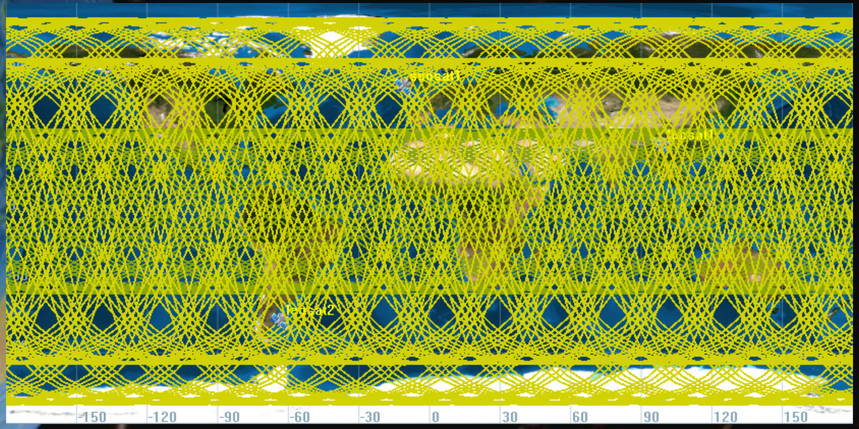


Fig 11: Bender constellation, ground track(4 days).

Data acquisition

- To map the spatial variations in greenhouse gases, Argus 2000 IR spectrometer will be used.
- To capture the glacial lake data, Multiscape 100 CIS imager will be used.
- A hybrid NADIR/Spinning configuration will be used for optimal data acquisition.

Fig 12: Argus 2000 IR Spectrometer

Fig 13: Multiscape 100 CIS imager

SATELLITE DESIGN

Payloads:
- Spectrometer and Imager

ADCS
- 3 reaction wheels, 3 magnetorquer and a star tracker

Communication system
- X-band transmitter and an S-band transceiver

Command and Data-handling system
- On-board computer with a combined mass memory

Power system
- 3U solar panels on the sides
- 6U-XL solar panels on the front and the back
- Maximum generated power = ~55W
- 50 W-h Li-Po Battery

Structure
- 6U-XL Aluminum structure

Projected cost = <$500,000 per satellite

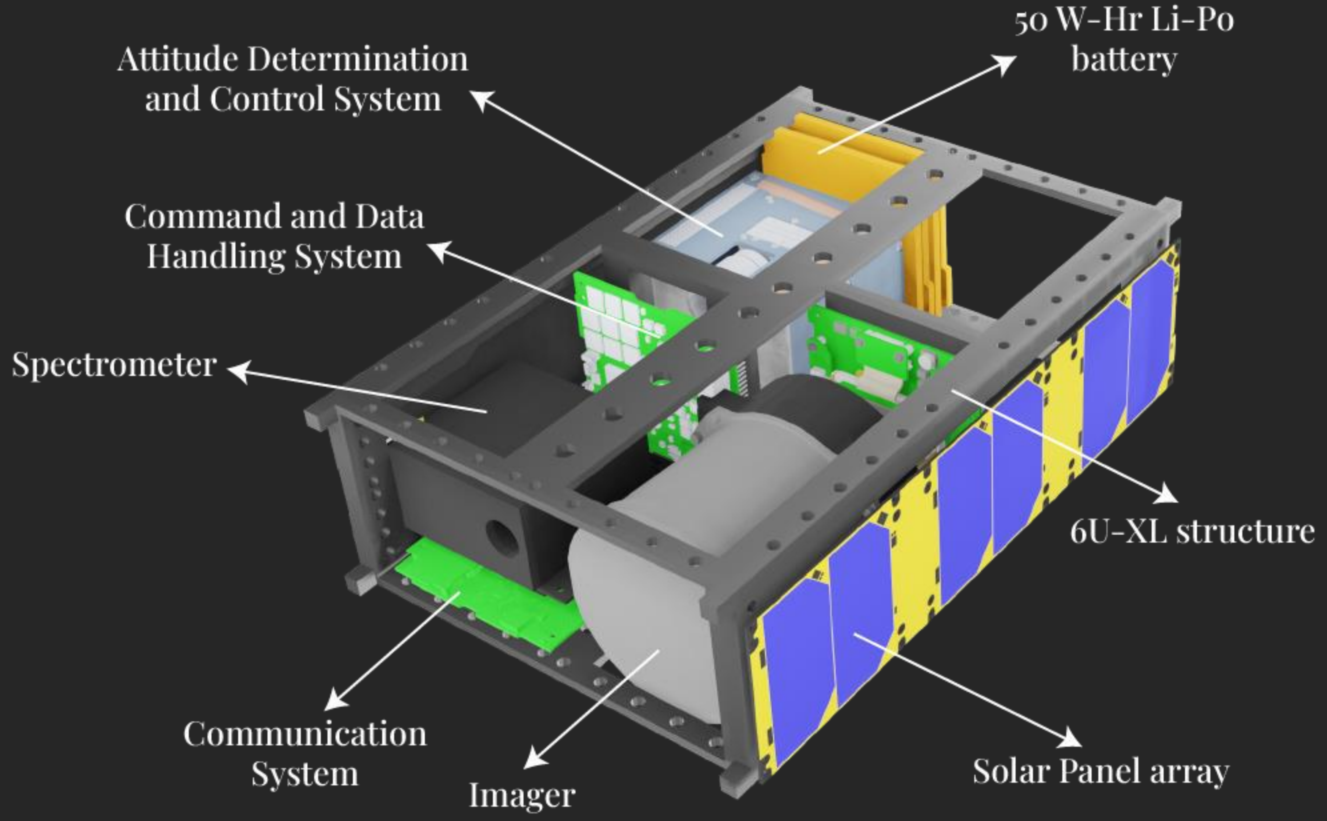


Fig 14: Bus design

SATELLITE DESIGN

Risk

RISK	CAUSE	MITIGATION
Insufficient Solar Power	Satellite configuration	Power optimization mode for satellites in LEO
Data Downlink	Frequency band incompatibility	Using leased compatible ground station network

IMPLEMENTATION PLAN

IMPLEMENTATION PLAN

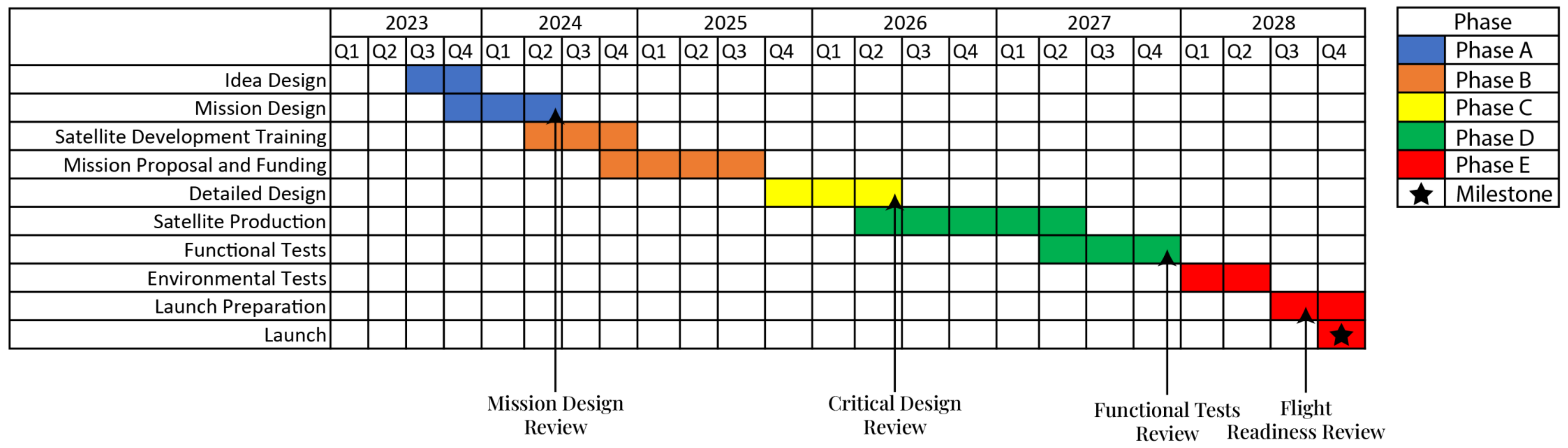


Fig 15: Gantt chart

Conclusion

Lack of data in GHG induced climate change

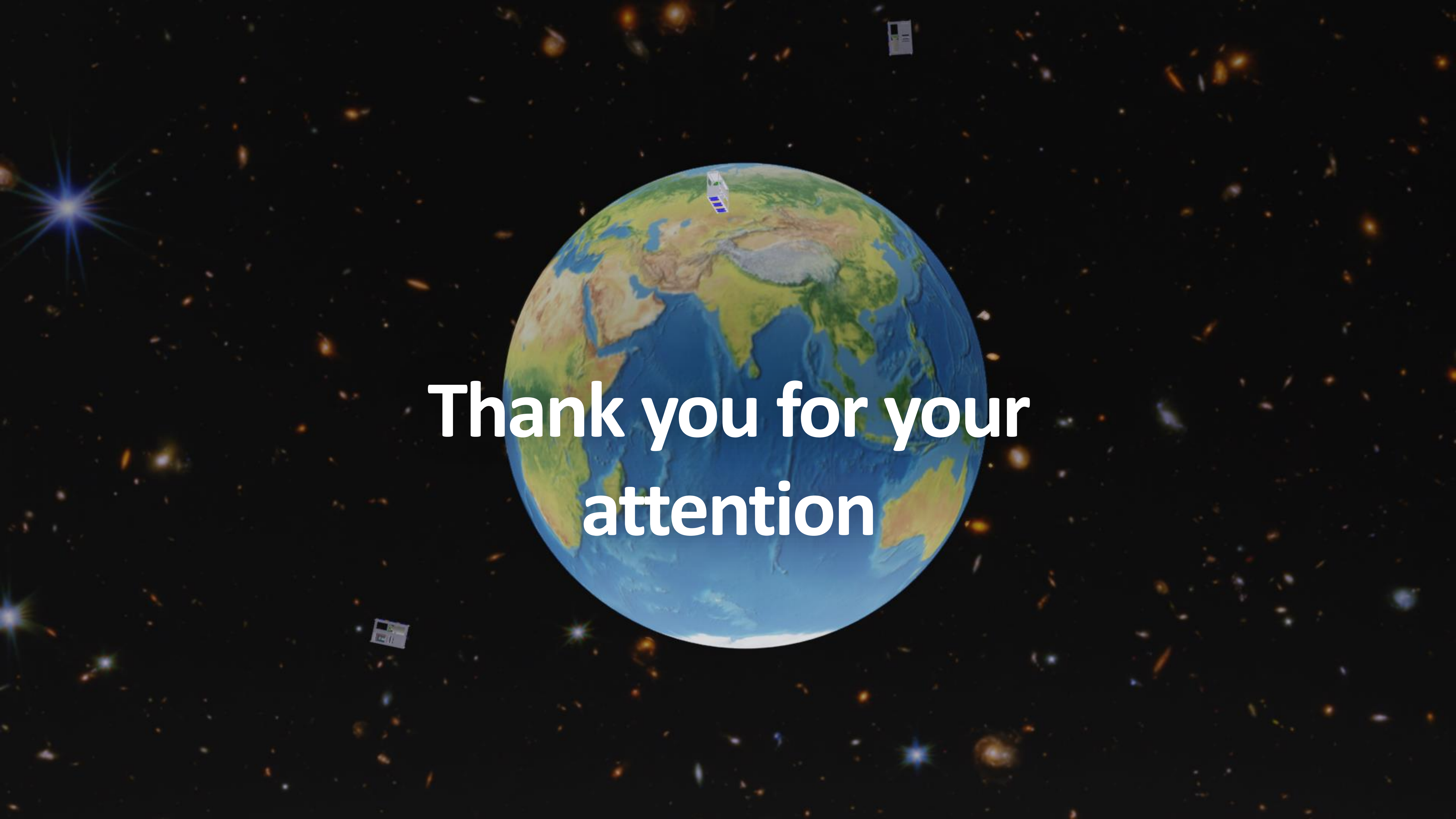
Possible relation between greenhouse gas and outburst flood occurrence

Constellation of three 6U satellites

Mitigate the effects of outburst floods in the downstream communities

Fill the data gap that has been missing

Use the relevant findings for a credible scientific assessment



Thank you for your attention


Questions?

Appendix

Subsystem	Mass	Power	Size
Spectrometer – Argus 2000 IR	280 gm	< 1W	$46*80*80mm^3$
Imager – Multiscape 100 CIS	1600 gm	2.5 W – readout 5.8 W – imaging	98 x 98 x 176 mm
ADCS – iADCS400	1300 gm	2-5 W	95.4 x 95.9 x 67.3 mm
Communications			
mini-X-band transmitter	300gm	<10W	$96*90*24\ mm^3$
microTTC S-band transceiver	N/A	<10W	$96*90*24\ mm^3$
Command and Data handling – Sirius Command and Data Handling System	130 gm	1.3W	$230*155*37\ mm^3$
Electrical Power Subsystem			
Solar Panels	390*2 + 146*2 gm = 1072 gm	19.2*2 + 8.4*2 Orbital Power - N/A	$226.3*366*1.6mm^3$ $100*366*1.6\ mm^3$
Battery	210 gm	50 Whr	$89*95*7\ mm^3$
Structure			
6U-XL Aluminum structure	908 g		$100 \times 226.3 \times 366\ mm^3$

Table 1: Mass and Power budget

Appendix

Orbital Parameters	LEO SAT 1	LEO SAT 2	SSO SAT 3
Semi major axis (km)	6978.14	6978.14	6978.14
Eccentricity (deg)	0.0007	0.0007	0
Inclination (deg)	35	65	97.8
Angle of perigee (deg)	280	280	0
RAAN (deg)	250	250	82.5
True Anomaly (deg)	0	180	0
Pointing	NADIR	Spinning	NADIR

Table 2: Orbital parameters and pointing configuration

Appendix

Ground Station	Transmitter 1		Transmitter 2		Transmitter 3		Average	
	Duration	No of Access	Duration	No of Access	Duration	No of Access	Duration	No of Access
KyuTech	698.492	7	628.858	6	697.162	4	673.602	6
UPD	637.927	9	586.477	5	661.72	4	586.477	6
DITT	662.623	8	563.822	6	579.324	5	609.502	6
UiTM	639.345	7	532.601	5	695.39	4	604.999	5
NRSC	640.995	9	705.908	4	528.697	5	624.226	6

Table 3: Ground station access times

Image Credit

Background Credit: James Webb Space telescope, NASA
Earth: https://www.istockphoto.com/photo/earth-map-gm172263073-2870355
Fig 1: Dig Tsho (4,400 m a.s.1.), the pear-shaped glacial lake lies embedded in the uppermost Langmoche valley, one of the tributary valleys of the Bhote Kosi valley, above Thame, Khumbu Himal. Photograph by Tj. Peters, 14 October 1982.
Fig 2: https://www.washingtonpost.com/weather/2019/08/19/virginias-deadliest-natural-disaster-unfolded-years-ago-hurricane-camille/
Fig 3: Watanabe, Teiji & Byers, Alton & Somos-Valenzuela, Marcelo & Mckinney, Daene. (2016). The Need for Community Involvement in Glacial Lake Field Research: The Case of Imja Glacial Lake, Khumbu, Nepal Himalaya. 10.1007/978-3-319-28977-9_13. , photographs by Alton Byers
Fig 4: https://www.forbes.com/sites/davidbressan/2016/12/20/evaluating-avalanches-danger-in-a-warming-world-lessons-from-past-climate-change/?sh=4ad4aa33594a
Fig 6: https://www.indiatoday.in/science/story/isro-pslv-c54-mission-oceansat-eos-06-nano-satellites-sriharikota-2301072-2022-11-24
Fig 7: NRSC, ISRO.
Fig 8: *Gu, C. et al. Monitoring Glacier Lake Outburst Flood (GLOF) of Lake Merzbacher Using Dense Chinese High-Resolution Satellite Images*

Image Credit

Fig 9: Food and Agricultural Organization, https://www.fao.org/home/en
Fig 10: International Centre for Integrated Mountain Development (ICIMOD), https://www.icimod.org/
Fig 11: NASA General Mission Analysis Tool (GMAT)
Fig 12: http://thothx.com/getmedia/4c0d3242-b4fb-4e9d-abf7-85dbb5c6653f/20180815-Argus-2K-Owner-s-Manual,-Thoth-Technology,-rel-1-03.aspx
Fig 13: https://catalog.orbitaltransports.com/multiscape100-cis/