



THERMAL INFRARED REMOTE SENSING USING NANO-SATELLITES FOR MULTIPLE ENVIRONMENTAL APPLICATIONS

A Mission Idea and Business Model

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The UP Department of Geodetic Engineering is the country's leading institution in geospatial research and instruction, serving the nation through its undergraduate and graduate degree programs, and its various training modules.

Charting the Future...

Environmental Systems Applications of Geomatics Engineering (EnviSAGE) Research Laboratory

- Recently created Research Laboratory of the UP DGE-TCAGP
- Focuses on the use of Geomatics for environmental research, including the interactions between the physical and natural environments and socio-economic systems.



Head: Dr Ariel C. Blanco
Chairman, UP DGE-TCAGP
Regional Coordinator, MIC

On-going Projects

- JST-JICA Coastal Ecosystem Conservation and Adaptive Management (CECAM) Project
- Guimaras Project (Assessment of hydrologic carrying capacity of island watersheds: Groundwater resource assessment)
- Establishing the 3D Campus GIS of UP Diliman (UPDGIS-3D) Project

The EnviSAGE MIC Team



- Edgardo G. Macatulad – Team Leader
Research Field: Disaster Risk Reduction and Mitigation



- Ed Carla Mae A. Tomoling
Research Field: Water Resource Monitoring and Management



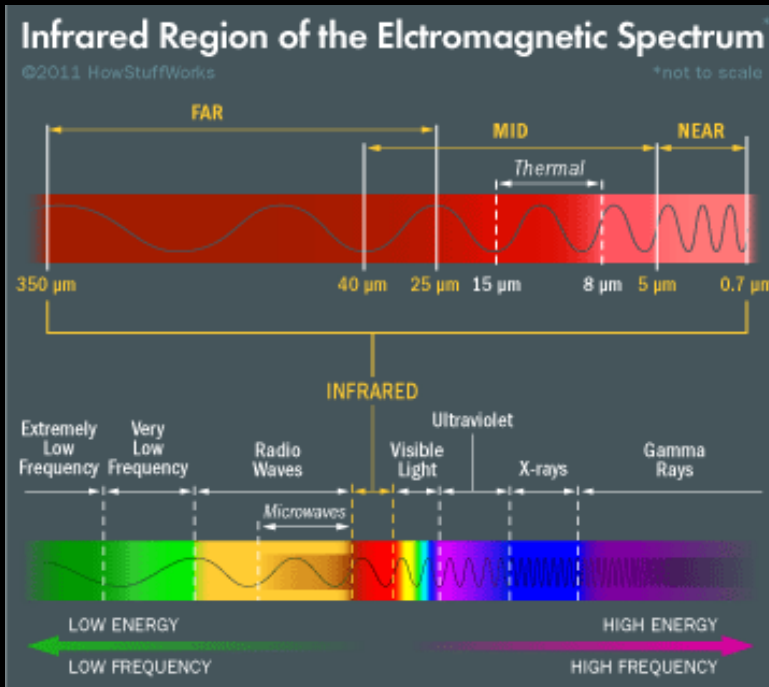
- Mylene J. Villanueva
Research Field: Urban Environmental Conditions Assessment and Modelling

Outline

- Introduction
 - TIR RS for the Philippine environmental setting
- Mission Idea and Business Model
- Business Feasibility
 - Cost Model
 - Projected Financial Estimates
- Risk Analysis
- Conclusion and Recommendation

Thermal Infrared (TIR) Remote Sensing

- Sensing of emissive energy or “temperature” using TIR region of electromagnetic spectrum



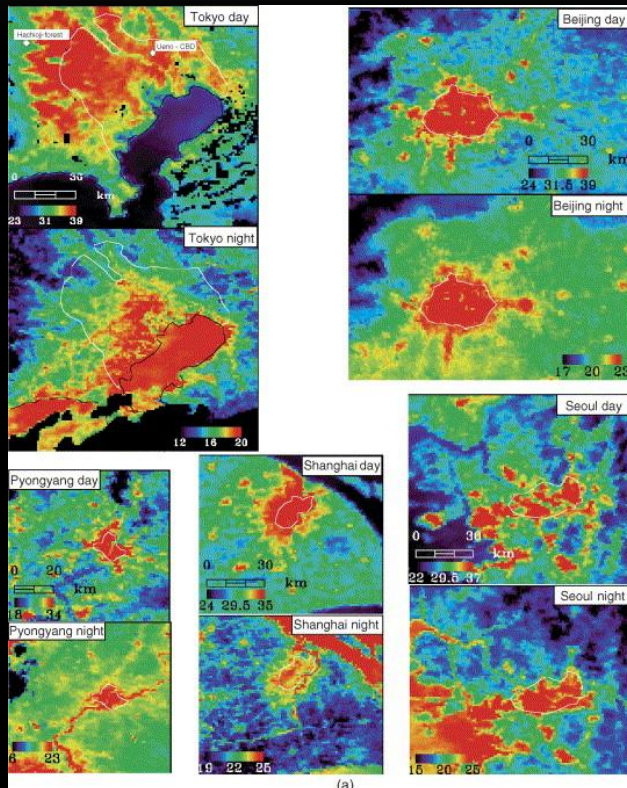
- Used in studies concerned in thermal properties or characteristics of an area

TIR RS for the Philippine environmental setting

1. Urban Heat Island Effects/Climatology
2. Temperature Analysis for Weather Predictions
3. Pre-Earthquake Temperature Anomaly Studies for Earthquake Prediction
4. Identification and Monitoring of Volcanic Activity
5. Water Quality Monitoring for Ecosystem and Resource Management

TIR RS for the Philippine environmental setting

1. Urban Heat Island Effects/Climatology



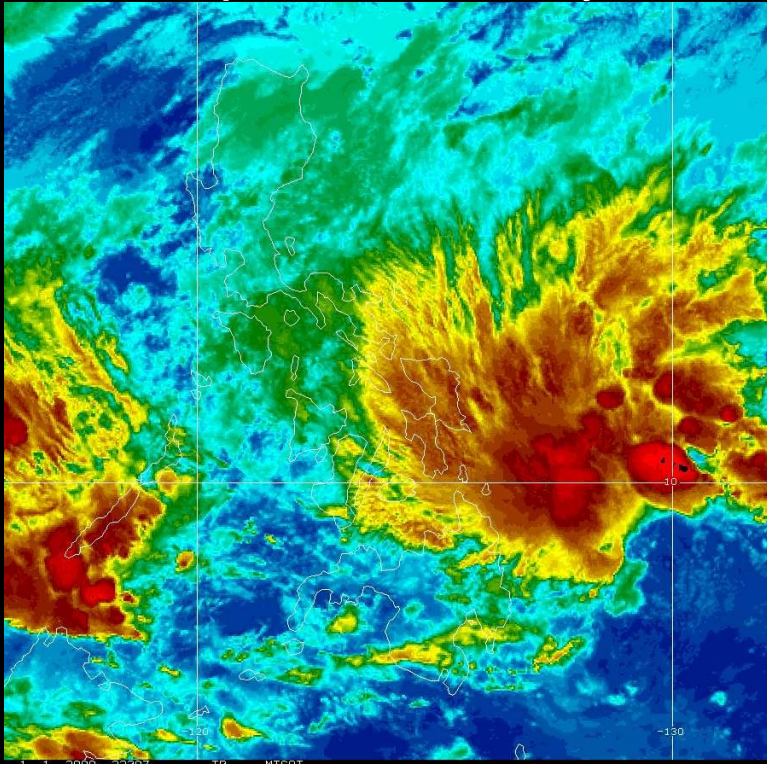
- Integrated with in-situ data to determine internal climates of buildings and model energy exchanges with the urban atmosphere

Assessment with satellite data of the urban heat island effects in Asian mega cities
Hung Tran et .al.

<http://ars.els-cdn.com/content/image/1-s2.0-S0303243405000565-gr3a.jpg>

TIR RS for the Philippine environmental setting

2. Temperature Analysis for Weather Predictions



<http://img81.imageshack.us/img81/7122/philvisyi2.jpg>

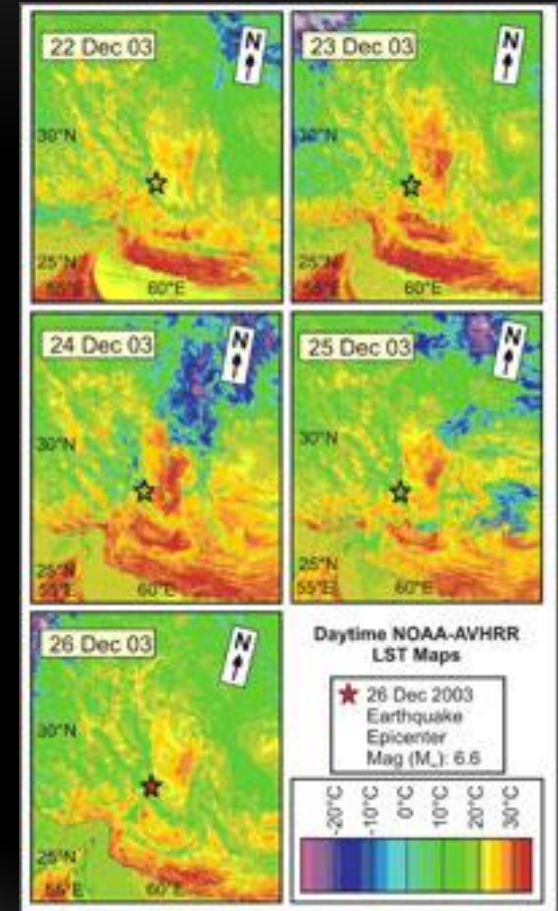
- Typhoon tracking and intensity determination
- Determining cloud heights and types
- Calculation of land and surface water temperatures

TIR RS for the Philippine environmental setting

3. Pre-Earthquake Temperature Anomaly Studies for Earthquake Prediction
 - Thermal Anomalies before an imminent Earthquake can help predict location of epicenters

Detecting Earthquake Precursor: A Thermal Remote Sensing Approach, Arun K. Saraf et.al.

Daytime NOAA-AVHRR LST time series map of Iran before and after the earthquake in Bam, Iran on 26 Dec 2003

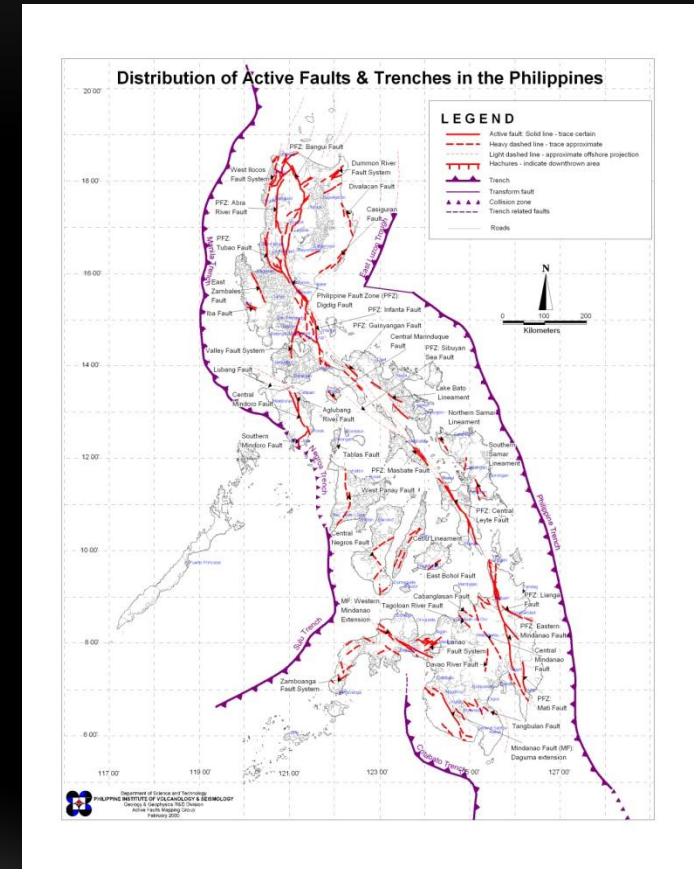


http://www.gisdevelopment.net/application/natural_hazards/earthquakes/images/mi08299_1.jpg

TIR RS for the Philippine environmental setting

3. Pre-Earthquake Temperature Anomaly Studies for Earthquake Prediction

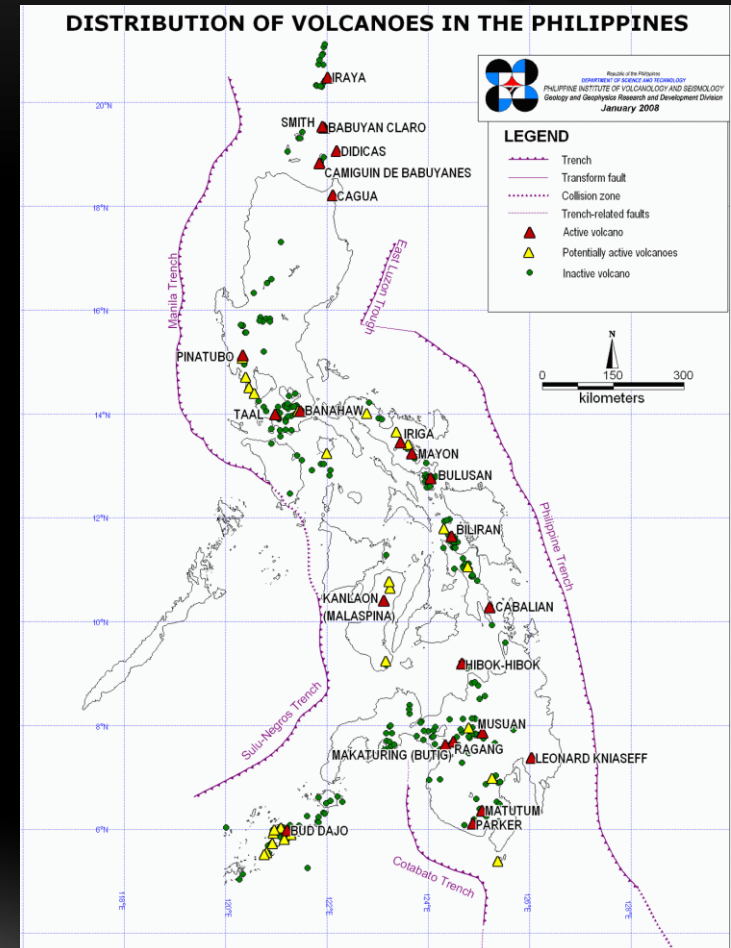
- Will be beneficial for the Philippines, being located in the “Pacific Ring of Fire”



http://www.phivolcs.dost.gov.ph/index.php?option=com_content&view=article&id=78&Itemid=500024

TIR RS for the Philippine environmental setting

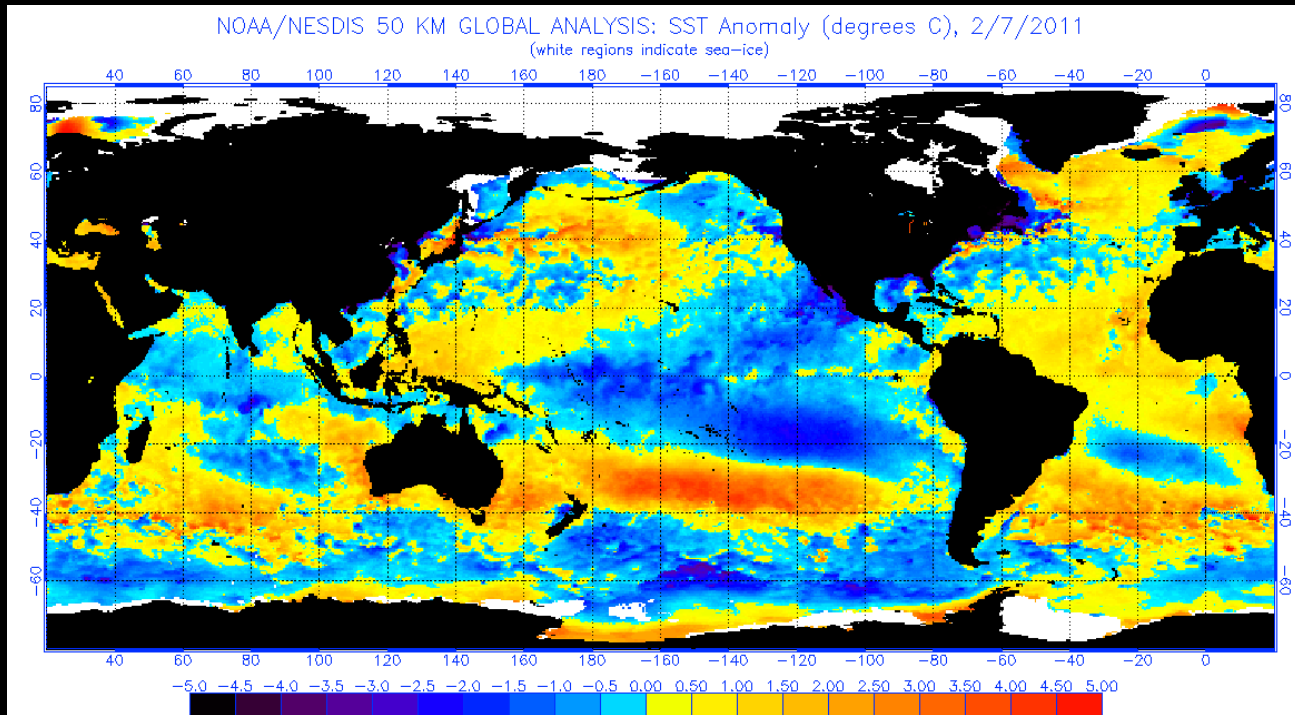
4. Identification and Monitoring of Volcanic Activity
 - As of 29 July 2008, there are 23 listed active volcanoes in the Philippines
 - Detecting, tracking, and quantifying eruption clouds and lava flows



<http://www.maps.nfo.ph/philippines-distribution-of-volcanoes/>

TIR RS for the Philippine environmental setting

5. Water Quality Monitoring for Ecosystem and Resource Management



<http://www.osdpd.noaa.gov/data/sst/anomaly/2011/anomnight.2.7.2011.gif>

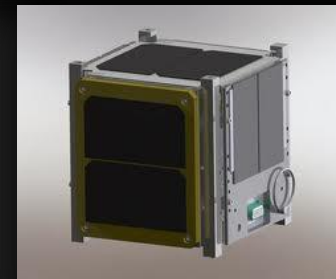
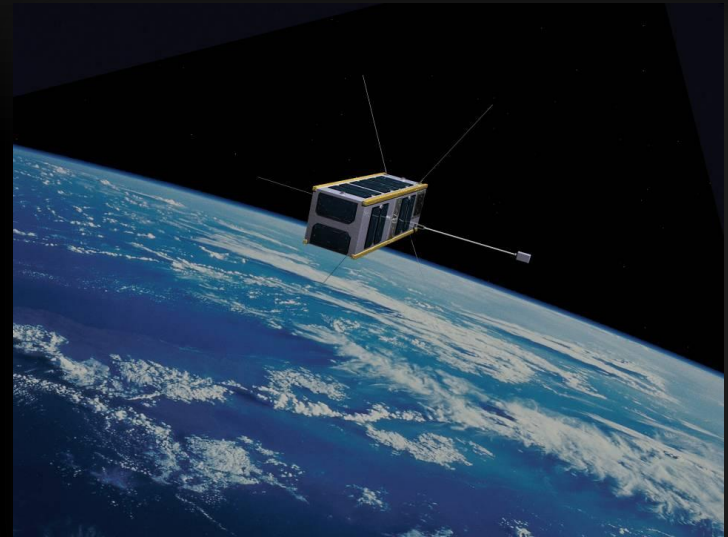
- SST
- Heated effluent discharges
- Upwelling phenomena

TIR RS for the Philippine environmental setting

- Other Studies Relating to Climate Change
 - Studies on vegetation stress in agriculture to analyze and predict harvest conditions
 - Regional water stress and drought assessment
 - Habitat classification, and analysis of suitability and changed trends in ecosystems

Why Nano-Satellites?

- Less demands in terms of financial and technical requirements
- Less complicated satellite design
- Faster implementation
- Give developing countries opportunities to engage in own satellite missions



Space Program in the Philippine Setting

- The country's space program is still in its infant stage
- No official agency mandated to undertake and manage space research, missions and development
- UP DGE Recent Initiatives:
 - 2010 – Prof. Florence Galeon, KARI Workshop for Small Satellite Systems
 - August 2012 – Prof. Rosario Ang, UNISEC 3rd CanSat Leader Training Program

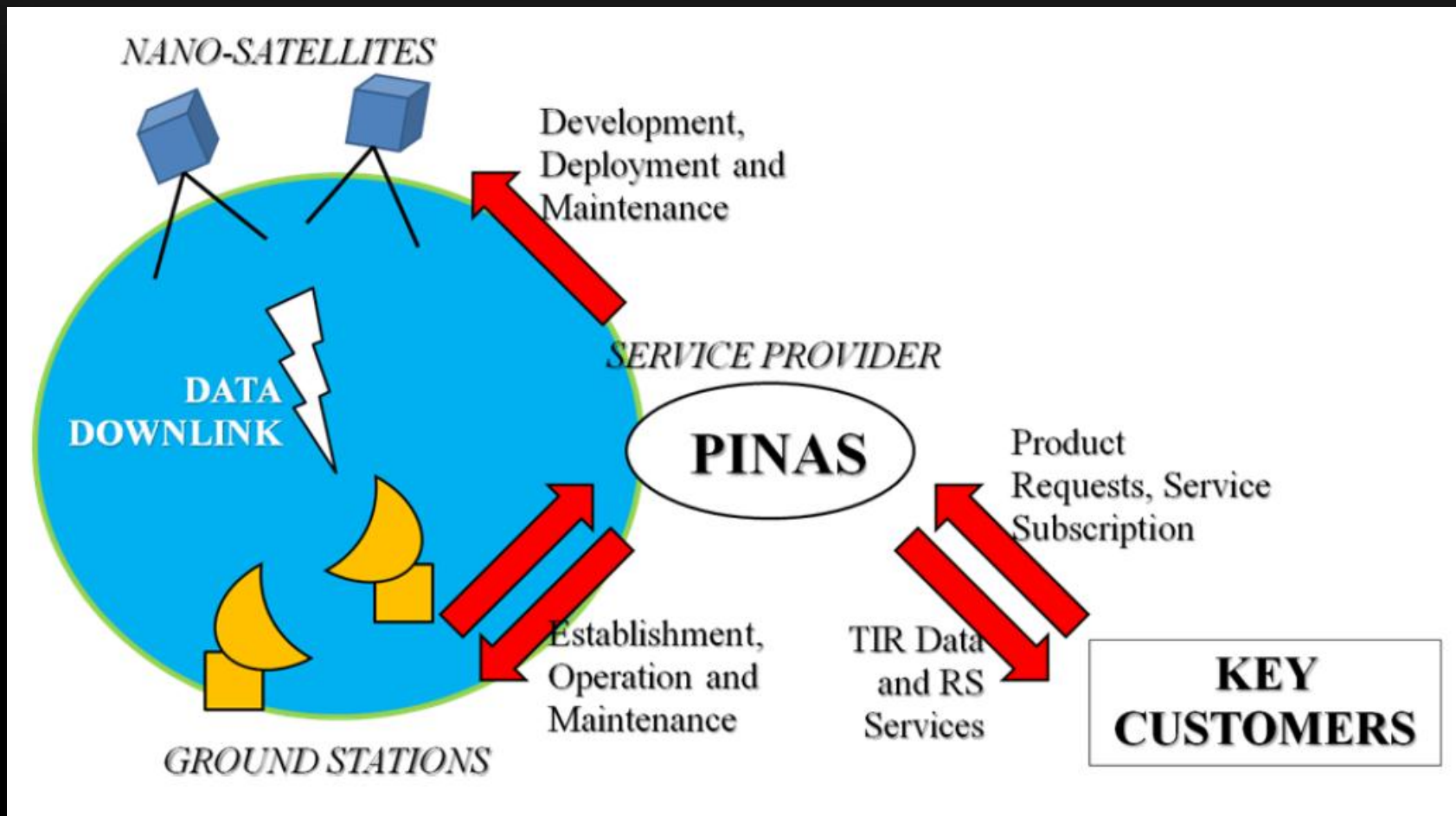
Mission Idea:

Philippine National Agency for Space (PINAS)

- Will be the lead agency responsible for the development, management and maintenance of space and nano-satellite missions including the acquisition and distribution of data products.
- It shall provide its services to academic, government and private institutions in the country.



Business Model Structure



Service Provider



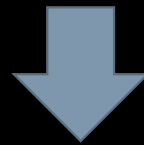
DOST-PCASTRD



NAMRIA



UP DGE-TCAGP



Key Customers

- Lead Government Agencies:
 - Department of Environment and Natural Resources
 - Philippine Institute of Volcanology and Seismology
 - Philippine Atmospheric Geophysical and Astronomical Services Administration
- Local Government Units
- Academic Institutions
- Other organizations, private individual and companies which deals with environmental programs, projects and researches

Key system specifications

SYSTEM	SPECIFICATIONS
Payload and Bus Level	Temp. Resolution of 0.5 Kelvin, Ground resolution of 50m, Coverage area of 25 x 25km ; Medium Bus level requirement ; Image size of 0.5MB for a 20km x 20km compressed JPEG image
Number of Satellites (N)	Two (2) nano-satellites; Revisit interval $L = 1$ day for both satellites; Ave. Revisit Interval $(L/N) = 0.5$ days
Number and Specifications of Ground Stations (G)	Four (4) Ground Stations, each with 1Mbps downlink speed ; Downlink Latency (12hrs/G) = 3 hrs. ; 2,400 images can be downlinked per day $(2400 \times G \times \text{Downlink} \times \text{speed}/\text{Data size})$
Launch Configuration	Coordinated “piggyback” launch

Product and Services

PRODUCT/ SERVICE	DETAILS	NEW ACQUISITION	ARCHIVE*
Thermal Infrared Image	<ul style="list-style-type: none"> ▪ Scene size: 20km x 20km ▪ Downloadable through FTP or in CD format through shipping 	\$ 1000/scene	\$ 500/scene
Service Subscription	<ul style="list-style-type: none"> ▪ Monthly service subscription for the TIR RS service ▪ Minimum of 6 months subscription is required 	\$ 75000/month	<ul style="list-style-type: none"> ▪ FREE Archive access ▪ Maximum of 30 scene downloads per month

**Imagery is defined as "Archive" ninety (90) days after collection
Level 1 Image Processing and Base License included in the image price
Standard Delivery Time: within 3 days from order*

Programming Services, Special Delivery Service and Special Licenses are available with corresponding Price Adjustments

Cost model

	SPECIFICATIONS	UNIT COST (M\$)	TOTAL COST (M\$)
Bus Cost (2 Nano Satellites)	Medium (1 Mbps downlink speed)	2	4
Bus Cost (2 Nano Satellites)	Infrared thermal sensor (Temperature resolution 0.5 Kelvin, ground resolution 50m, 25 x 25km)	1.2	2.4
Ground Station Operation Cost (4 Stations)	1Mbps downlink speed	0.5	2
Launch Cost (2 Nano Satellites)	Coordinated "piggyback"	4	8
TOTAL INITIAL COST (ONE TIME)			16.4
Ground Station Operation Cost (4 Stations)	1Mbps downlink speed	0.2	0.8
Data Analysis Cost	Infrared thermal sensor	1	1
TOTAL YEARLY COST (PER ONE WHOLE YEAR)			1.8

Projected 6-Year Revenue Stream

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
No. of New Acquisition Requests (\$1000 per scene)	1000 M\$ 1	2000 M\$ 2	3000 M\$ 3	4000 M\$ 4	5000 M\$ 5	6000 M\$ 6
No. of Archive Requests (\$500 per scene)	0	1000 M\$ 0.5	2000 M\$ 1	3000 M\$ 1.5	4000 M\$ 2	5000 M\$ 2.5
No. of Subscriptions (\$75,000 per 1 month)	0	1 M\$ 0.9	1 M\$ 0.9	2 M\$ 1.8	2 M\$ 1.8	2 M\$ 1.8
TOTAL REVENUE (M\$)	1	3.4	4.9	7.3	8.8	10.3

Projected 6-Year Financial Estimates

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
TOTAL COST (M\$)	18.2	1.8	1.8	1.8	1.8	1.8
Total Initial Cost	16.4	-	-	-	-	-
Total Yearly Cost	1.8	1.8	1.8	1.8	1.8	1.8
TOTAL REVENUE (M\$)	1	3.4	4.9	7.3	8.8	10.3
TOTAL PROFIT (M\$)	-17.2	-15.6	-12.5	-7.0	0.0	8.5

Anticipated Risks

- Market acceptance and competition
- Financing and Financial stability
- Organizational structure
- Technical Capacity and Capability

Anticipated Risks

- Market acceptance and competition
 - Existing satellite services with sensors that already provide both imaging and thermal; competitors who are more established in terms of market presence, technical capability, and financial stability
 - ✓ The proposed business model intends to offer an advantage through higher ground resolution and shorter revisit time, producing more accurate and up-to-date TIR data.

Anticipated Risks

- Financing and financial stability
 - There may be concerns on the availability of financial resources and sustaining funds for subsequent years of operation
 - ✓ Possible sources of funding: sponsorship through international space initiative collaborations, or through the Congressional Commission on Science & Technology and Engineering (COMSTE) of the Philippine Government.

Anticipated Risks

- Organizational Structure
 - Due to many different agencies coming together to create a national space agency, complex organization scheme may arise; this can be subject to several institutional concerns
 - ✓ Well facilitated and participated forum on the establishment of a national space agency is necessary to achieve the best possible effective and efficient organizational structure for the same.

Anticipated Risks

- Technical capacity and capability
 - Requires specialized researches, trainings and consultations with experts in the field of satellite technologies
 - ✓ Continuous efforts of capability building for developing country's space agency (i.e. visit to KARI, delegation of participant to the Regional Space Application Programme for Sustainable Development)

Conclusion and Recommendations

- Establishment of the PINAS would not just be a means to earn income, but also to have a provider of relevant and up to date TIR RS data of the Philippines.
- PINAS would provide for the forging of environmental solutions for the country, considering effects such as climate change, among others.
- Further capacity and capability building is needed to create a mature space agency envisioned to spearhead the development of the country's space technology.
- A common objective mindset for all concerned: “We want to see it happen.”

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Thank you for listening...

