NARLabs 國家實驗研究院
國家太空中心
National Space Organization
NSPO

WG5: AGRICULTURE & FOOD SECURITY

FORMOSAT SATELLITES IN AGRICULTURAL MONITORING

Franz M.C. Cheng & Satellite Image Division

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2017/1/12

NARLabs

Outline

NSPO Introduction

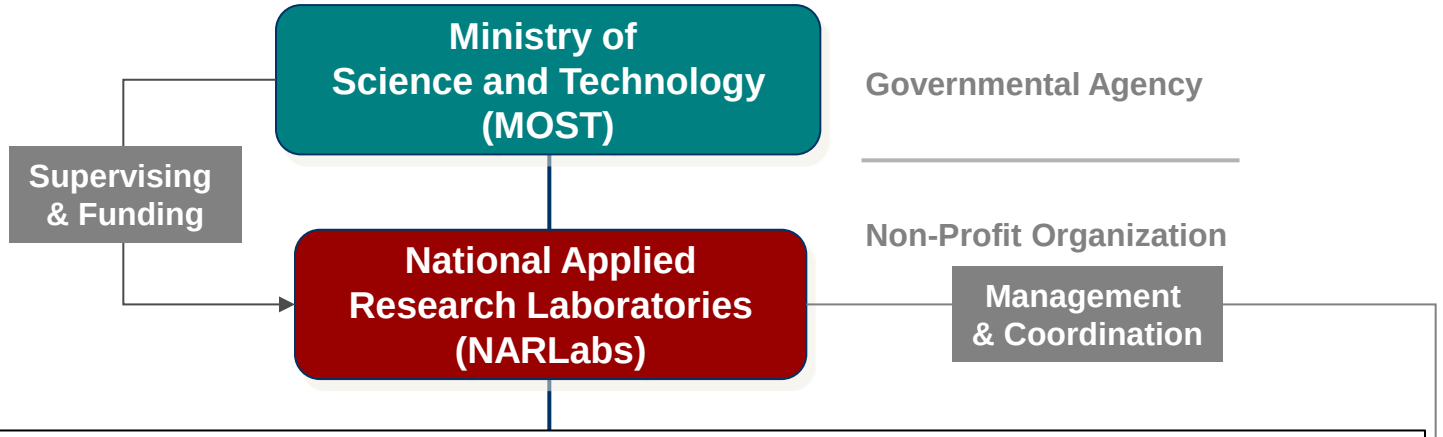
Formosat-2 Mission & Achievement

Formosat-5 Mission

Concluding Remarks

NSPO INTRODUCTION

National Applied Research Labs



Earth Sciences and Environmental/ Disaster Mitigation Technology

Information, Electronics, and Communications

Biomedical Technology

Space Science & Technology

Operations Model

Users | **Technology R&D** | **Mission Data** | **Products & Services**

Domestic Partners

International Cooperation

Technology

Systems Engineering

- Mission Definition
- System Design
- System Verification
- System I&T

Spacecraft

- Spacecraft Design
- Key Components
- GSE

EO RSI

- Instrument Design
- Key Components
- Instrument I&T

Satellite Ops

- Ops & Ctrl Software
- Ops Engineering
- Constellation Ops

Data Processing

- Image Processing
- GPS RO Data

Satellite Programs

- Data Value-Added Applications
- Spacecraft Products
- Satellite Images
- GNSS-RO Data
- Science Data

- Space Qualification
- I&T Services
- Solution Provider
- Industry/University Services
- Space Education/ Outreach

Facility

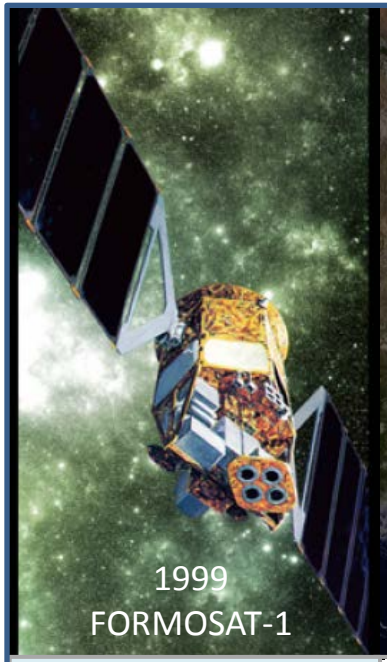
Satellite I&T Facility

Mission Operation & Control Center

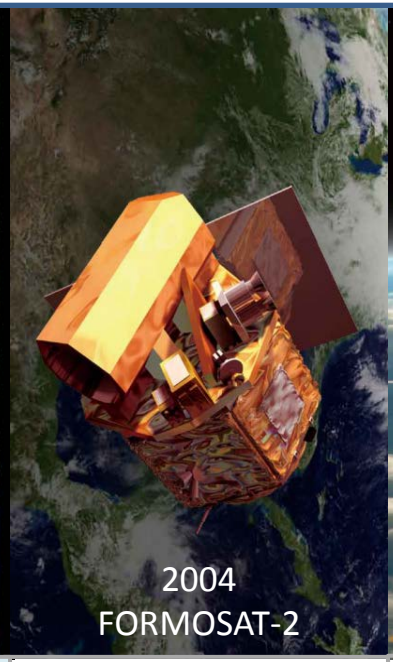
Image Processing Center

R&D Labs

FORMOSAT PROGRAMS OF NSPO

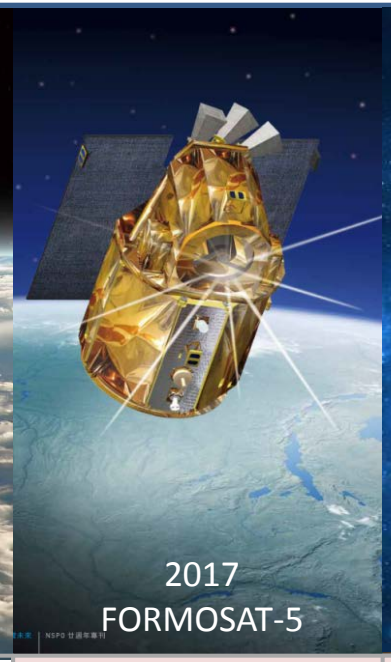


Scientific mission for ocean color monitoring, ion distribution data, & communication experiment.
Mission completed in 2004



Mission: Earth Observations
Orbit: 891 km SSO
Revisit: 1 day
Resolution: 2m (PAN)/ 8m (MS)
Swath: 24km
Life: 5 years

6 Satellite Constellation Observation System for Meteorology, Ionosphere, and Climate
Life: 5 years

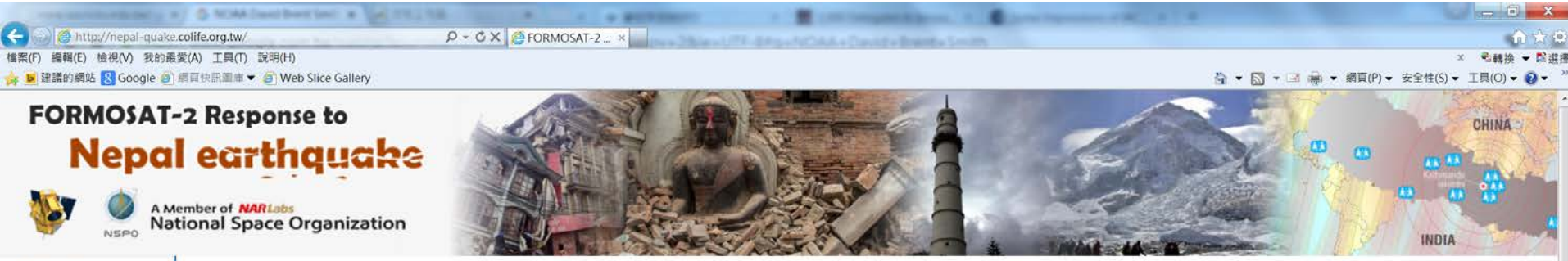


Mission: Earth Observations
Orbit: 720 km SSO
Revisit: 2 day
Resolution: 2m (PAN)/ 4m (MS)
Swath: 24km
Life: 5 years

12+1 Satellite Constellation Observation System for Meteorology, Ionosphere, and Climate
Life: 5 years

FORMOSAT-2 MISSION & ACHIEVEMENTS

IMAGE PRODUCT/SERVICE VALUE CHAIN

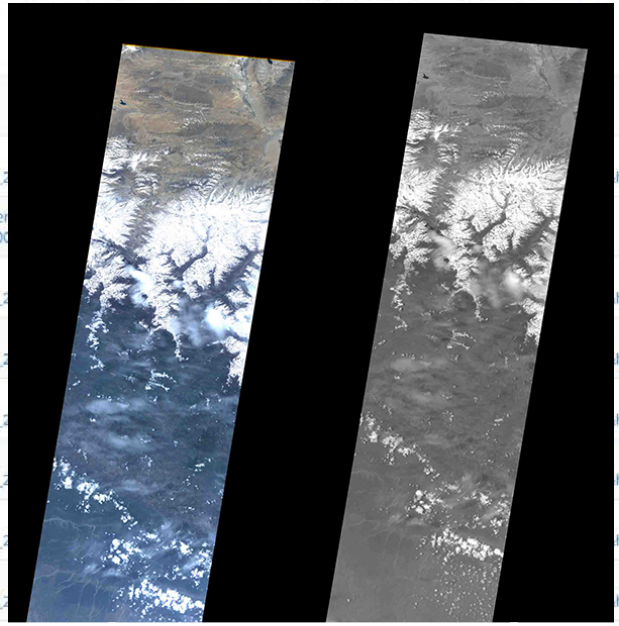


Web Map Service

Web Map Service

2015/5

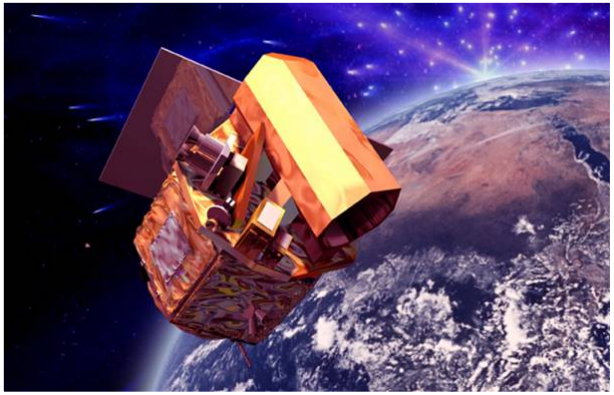
No.	Image Date	Title	URL
1	2015/05/13	Nepal_20150513_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2
2	2015/05/07	Nepal_20150507_Level_04 (f0020032)	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&ver&styles=&bbox=284000.0,3028000.0,389996.0,3168000.0&width=700
3	2015/05/06	Nepal_20150506_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2
4	2015/05/05	Nepal_20150505_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2
5	2015/05/04	Nepal_20150504_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2
6	2015/05/03	Nepal_20150503_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2
7	2015/05/02	Nepal_20150502_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2
8	2015/05/01	Nepal_20150501_Level_04	http://140.110.20.179:8080/geoserver/Nepal/wms?service=WMS&version=1.1.0&request=GetMap&layers=nspo:Nepal_2



Value Chain	Satellite	Data Provision	Data Analysis	Service Provision	ENDUSER
	FORMOSAT-2	NSPO	NCU CSRSR	NCHC, FCU GIS	

FORMOSAT-2 MISSION

- FORMOSAT-2 is a high-resolution electric-optical (EO) type remote sensing satellite with a secondary scientific payload to observe the natural upward lighting discharge phenomenon. FORMOSAT-2 was successfully launched on May 21, 2004.
- FORMOSAT-2 operates in a sun-synchronous orbit with revisit time equal to one day. The unique feature of this daily revisit capability is significantly useful for post disaster assessment and environmental monitoring.



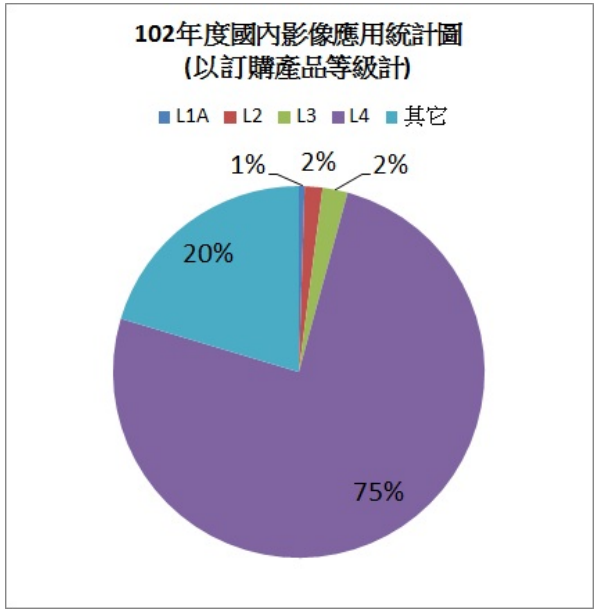
Item	Unit	Achievement
Image Acquisition	M km^2	1,251
Government and Academia Supports	Gov. Agency	181
	Academic Institute	169
Disaster Supports	Event	286
	Country	63
Revenue	Sale ($M USD)	17.32
	Paper Money ($M USD)	28.71

As of December 2014

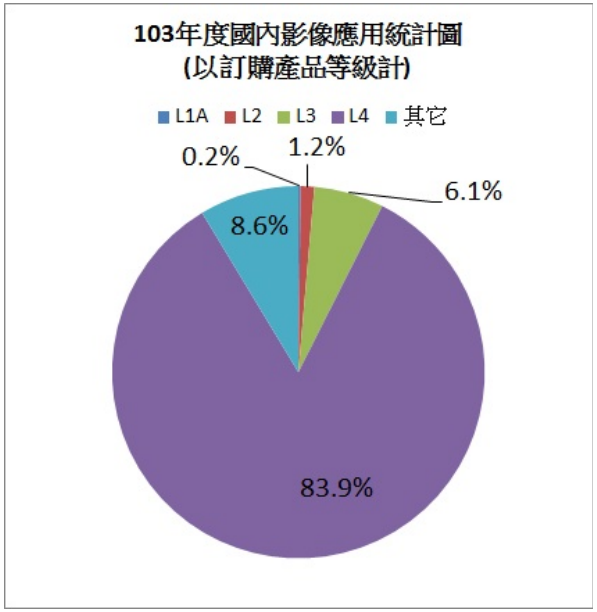
FORMOSAT-2 Supports the Japan Tsunami and Earthquake in 2011

STATISTICS OF DOMESTIC USE OF FORMOSAT-2 IMAGES

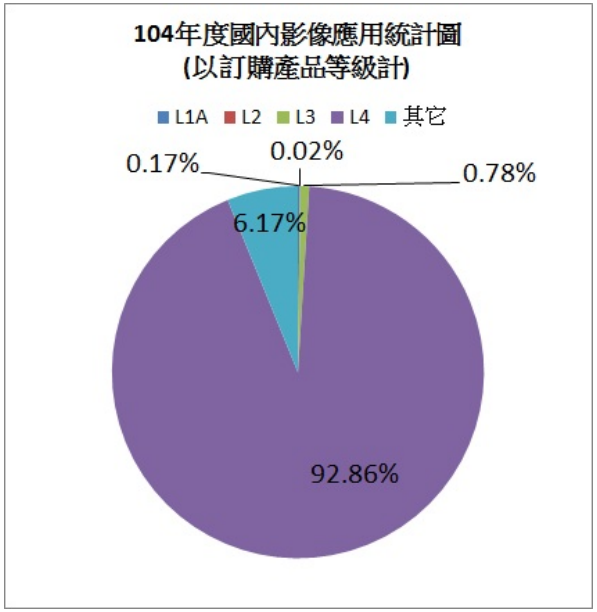
2013



2014

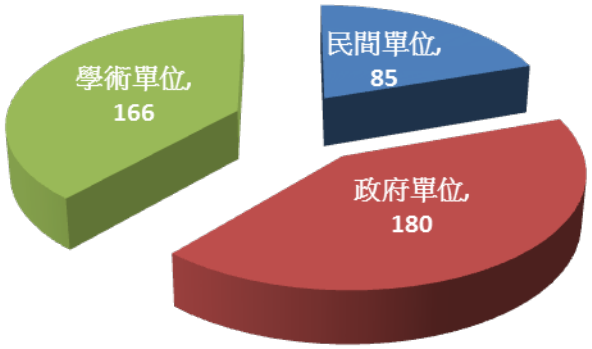


2015



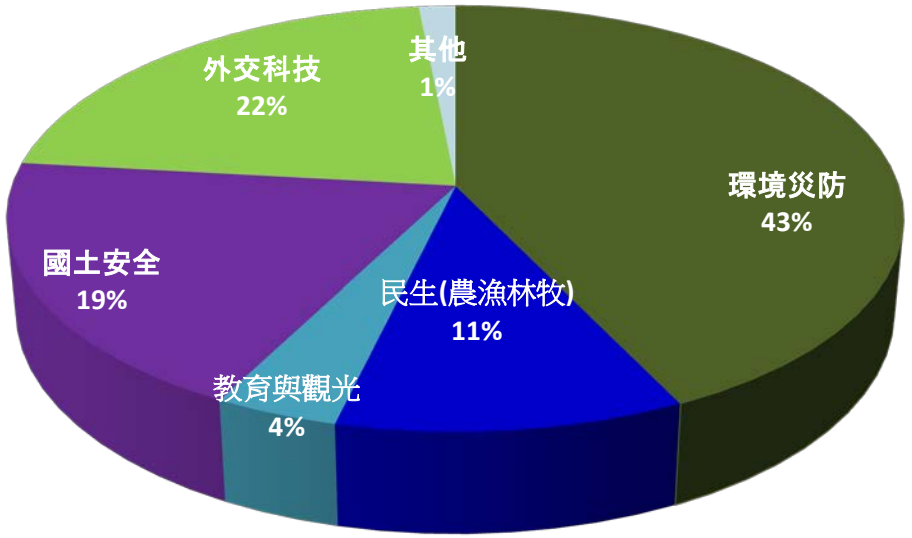
STATISTICS OF DOMESTIC USE OF FORMOSAT-2 IMAGES

支援政府、學術研究及民間計畫數



福衛二號影像支援政府執行計畫之應用

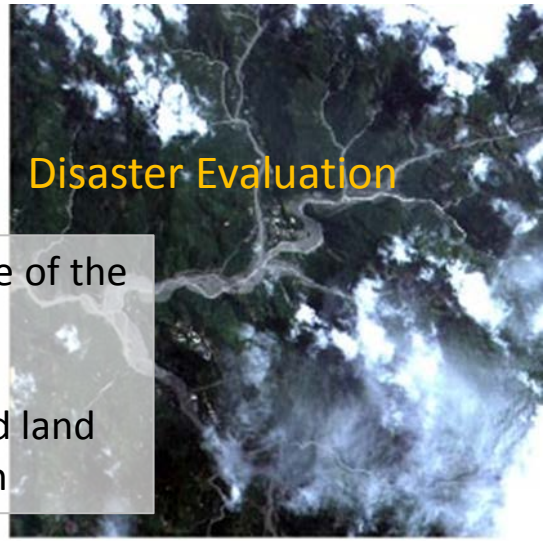
(百分比)



- **More Users Ordered Level 4 Processed Data**
- **Ample of Rooms for Promotion in Utilization of Data in Agriculture, Fishery, Forestry**

FORMOSAT-2 IMAGE IN INTERNATIONAL APPLICATIONS

Disaster Evaluation



- ✓ quick response of the disaster areas
- ✓ vital disaster evaluation and land reconstruction

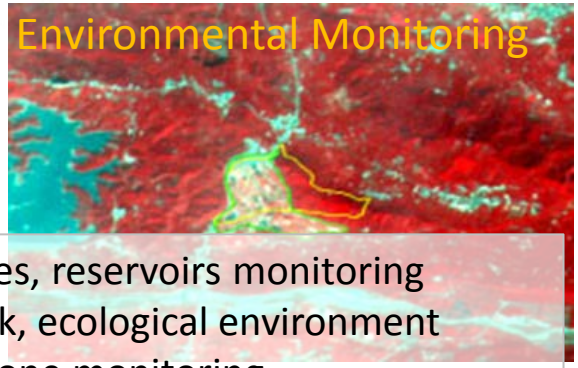
Land Usage

- ✓ land development plan
- ✓ categorization of land usage
- ✓ changes of land usage

Farmland and Forest Plan

- ✓ production outputs of farmlands.
- ✓ changes in national forests,
- ✓ agricultural damage prevention.

Environmental Monitoring



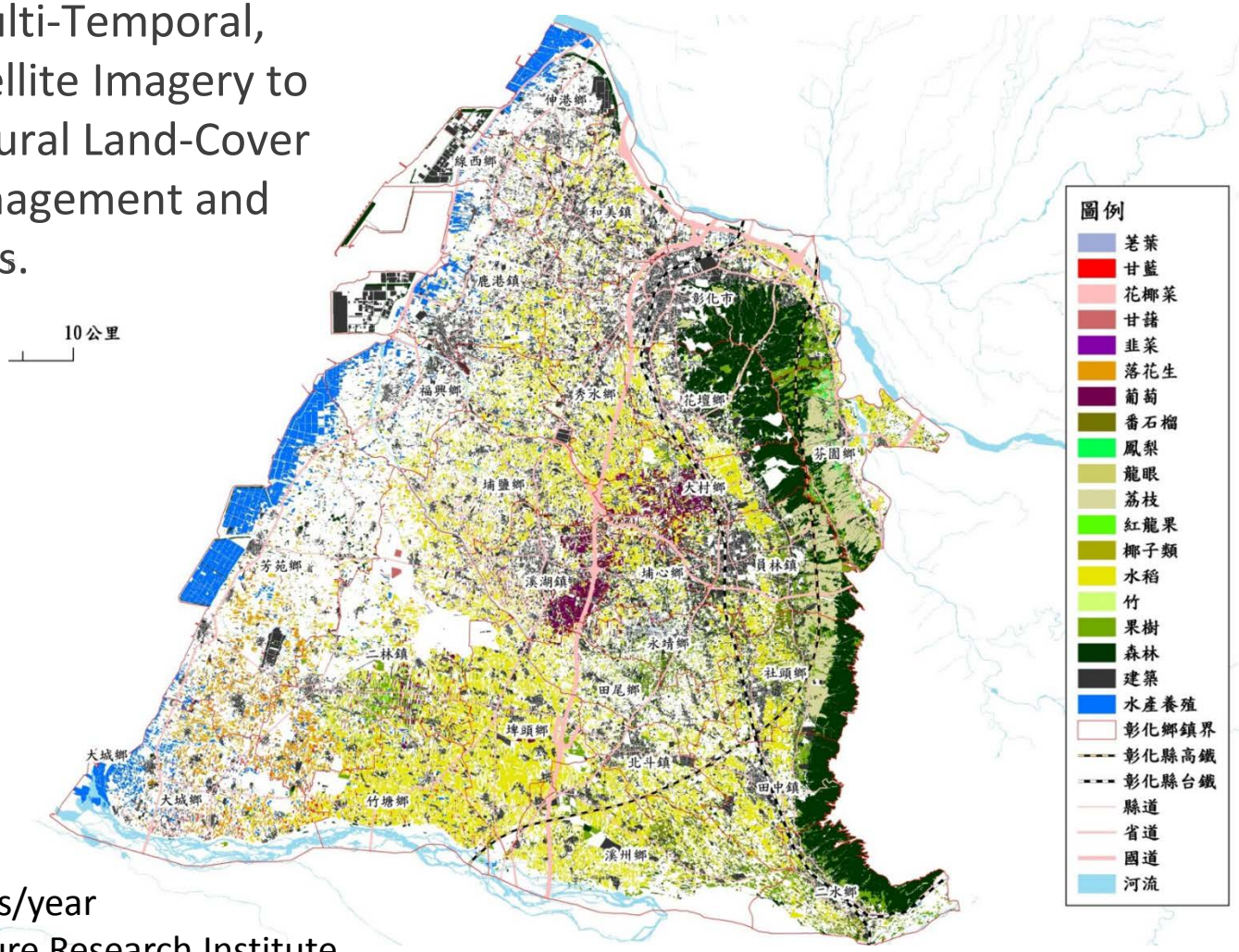
- ✓ water sources, reservoirs monitoring
- ✓ national park, ecological environment protection zone monitoring.
- ✓ industrial wastes and spoils monitoring.

Scientific Research and Education

Exchange images and information of earth's natural resources and environmental evaluation with allies.

AGRICULTURAL LAND – COVER DATABASE

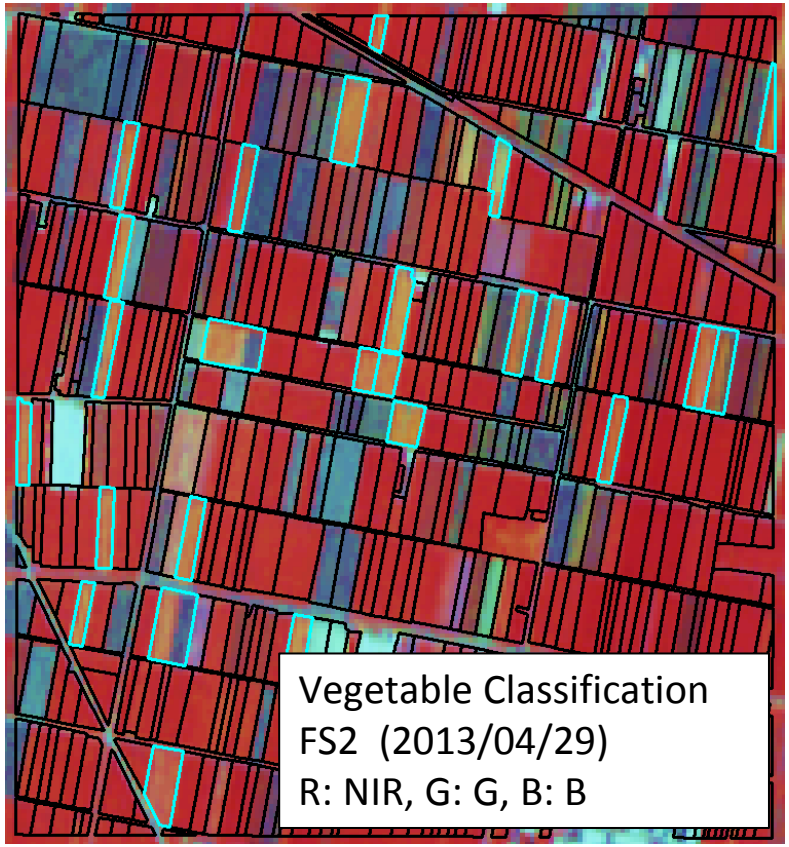
- TARI analyzed Multi-Temporal, Multi-Sensor Satellite Imagery to establish Agricultural Land-Cover Database for management and research purposes.



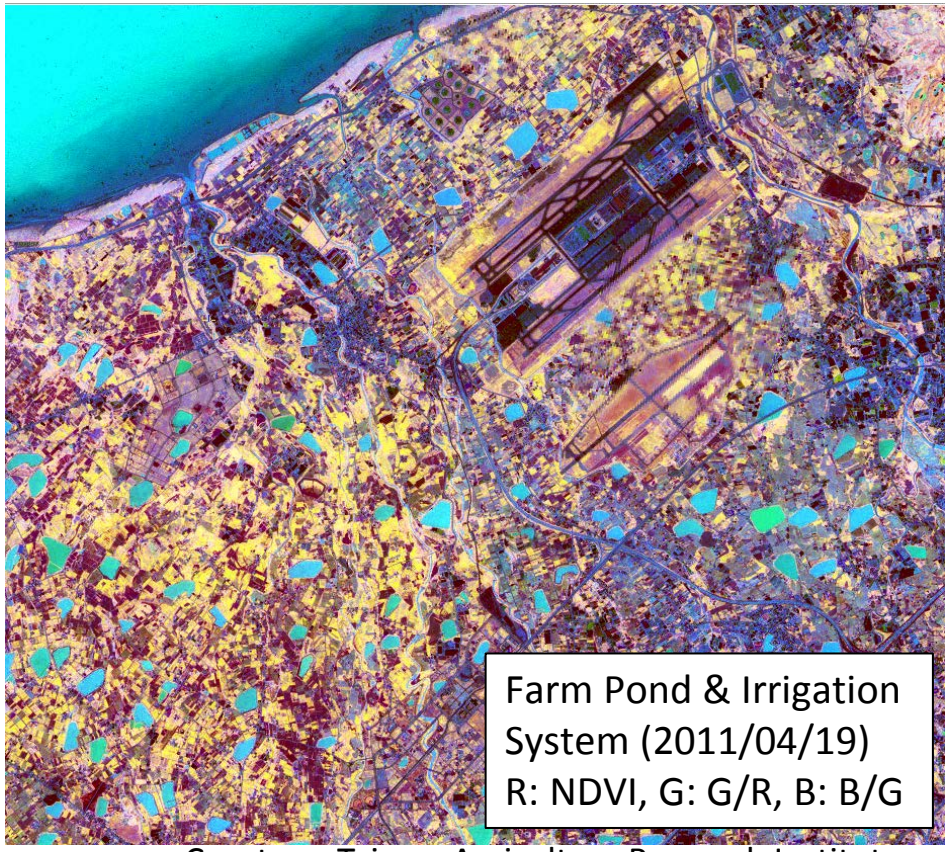
Update Frequency: 3 times/year
Courtesy: Taiwan Agriculture Research Institute

Vegetables & Irrigation Classification

- FORMOSAT-2 has the advantage in applications of Vegetable, Farm Pond & Irrigation Classification, and Rice Monitoring



Vegetable Classification
FS2 (2013/04/29)
R: NIR, G: G, B: B

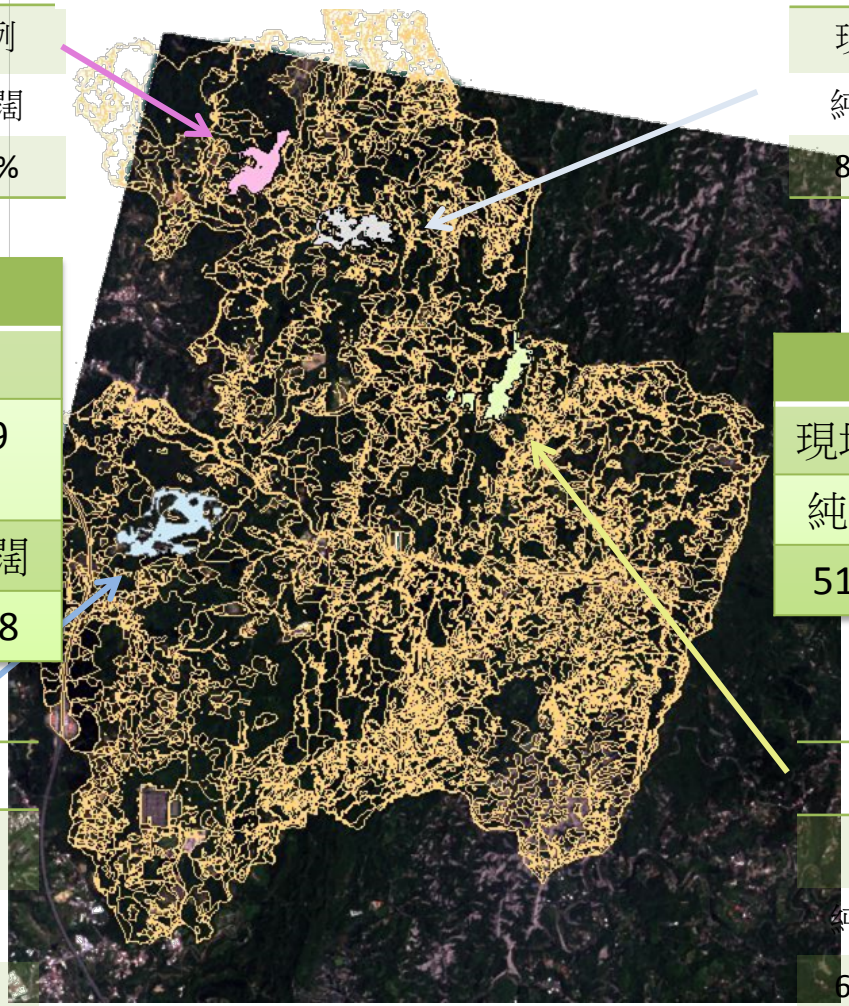


Farm Pond & Irrigation System (2011/04/19)
R: NDVI, G: G/R, B: B/G

Courtesy: Taiwan Agriculture Research Institute

SUPPORT TO FOREST MONITORING – CARBON STOCK

研究區域 ：台南市龍崎區



B區

現地調查比例		分類結果比例	
純竹	純闊	純竹	純闊
60%	40%	83%	17%

C區

現地調查比例		分類結果比例	
純竹	純闊	純竹	純闊
80%	20%	81%	19%

全區面積估算(單位:公頃)

現地調查		分類結果	
整區: 6,257.67		整區:6,019	
純竹	純闊	純竹	純闊
3,171	640	2,139	838

全區(包含其他物種)

現地調查比例		分類結果比例	
純竹	純闊	純竹	純闊
51%	10%	36%	14%

D區

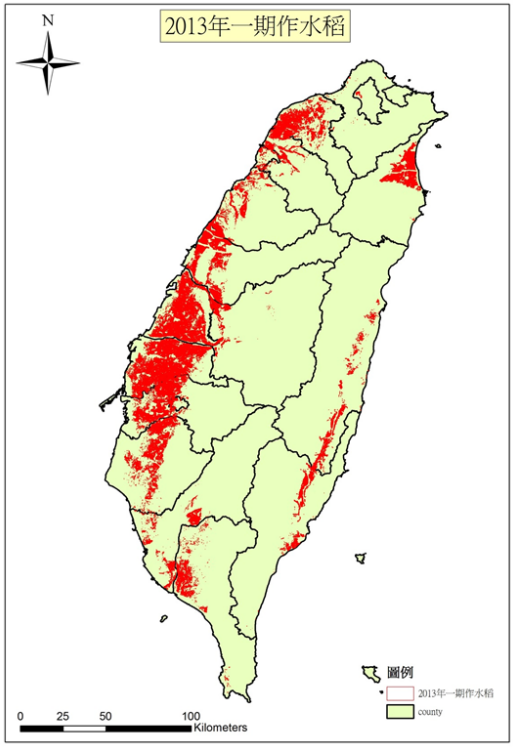
現地調查比例		分類結果比例	
純竹	純闊	純竹	純闊
70%	30%	77%	23%

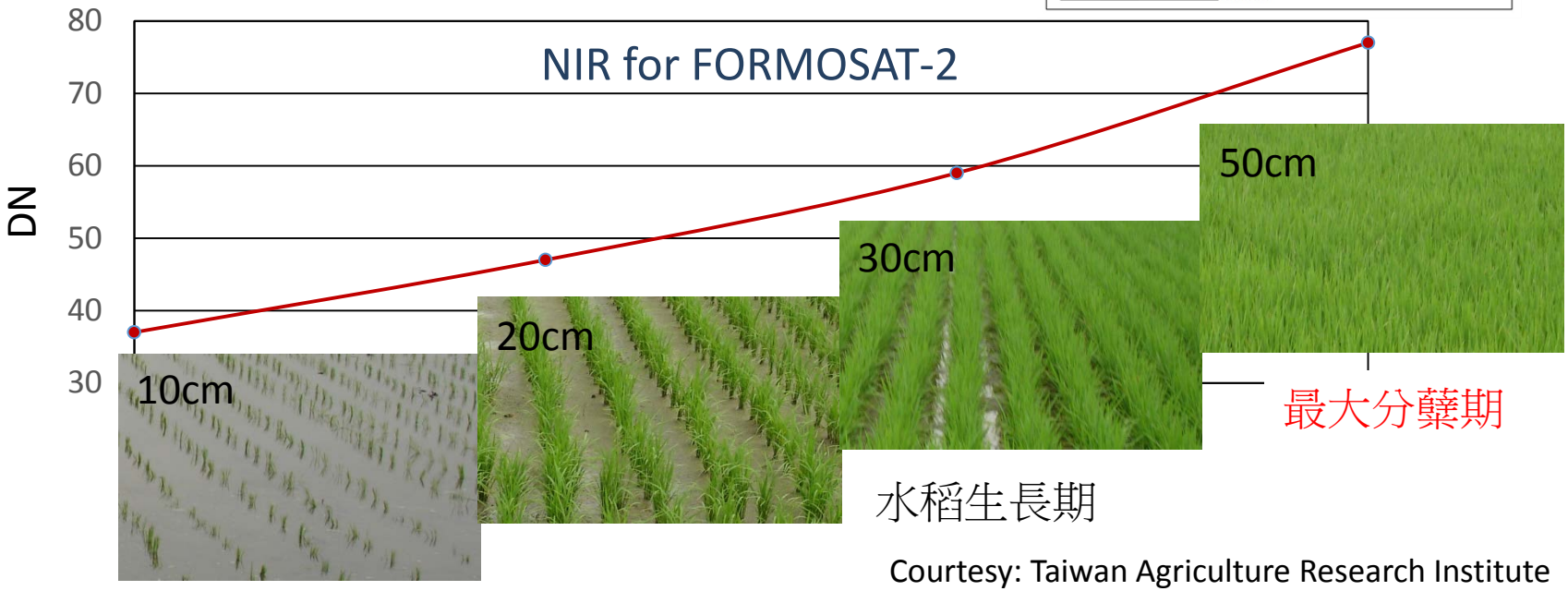
A區

現地調查比例		分類結果比例	
純竹	純闊	純竹	純闊
60%	40%	80%	20%

Rice Monitoring

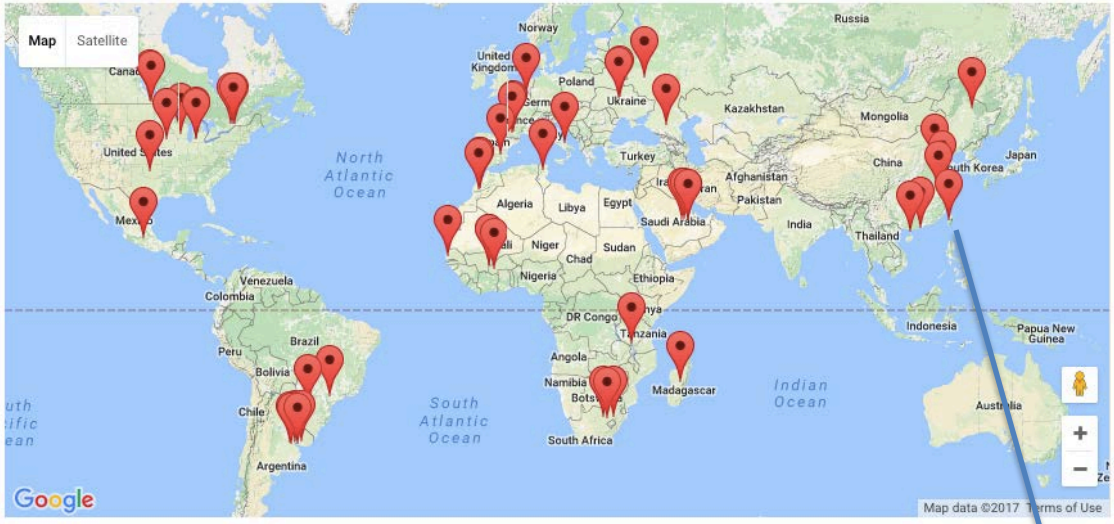
- Distribution of Rice Farm Land
- Data from NIR sensor can be used to obtain projection of the annual yield

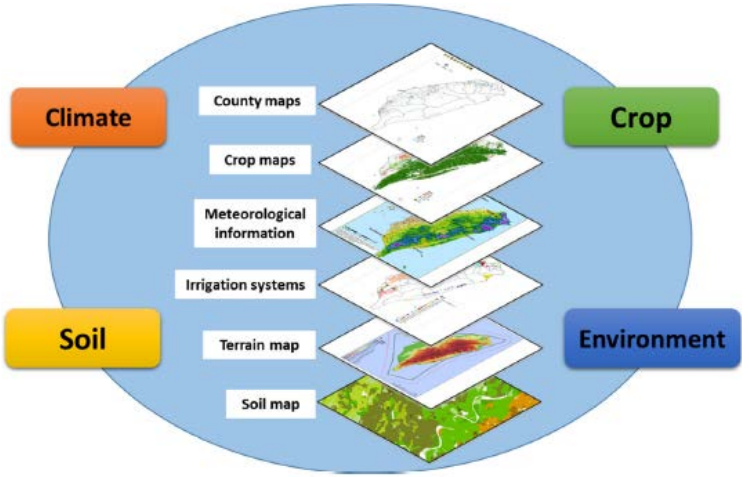




Courtesy: Taiwan Agriculture Research Institute

R&D Component – JECAM Study Site





JECAM Taiwan TARI site

JECAM/GEOGLAM Science Meeting

Brussels, Belgium

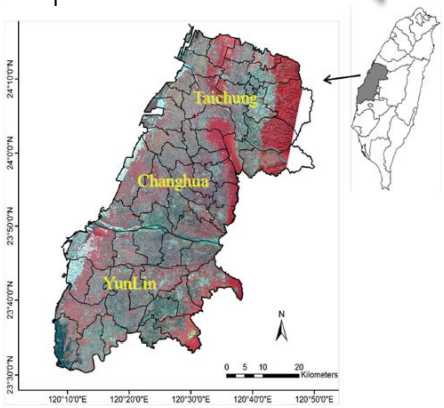
16-17 November, 2015

Investigators:

Dr. Chi-Farn Chen, CSRSR, NCU, Taiwan
Mr. Horng-Yuh Gua, TARI, Taiwan
Dr. Nguyen Thanh Son, CSRSR, NCU, Taiwan
Dr. Cheng-Ru Chen, CSRSR, NCU, Taiwan
Mr. Tsz Feng Lin, TARI, Taiwan

JECAM
Joint Experiment for Crop Assessment and Monitoring

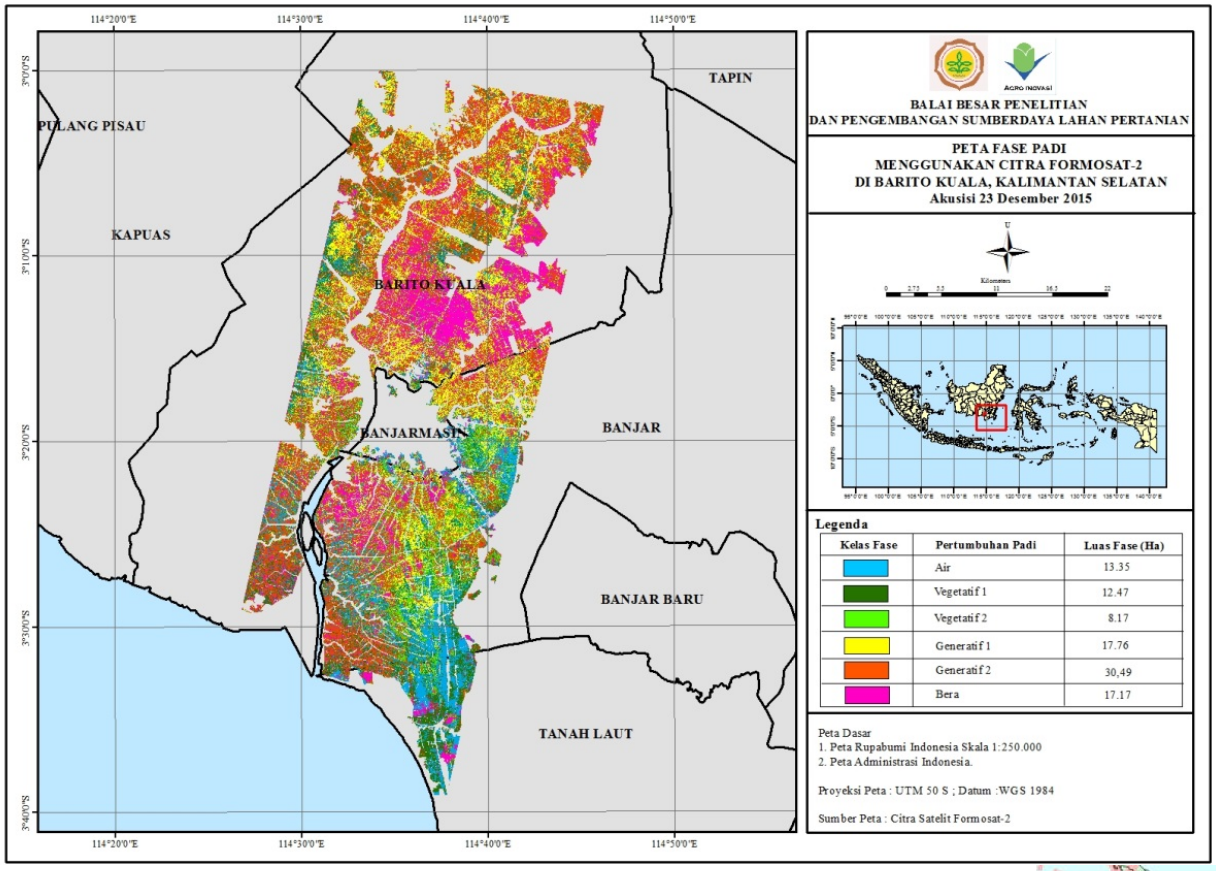
GEO GROUP ON EARTH OBSERVATIONS



Crop identification and crop area estimation

- Aerial photo
  - Rice field
- Optical satellite image
  - FORMOSAT-2, SPOT, Landsat and so on.
- Data fusion
  - SPOT/MODIS, Landsat/ MODIS
- SAR
  - Radarsat-2 2014 (SOAR-JECAM Project)

SUPPORT TO SOUTHEAST ASIAN COUNTRIES

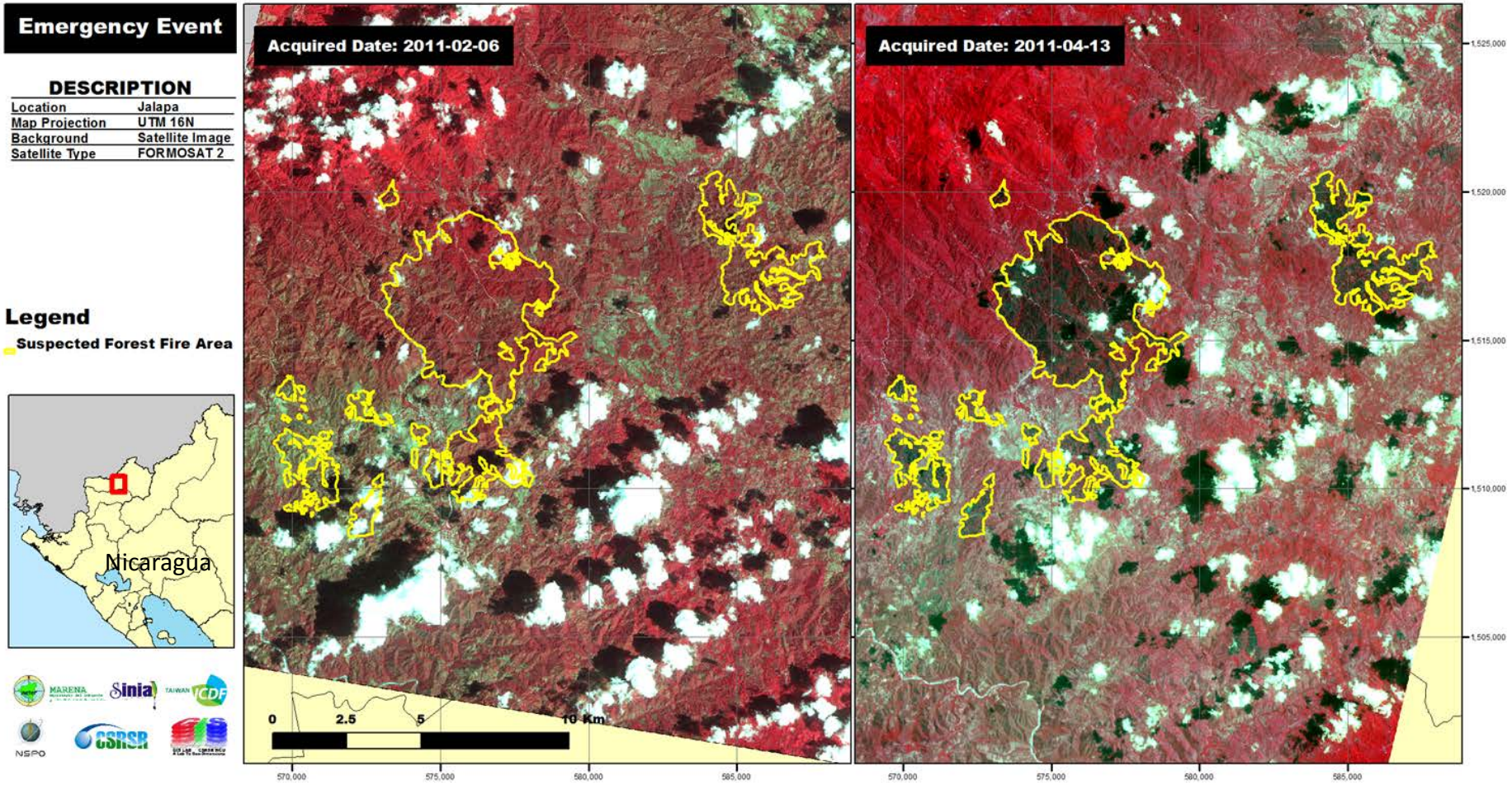


FORMOSAT-2 data used to support assessing paddy growth stage in Batola, South Kalimantan & then Subang area in Indonesia

ICALRD developed a method for identifying paddy growth stage. result of accuracy assessment: 78.26% (overall accuracy)

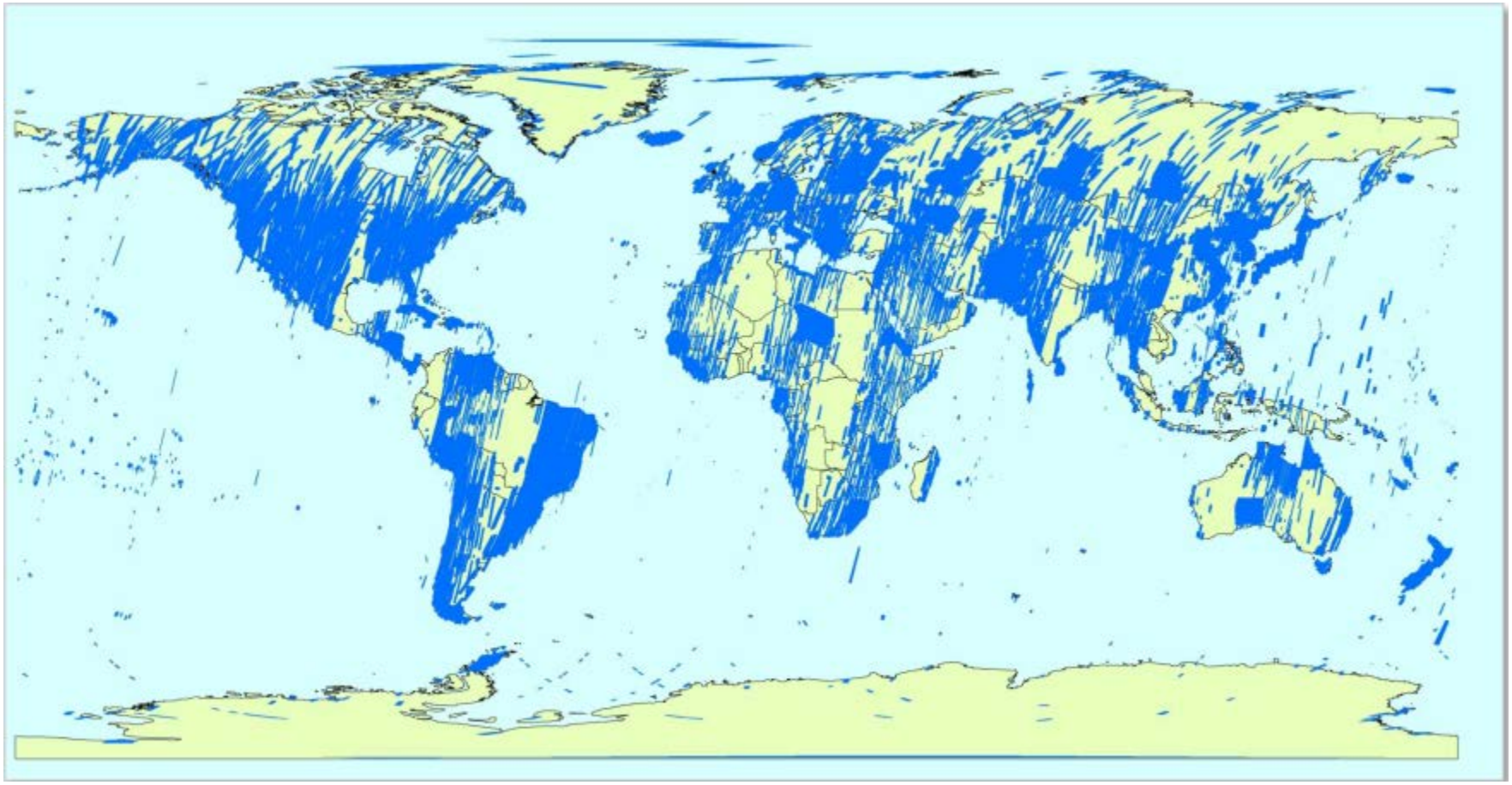
Credit: Indonesian Center for Agricultural Land Resources Research and Development (ICALRD), Indonesian Agency of Agricultural Research and Development (IAARD), Ministry of Agriculture

FOREST FIRE MONITORING – NUEVA SEGOVIA



Source: Center of Satellite Remote Sensing and Research,
National Central University

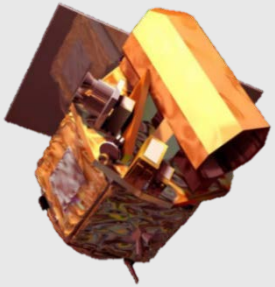
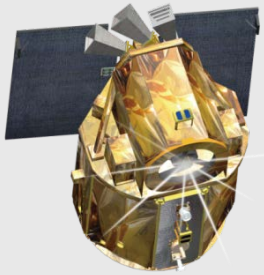
FORMOSAT-2 IMAGE ARCHIVE COVERS 12 YEARS



56.0 % global land area during 2004.6.4~2016.6.20

FORMOSAT-5 MISSION

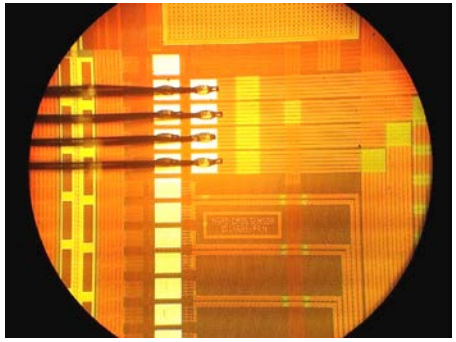
FORMOSAT REMOTE SENSING SATELLITES

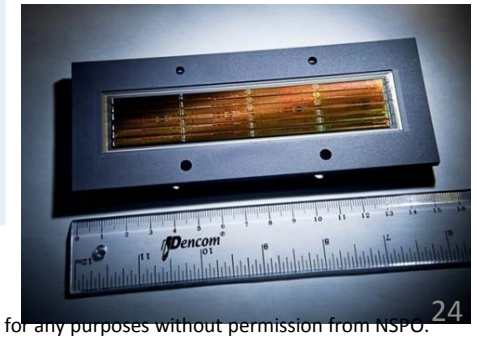
Key Parameter	 FORMOSAT-2	 FORMOSAT-5
Orbit	SSO @ 891 km/99.10°	SSO @ 720 km/98.28°
Revisit Period	1 day	2 days
Mission Life	5 years	5 years
GSD	PAN (2m)/MS (8m)	PAN (2m)/MS (4m)
Swath	24km	24km
Spectral Bands	1PAN+4MS	1PAN+4MS
RSI Image Sensor	CCD	**CMOS Image Sensor**
RSI Duty Cycle	8%	8%
Satellite Weight	760 kg	475 kg

Remote Sensing Instrument

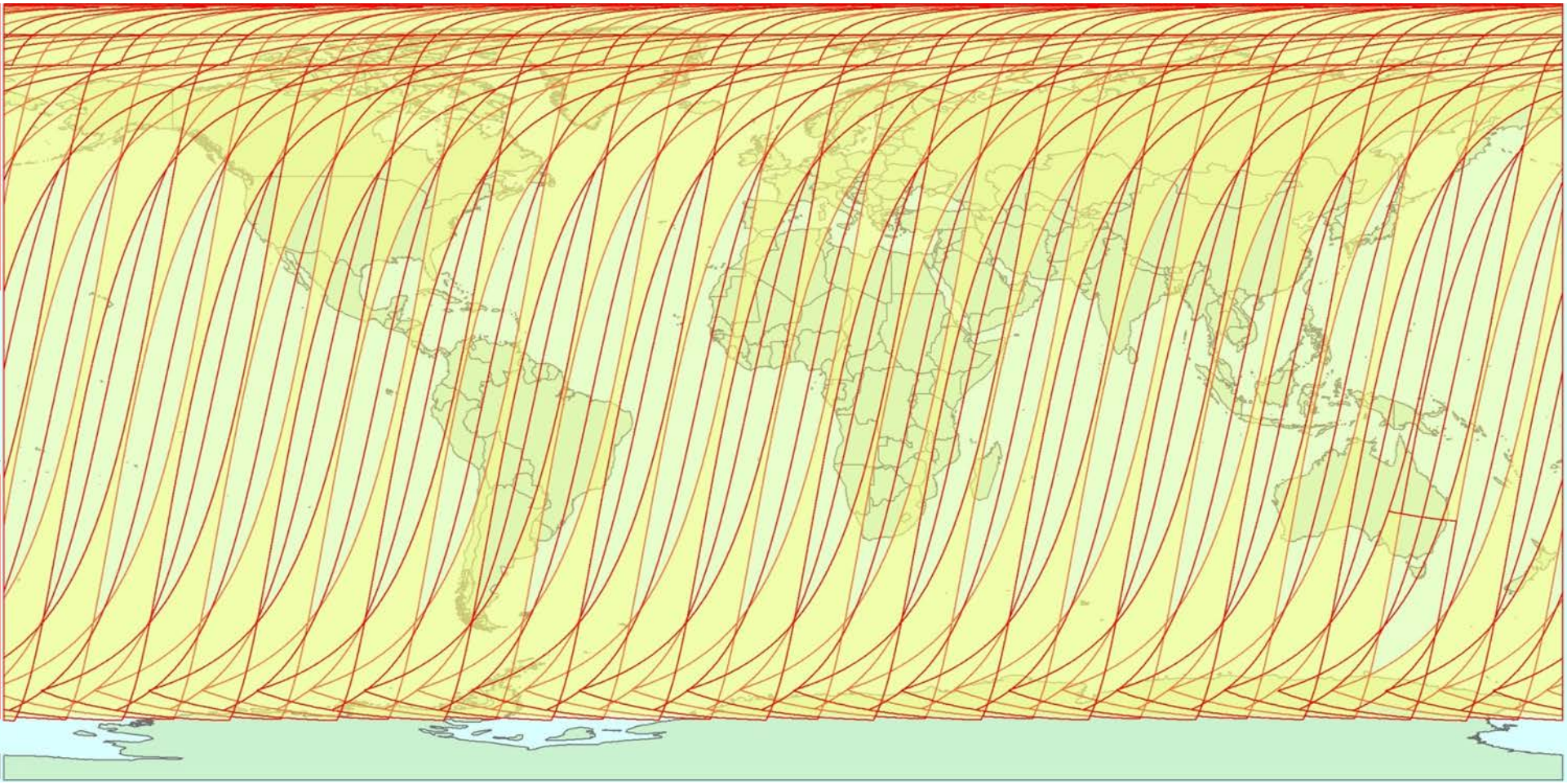
- **FORMOSAT-5 takes advantages of Taiwan's industrial strength in IC and microelectronics to develop the largest CMOS Single Chip in the World.**
  - 12 cm x 2.4 cm chip
  - PAN+4 MS bands
  - 12,000 10μm pixels (PAN); 6,000 20μm pixels (MS)
- **FORMOSAT-5 will become the first high-resolution EO satellite utilizing CMOS-type image sensor.**

Spec	FS-2 Image Sensor (CCD)	FS-5 Image Sensor (CMOS)
Wavelength (PAN)	0.45~0.90μm	0.45~0.70μm
Wavelength (MS)	0.45~0.52μm (Blue) 0.52~0.60μm (Green) 0.63~0.69μm (Red) 0.76~0.90μm (Near IR)	0.45~0.52μm (Blue) 0.52~0.60μm (Green) 0.63~0.69μm (Red) 0.76~0.90μm (Near IR)



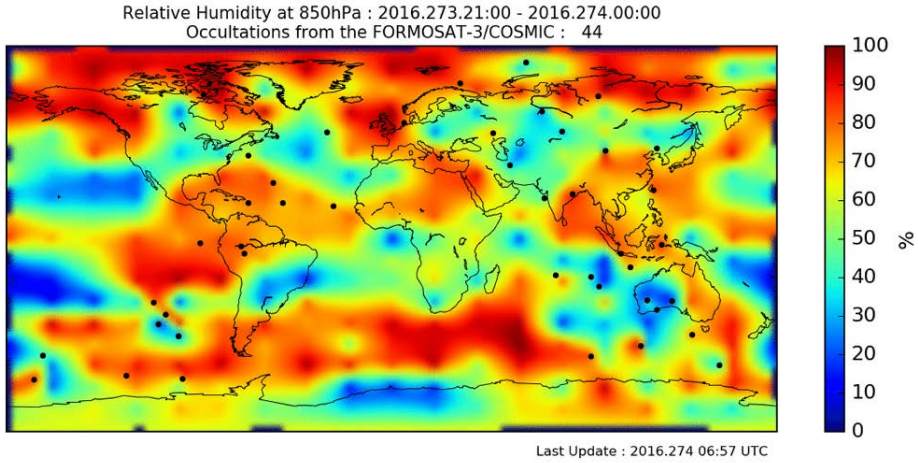


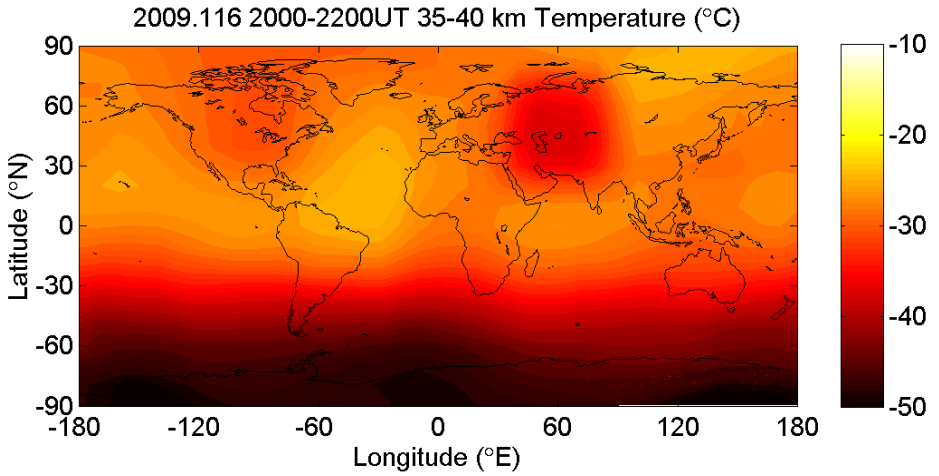
FORMOSAT-5 GLOBAL COVERAGE

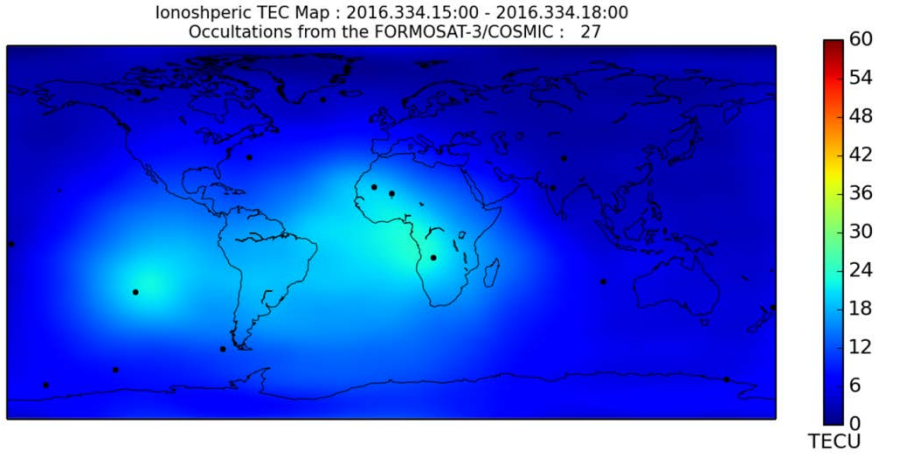


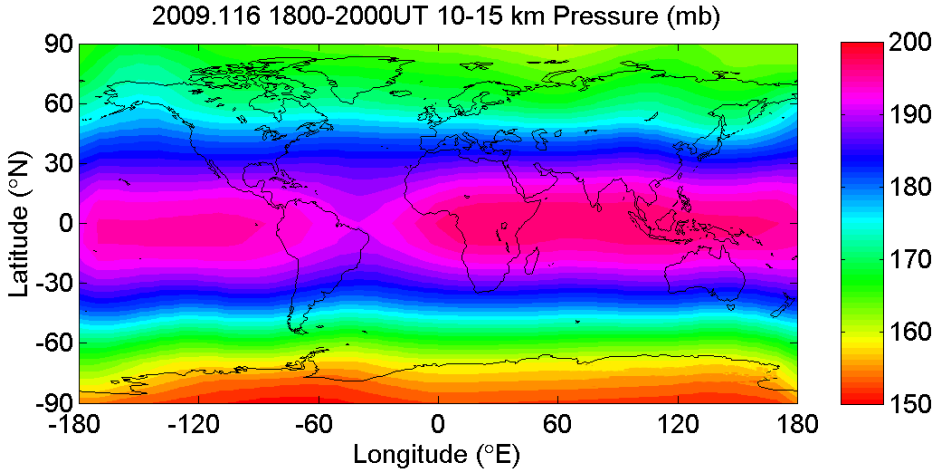
- **Global coverage with 2 day revisit**

FORMOSAT-3/COSMIC – RADIO OCCULTATION









CONCLUDING REMARKS

- **NSPO has a mandate to fulfill pronounced societal impacts**
- **Formosat-2 & 3 has successfully supported with Earth observation data to international community, including**
  - **Agriculture: TARI & NCU CSRSR in JECAM experiments,**
  - **Climate change: Extreme weather predictions**
- **Along with Formosat-5 & 7, NSPO will engage more in GEOGLAM and extend to more societal benefits areas through international collaborative projects**

NSPO

NATIONAL SPACE ORGANIZATION

In pursuit of global excellence !