

**NAR Labs**

National Applied Research Laboratories

太空中心簡介&  
福衛五號現況與影像應用

NSPO

2018/09/08

# Outline

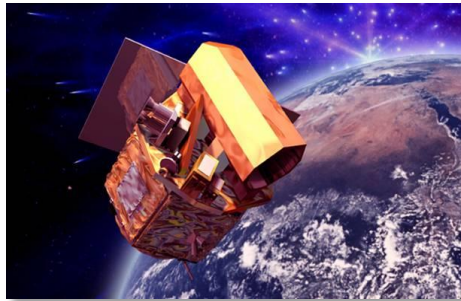
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- 一. 太空中心簡介
- 二. 福五任務執行現況、福五影像品質現況
- 三. 影像應用實例

# National Space Organization (NSPO)

承諾·熱情·創新

- Established by Ministry of Science and Technology (MOST) in 1991, National Space Organization (NSPO) has been serving as national space agency and responsible for space technology R&D in Taiwan.
- Vision: Become an excellent space center with domestic strength and global competitiveness for sustainable Taiwan
- Official website: <http://www.nspo.narl.org.tw/tw2015/>



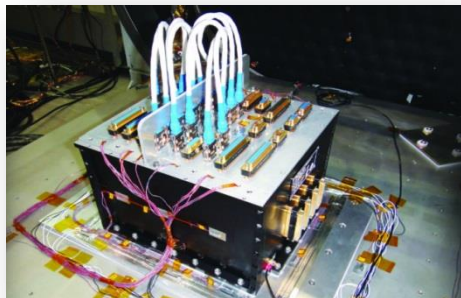
FORMOSAT-2



Remote Sensing Instrument



Mission Operation



On Board Computer

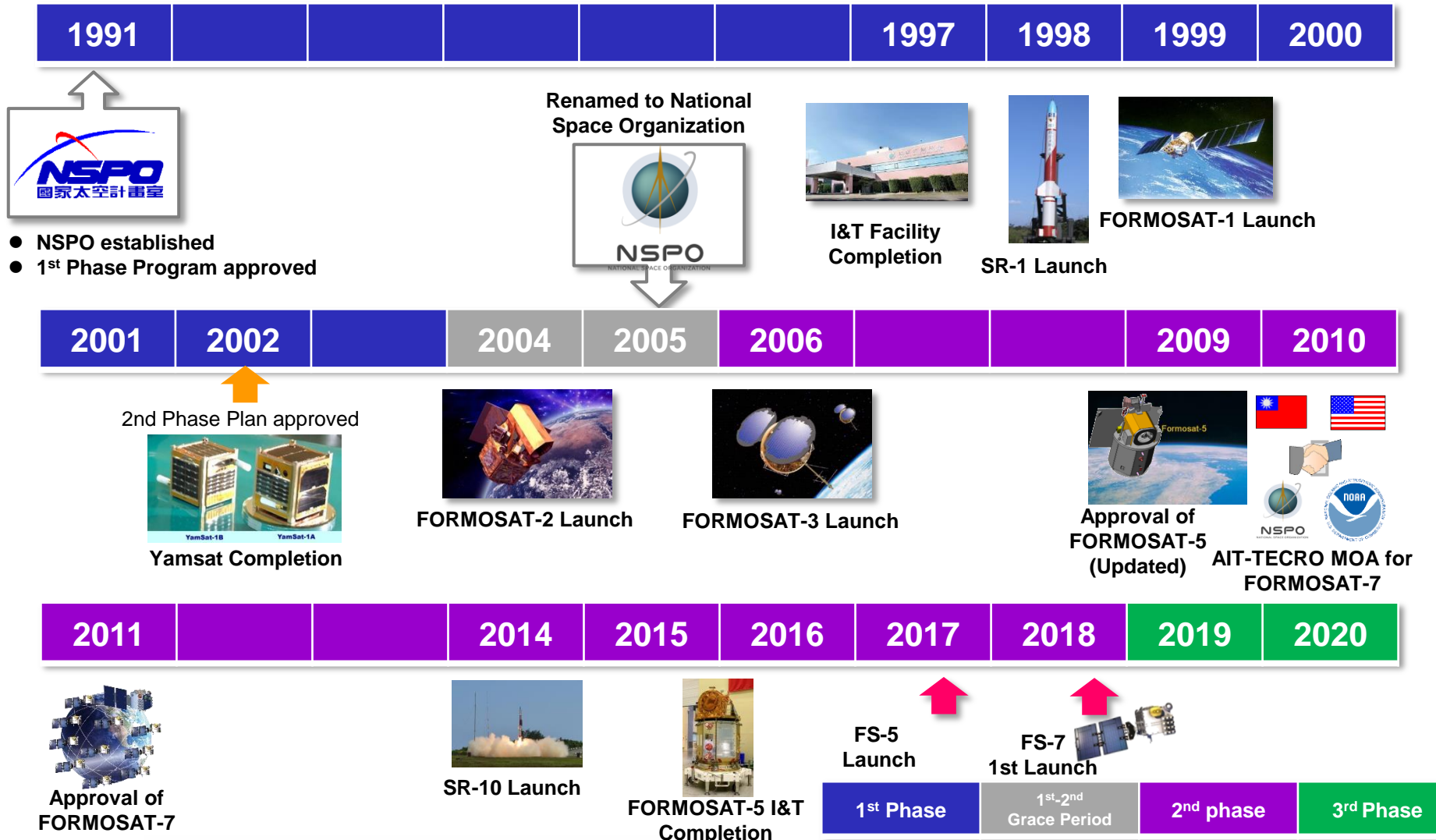


Sounding Rocket

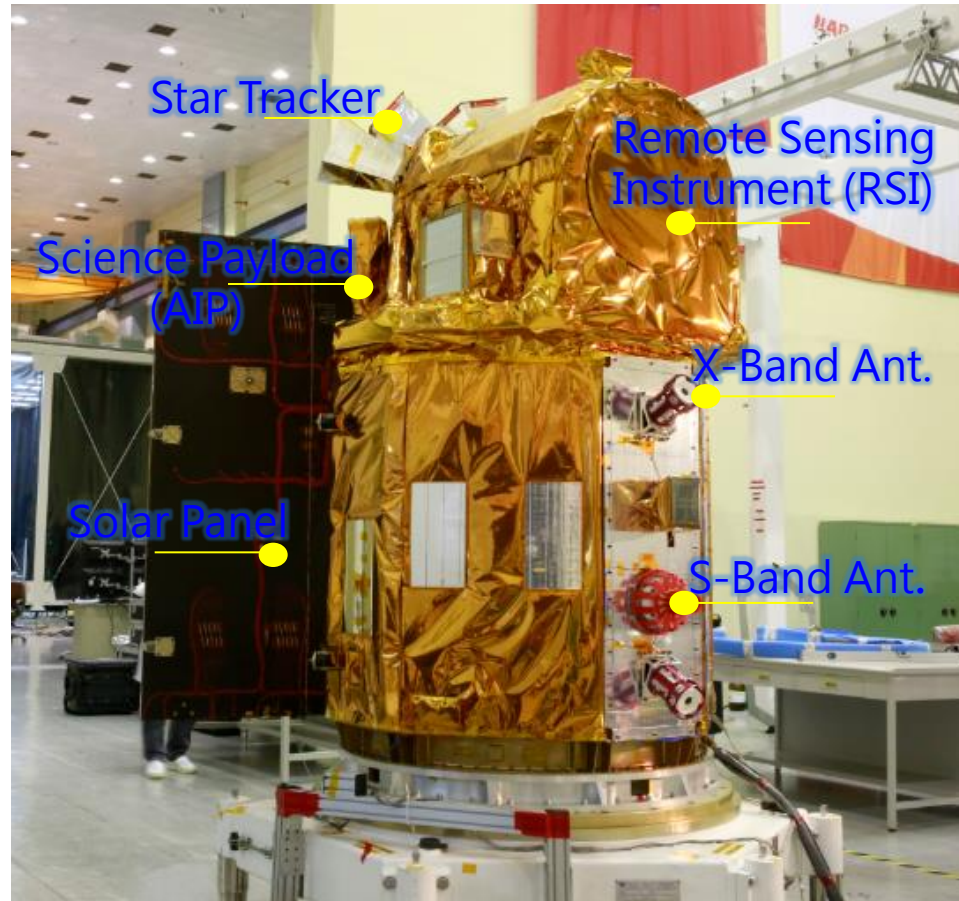


FORMOSAT-7R

## Major Milestones

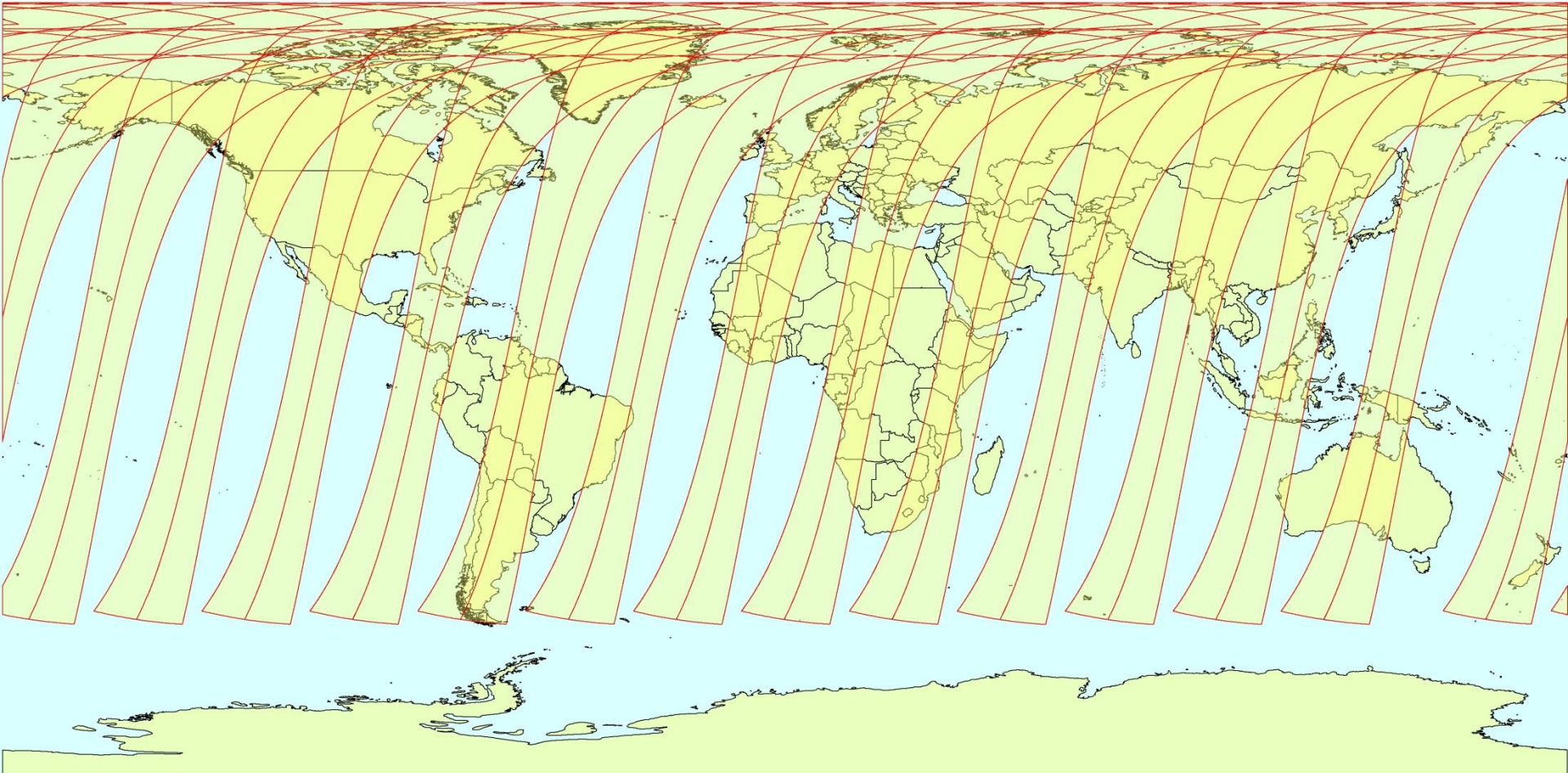


# 福衛五號主要參數

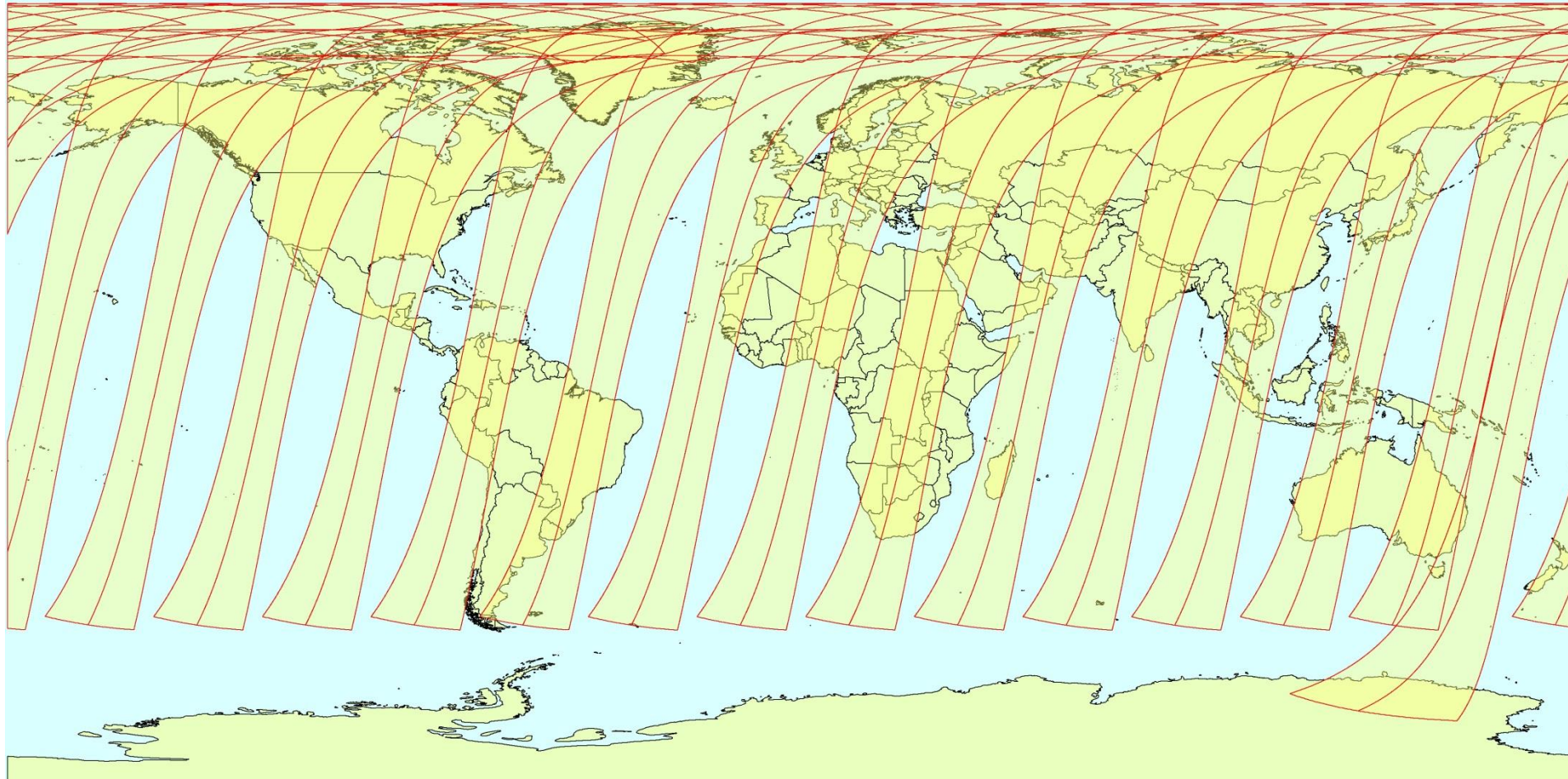


| 參數      | 規格                      |
|---------|-------------------------|
| 軌道      | 太陽同步軌道<br>@720km/98.28° |
| 再訪週期    | 2天                      |
| 任務壽期    | 5年                      |
| GSD     | PAN, 2m<br>MS, 4m       |
| 刈幅      | 24 km                   |
| 可視域     | ±45°                    |
| 頻譜      | PAN + 4 MS              |
| 酬載      | RSI/CMOS<br>AIP         |
| RSI負載循環 | 8%                      |

# 福衛五號覆蓋範圍 Day1



# 福衛五號覆蓋範圍 Day2



## 福衛五號任務執行現況

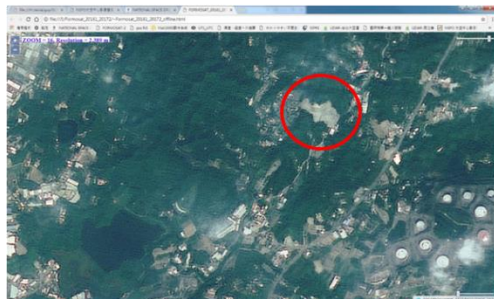
### ■ 至107上半年度成果

- ✓ 科學酬載與光學遙測酬載均已通過在軌功能驗證，正常地運作於地球720公里的太陽同步軌道。科學酬載每天收集超過100 Mega Bytes的高品質電離層參數資料，執行太空天氣觀測及地震前兆研究；光學遙測酬載已取**10,000組**以上的黑白 / 彩色影像，影像品質符合國土安全、環境監控、防災勘災等政府施政與民生用途。

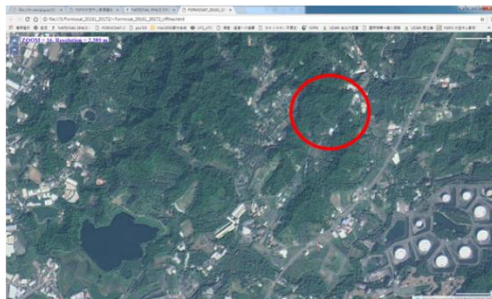
### ■ 下半年度預計工作

- ✓ 已研擬福五影像營運策略及訂價機制，預計**107年9/21正式營運**，**9月17舉行FS5影像運用研討會**，期能達到擴大影像應用、創新加值的新綜效，為臺灣太空發展之重要里程碑。

### ■ 監測山坡地違法開發

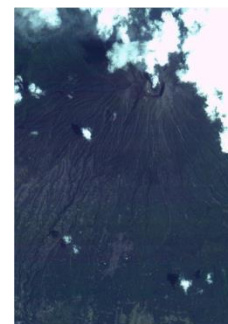


福衛五號影像 (106/11)

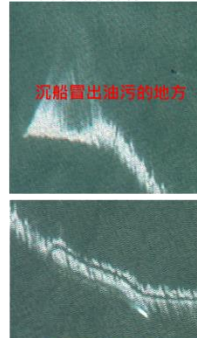


福衛二號影像 (105/03)

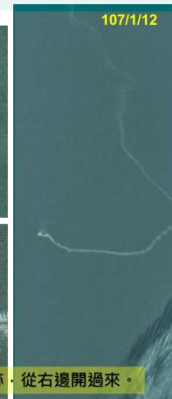
■ 印尼阿貢火山活動監測



■ 東海油污影像



深色線條為船的航跡 · 從右邊開過來。





# 希臘雅典彩色影像

**NAR**Labs



# 希臘雅典黑白影像

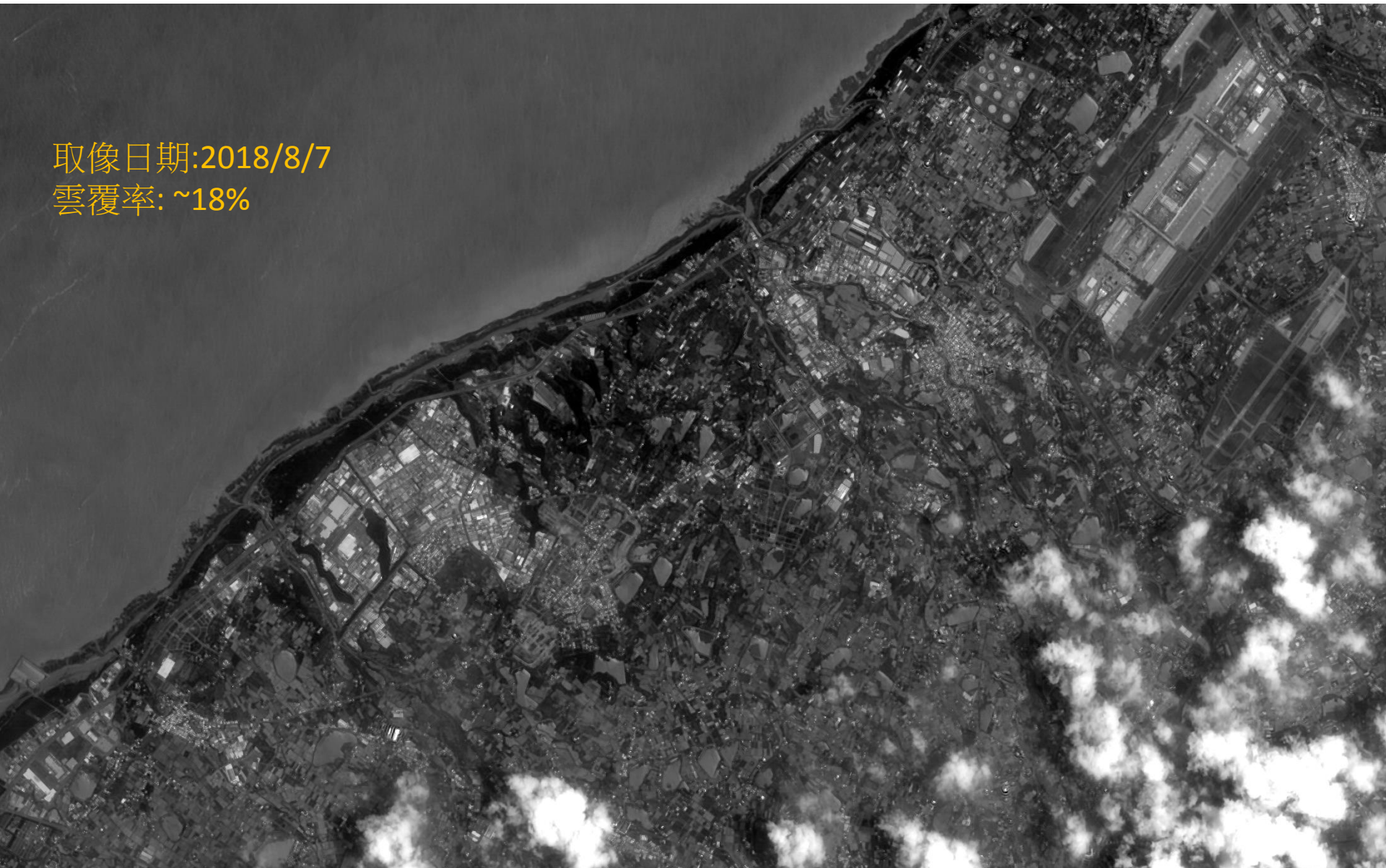
**NAR**Labs



# 台灣黑白影像(桃機)

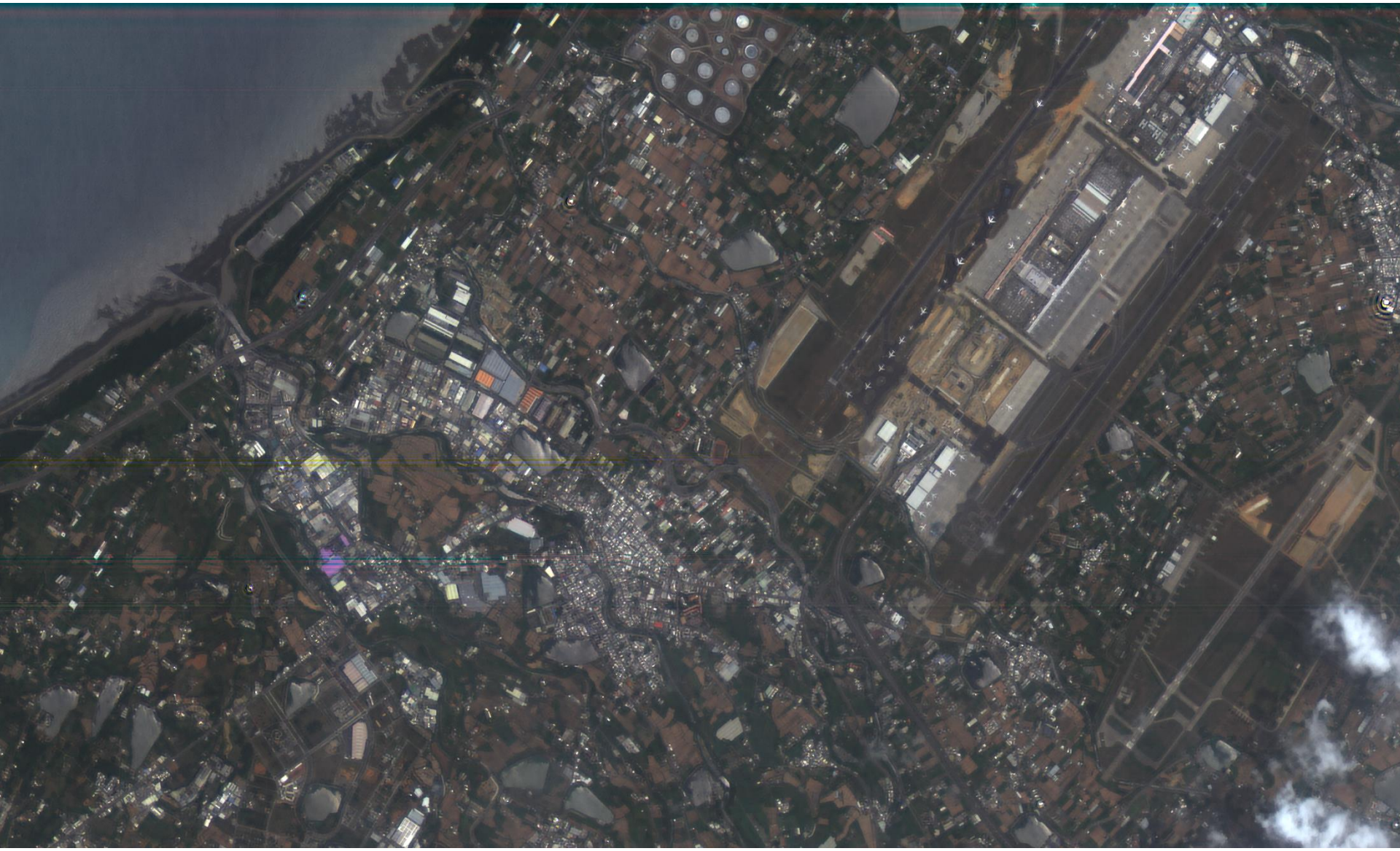
**NAR**Labs

取像日期:2018/8/7  
雲覆率:~18%



# 台灣彩色影像(桃機)

**NAR**Labs



## 飛機資訊(from flightradar24 的歷史資料)

**PLAYBACK Tue, Aug 7, 2018, 02:53**

Speed: 12x

Mon, Aug 6, 2018 23:00 Tue, Aug 7, 2018 00:00 01:00 02:00 03:00

**Boeing 787-8 Dreamliner**  
 REGISTRATION: JAR24  
 MODE-S CODE: 86D602  
 SERIAL NUMBER (MSN): 34834  
 AGE (SEP 2012): 5 years

**BR8 eva006**  
 EVA Air  
 ACTUAL: 11:06 ESTIMATED: 07:38  
 GREAT CIRCLE DISTANCE: 10,410 KM  
 TYPE: (B77W) Boeing 777-36N(ER)

**BR6 eva006**  
 EVA Air  
 ACTUAL: 11:23 ESTIMATED: 08:22  
 GREAT CIRCLE DISTANCE: 10,942 KM  
 TYPE: (B77W) Boeing 777-35E(ER)

**BR867 eva007**  
 EVA Air  
 ACTUAL: 11:09 ESTIMATED: 12:24  
 GREAT CIRCLE DISTANCE: 907 KM  
 TYPE: (A321) Airbus A321-211

Boeing 777-35E  
 機長73.9m<->  
 35.2 pixels  
 <-> 2.09m/px



| 機型                 | 機長 (m) | 機身寬度 (m) | GSD(m/px) |
|--------------------|--------|----------|-----------|
| Airbus A320        | 37.57  | 3.95     | 2.09      |
| Airbus A321        | 44.51  | 3.95     | 2.2       |
| Airbus A321        | 44.51  | 3.95     | 2.1       |
| Boeing 737-300     | 33.4   | 3.76     | 1.91      |
| Boeing 737-800     | 39.47  | 3.76     | 2.1       |
| Boeing 777-35E     | 73.86  | 6.2      | 2.09      |
| Boeing 777-36N     | 73.86  | 6.2      | 2.1       |
| Boeing 787-8       | 56.72  | 5.77     | 1.97      |
| Boeing 777-228(ER) | 63.7   | 6.2      | 2.15      |
| average            |        |          | 2.08      |

# 解析度判讀(飛機長度, MS桃機影像)

**NAR Labs**

Boeing 777-36N  
機長63,7m<-> 17.4  
pixels  
<-> 4.2 m/pxs

Boeing 777-36N

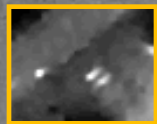


Airbus A321-211

Airbus A321-211  
機長44.51m<-> 10.73pixels  
<-> 4.15 m/pxs

# 實測台61線車輛衛星影像解析度 **NAR Labs**

## (2018年8月7日10點54分)



Car-1: 2.5 pixels



Car-2: 3.7 pixels



Car-3: 3.2 pixels

平均<-> 2.0 m/pxs

Car-3: 6.3m

Car-2: 7.5 m

Car-1: 5m

常見汽車尺寸

|    | 轎車     | 休旅車  | 自走式露營車                      |
|----|--------|------|-----------------------------|
| 長度 | 5M左右   | 5M左右 | 九人座(5M~7.5M)底盤車(6.3M~10.6M) |
| 寬度 | 約2.6左右 | 同左   | 同左                          |
| 高度 | 約1.3M  | 約2M  | ~2.8M                       |



# Outline

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一. 福五任務執行現況

二. 福五影像品質現況

三. 影像應用實例

in Agriculture

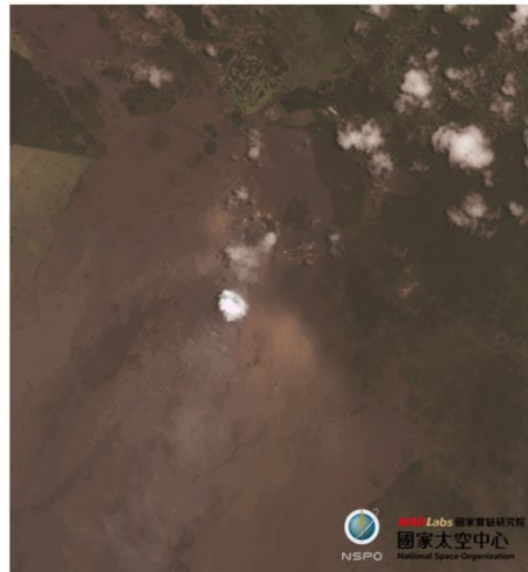
in Disaster Monitoring

in Change Detection

## 影像相關國際合作(一) - 日本

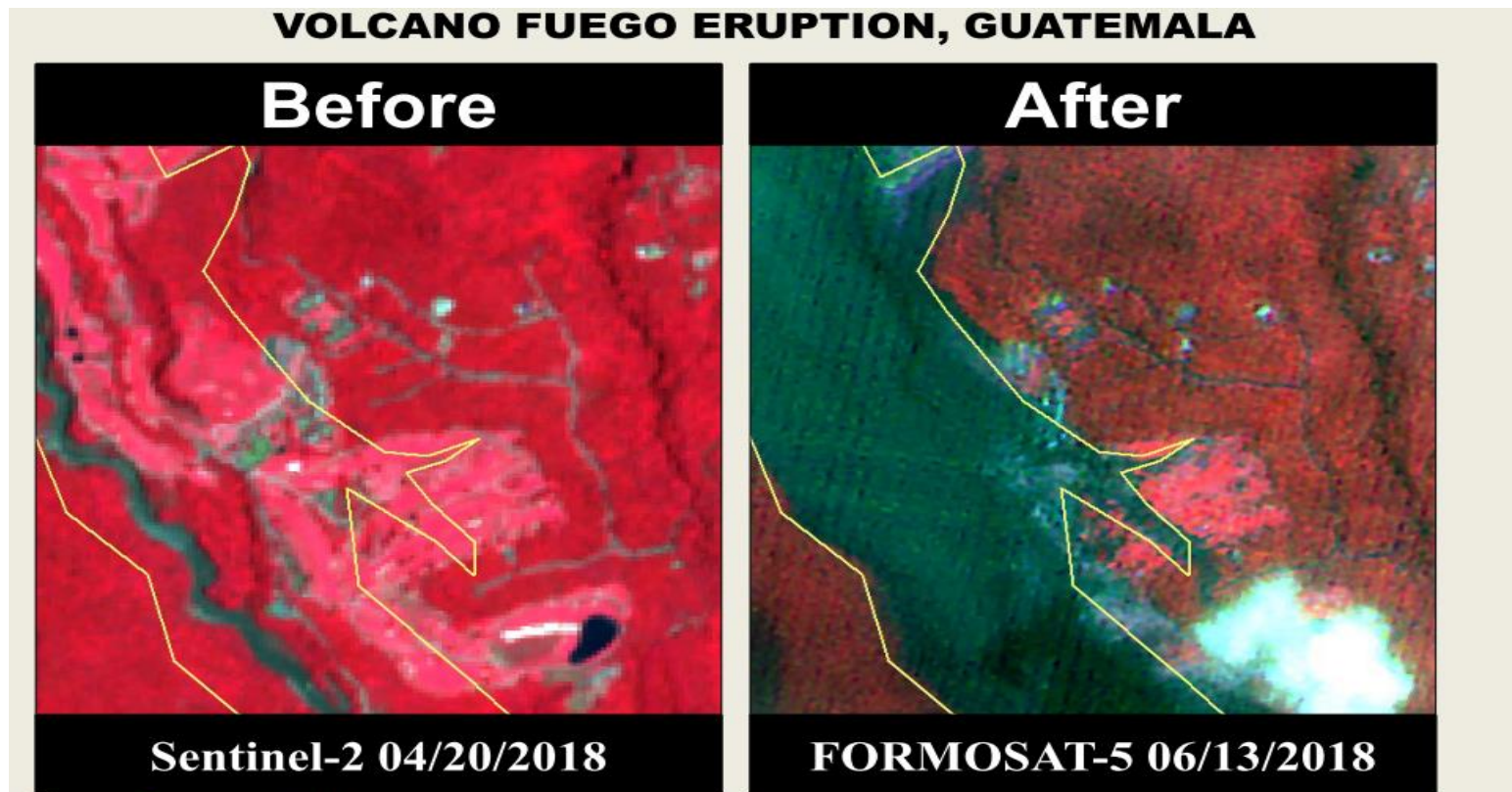
- 107/1/23-24與JAXA在台灣共同舉辦5th Joint Project Team Meeting for Sentinel Asia STEP 3，13國65人參加。
- 107/3/25提供日本新然岳火山福衛五號影像。
- 107/7 提供日本廣島安佐北區水災福衛五號影像。

夏威夷火山 (2018 May) 05/11



## 影像相關國際合作(二) – 瓜地馬拉

- 瓜地馬拉 FUEGO火山自6/4開始噴發, 造成附近居民重大傷亡, 福衛五號自6/7開始拍攝, 共取得6/9, 6/11, 6/13, 6/15天等連續影像。
- 中大太遙陳繼藩教授團隊, 利用Sentinel-2衛星災前影像, 與6/13災後福五影像, 做災前災後變遷分析, 可看出明顯變異點, 已將此分析成果, 寄送予瓜國大使。



# Thailand Oil spill Monitoring

承諾 · 熱情 · 創新

Oil spill occurred in southern of Thailand during 7-9 July 2018. It need to monitor oil spill in **Pangan Province**

 DMCR NEWS

ตรวจสอบคราบน้ำมัน หาดบ้านใต้ เกาะพะงัน



# 遙測影像民生需求- 國土監測

## ■ 監測山坡地違法開發



福五影像 2017/9/27  
拍攝時即可看出已遭濫墾



福二影像 2016/6/20  
拍攝時並仍未開發



三峽區三清萬甲仙境涉及山坡地濫墾  
(2018/5/18, 聯合報)

# 遙測影像民生需求-物候變化偵測

多元、多時期之高空間解析衛星影像來分析物候變化，以利偵測進行。

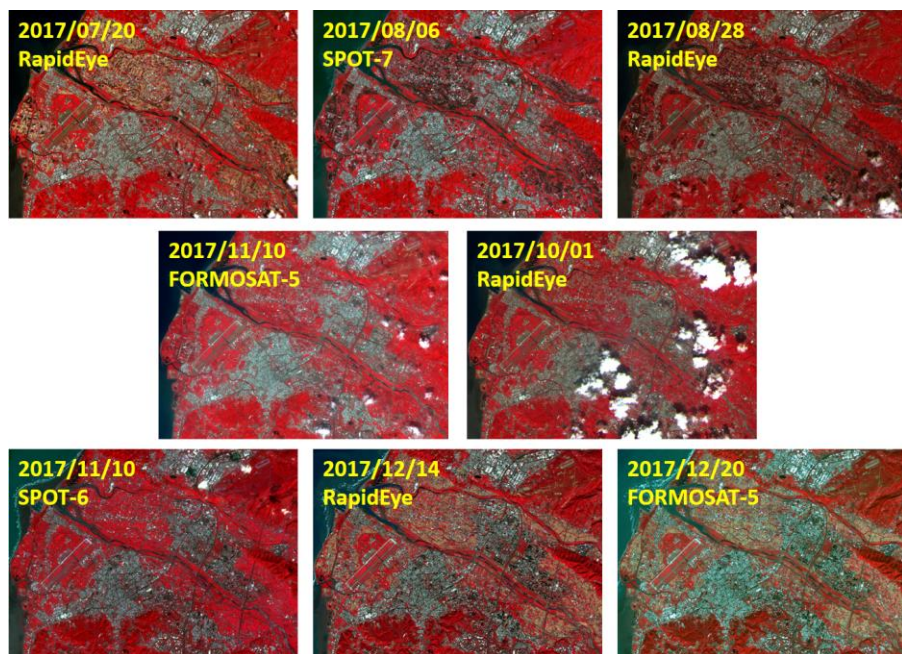


圖 4. 針對新竹縣市 106 年度二期稻作範圍，本研究所使用之測試範圍與對應之衛星影像

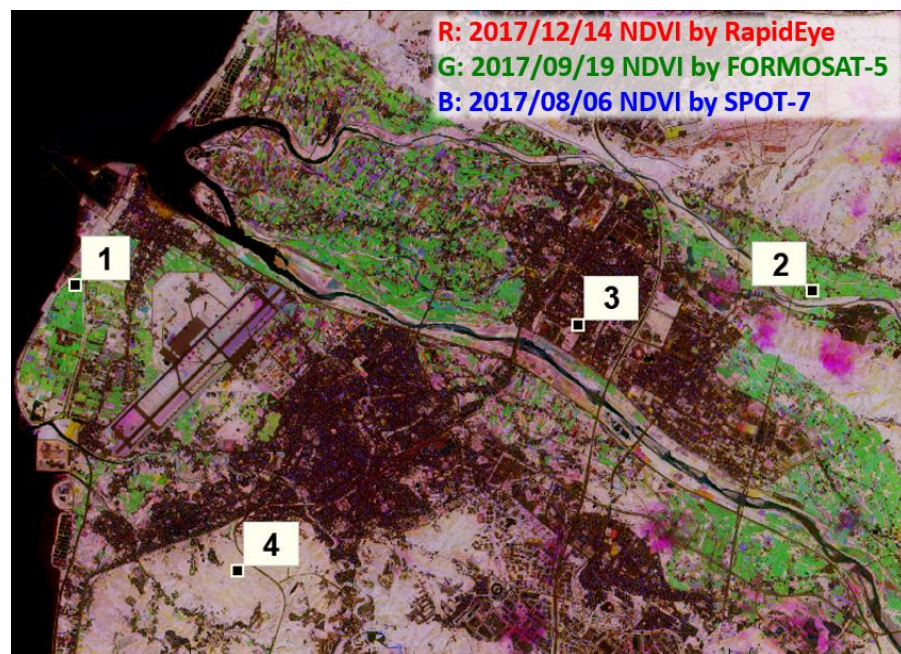


圖 5. 使用對應稻作播種期、抽穗期以及收割期之 NDVI 影像組成對應之 RGB 影像顯示時，在視覺上應可看出稻作分布的範圍

# 遙測影像民生需求- 國土變遷分析

## 福五影像 - 曾文水庫豐水期與枯水期比較



拍攝日期: 2018/1/1



拍攝日期: 20180519



# What can be done

## ■ With single image

### Index calculation

**NDVI (Normalized difference vegetation index)**

○

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

**EVI(Enhanced vegetation index)**

○

$$EVI = 2.5 \times \frac{NIR - RED}{NIR + 6 \times RED - 7.5 \times BLUE + 1}$$

**NDWI (Normalized difference water index)**

○

$$NDWI = \frac{GREEN - NIR}{GREEN + NIR}$$

**NDSI (Normalized difference soil index)**

×

$$NDSI = \frac{SWIR - NIR}{SWIR + NIR}$$

**GRVI (Green-Red vegetation index)**

○

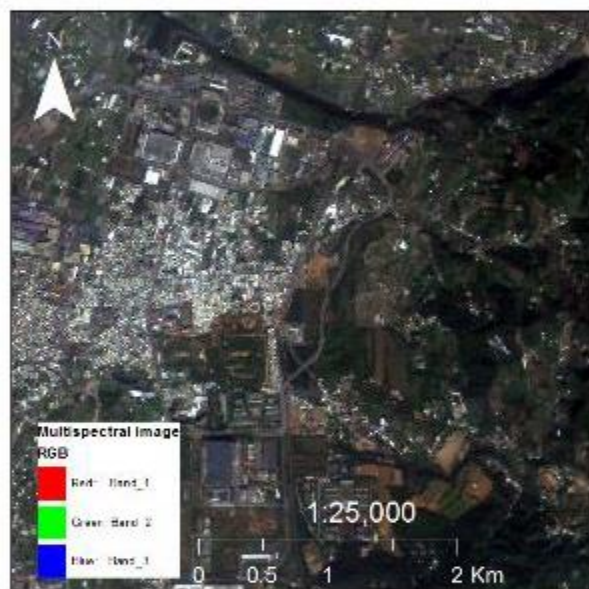
$$GRVI = \frac{GREEN - RED}{GREEN + RED}$$



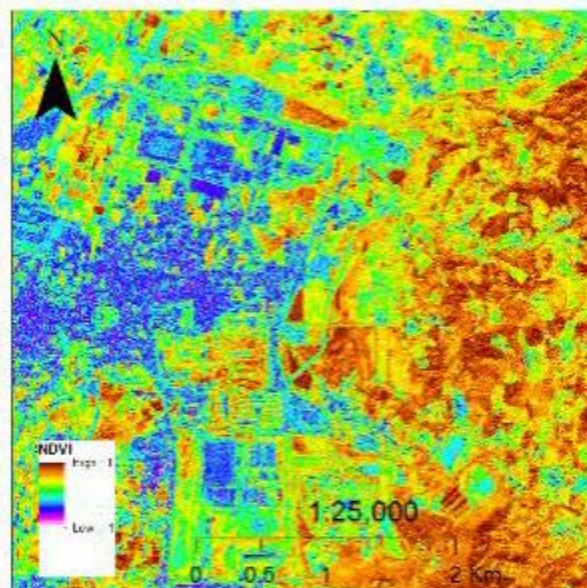


# Result of index calculation

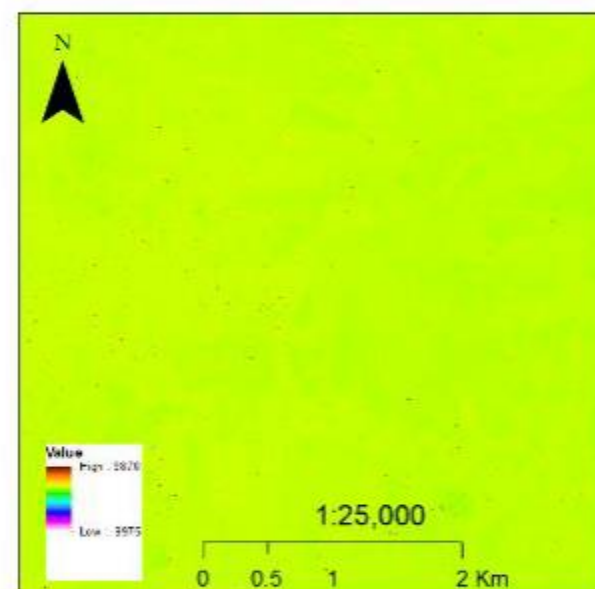
- Variable for MODIS was used to calculate EVI



RGB image



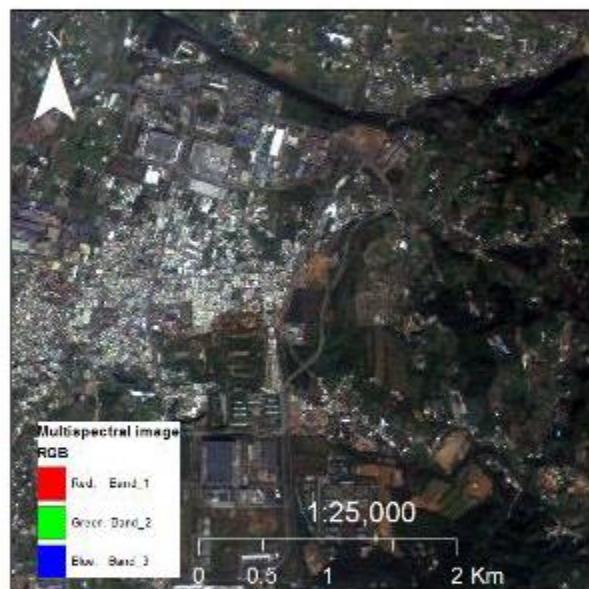
NDVI: Index showing distribution of the vegetation and its activity



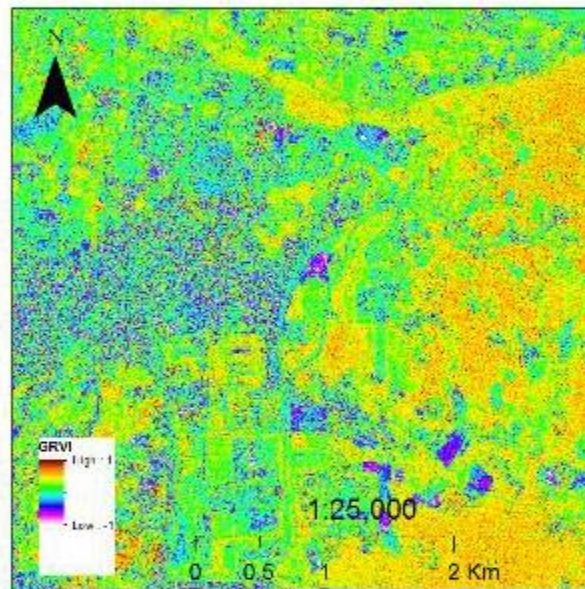
EVI: Index similar to NDVI but more suitable for high biomass regions



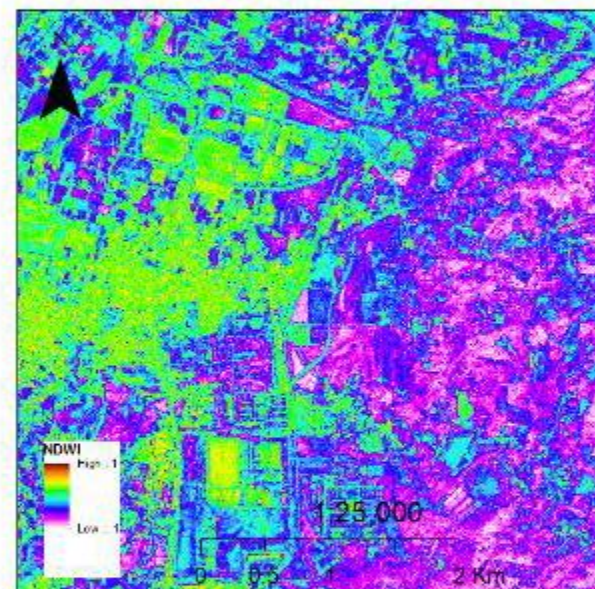
# Result of index calculation



RGB image



GRVI: Can be used for a phenological indicator such as leaf green-up and autumn coloring

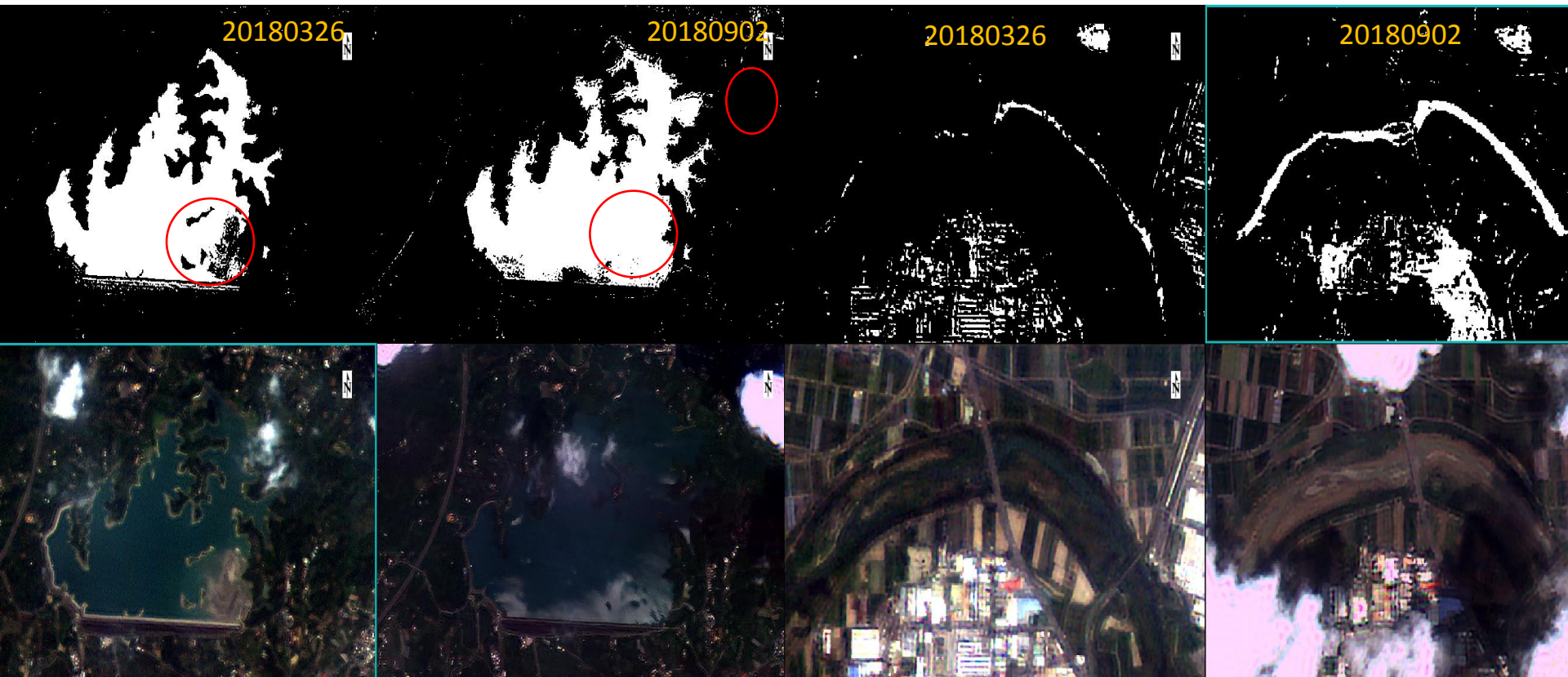


NDWI: Monitor changes in water content, water level (flooding impacts)

# 前後期影像NDWI比對( 08/23水災)

(水庫)

(河道)



# Formosat Images Data Cube Trial operation

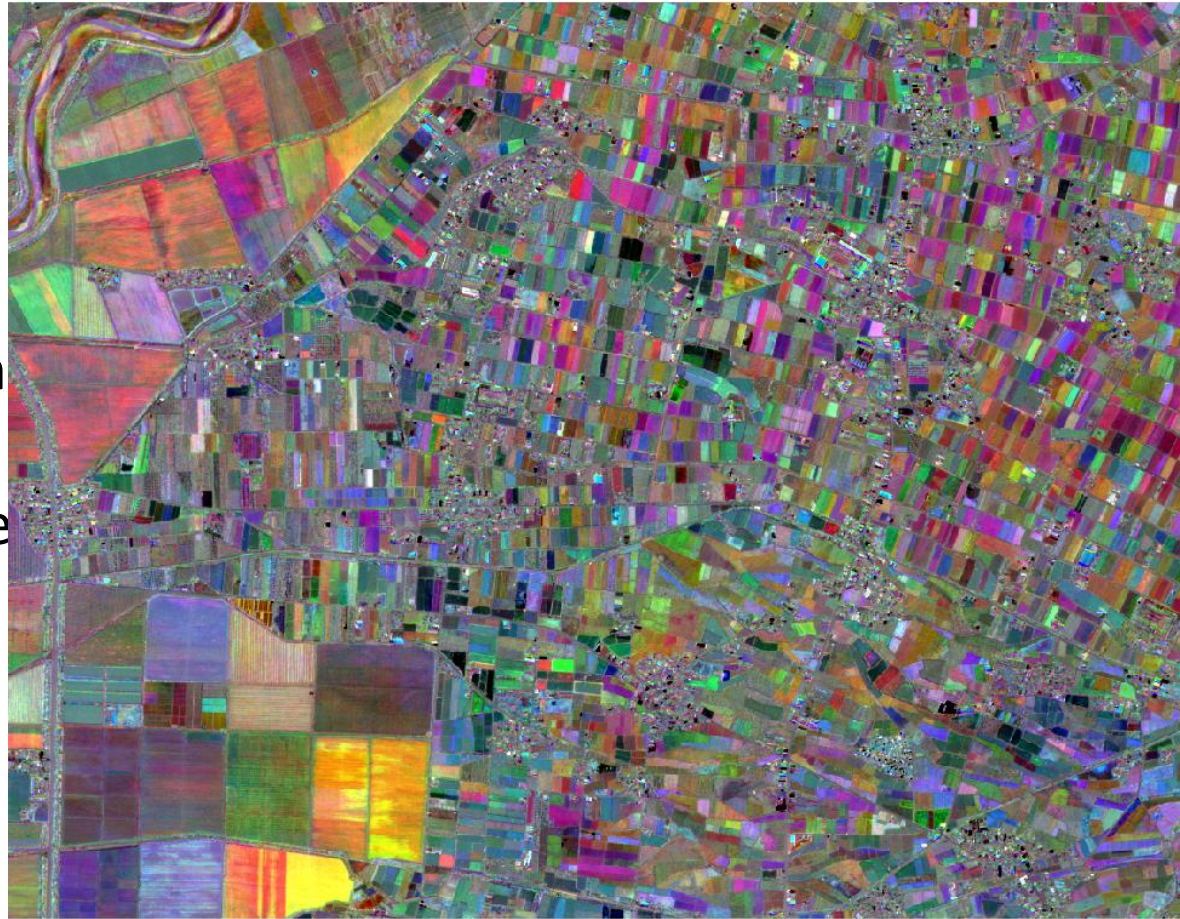
Formosat-2 time series images: 2005~2016, 428 frames

| Year         | PAN        | MSI        | Reference orthoimage |
|--------------|------------|------------|----------------------|
| 2005         | 9          | 9          | 1                    |
| 2006         | 18         | 18         | 1                    |
| 2007         | 22         | 22         | 1                    |
| 2008         | 20         | 20         | 1                    |
| 2009         | 19         | 19         | 1                    |
| 2010         | 26         | 26         | 1                    |
| 2011         | 11         | 11         | 1                    |
| 2012         | 13         | 13         | 1                    |
| 2013         | 22         | 22         | 1                    |
| 2014         | 28         | 28         | 1                    |
| 2015         | 19         | 19         | 1                    |
| 2016         | 7          | 7          | 1                    |
| <b>Total</b> | <b>214</b> | <b>214</b> | <b>12</b>            |



# Formosat Images Data Cube Trial operation

- Geometric and Radiometric Processing
  - Precise Image Co-registration
  - Top Of Atmosphere (TOA) Reflectance
  - Multi-Temporal Cloud Detection(MTCD) for Pixel Quality Index (PQI)
- Metadata File generation
  - YAML format
- Data Cube Internal Image Generation
  - NetCDF format



Formosat-2 Time Series PCA Principal component images

# Cooperation direction

- NSPO have cooperated with University and CRSRS in
  - Geometric and Radiometric Pre-processing
  - ingest Formosat images into Open Data Cube (by reference to <https://datacube-core.readthedocs.io/en/latest/>)
- Need more support from CSIRO about how to use the APP and Service; how to use the Data Cube to make the function and benefit is what we need to learn and develop.

Open Data Cube

Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: localuser Logout

## Dataset Types

Dataset type definitions are used to describe datasets contained in the Data Cube. Individual datasets are associated with a single dataset type. Each dataset type includes a variety of data and metadata including dataset measurement data, product types and platforms, and creation dates and users.

Show 10 entries Search:

| Id | Name                     | Platform   | Instrument | Product Type | Measurements   | Description                                      | View Datasets | View Full Defini |
|----|--------------------------|------------|------------|--------------|--|--|---------------|------------------|
| 1  | ls7_collections_sr_scene | LANDSAT_7  | ETM        | LEDAPS       | sr_band1, sr_band2, sr_band3, sr_band4, sr_ba...       | Landsat 7 USGS Collection 1 Higher Level SR s... | View datasets | View definition  |
| 2  | ls7_ledaps_general       | LANDSAT_7  | ETM        | LEDAPS       | blue, green, red, nir, swir1, swir2, atmos_opacity...  | Landsat 7 USGS Collection 1 Higher Level SR s... | View datasets | View definition  |
| 3  | ls8_collections_sr_scene | LANDSAT_8  | OLI_TIRS   | LaSRC        | sr_band1, sr_band2, sr_band3, sr_band4, sr_ba...       | Landsat 8 USGS Collection 1 Higher Level SR s... | View datasets | View definition  |
| 4  | ls8_lasrc_general        | LANDSAT_8  | OLI_TIRS   | LaSRC        | coastal_aerosol, blue, green, red, nir, swir1, swir... | Landsat 8 USGS Collection 1 Higher Level SR s... | View datasets | View definition  |
| 24 | sp6_ms_toa_scene         | SPOT6_MS   | H1M        | CSRortho     | TOA_band1, TOA_band2, TOA_band3, TOA_ba...             | SPOT 6 MS TOA scene                              | View datasets | View definition  |
| 26 | sp6_ms_CSR_general       | SPOT6_MS   | H1M        | CSRortho     | blue, green, red, nir, pixel_qa, Solar_Azimuth, S...   | SPOT6 processed using MSGPS. Resampled to ...    | View datasets | View definition  |
| 27 | s1_sigma0_scene          | SENTINEL_1 | SAR        | sigma0       | vh, vv,  | Sentinel-1A/B SAR Sigma0 scenes, processed t...  | View datasets | View definition  |
| 28 | s1_sigma0_general        | SENTINEL_1 | SAR        | sigma0       | vh, vv,  | Sentinel-1A/B SAR Sigma0, processed to the C...  | View datasets | View definition  |
| 31 | fs2_ms_toa_scene         | FS2_MS     | R1M        | CSRortho     | TOA_band1, TOA_band2, TOA_band3, TOA_ba...             | FORMOSAT 2 MS TOA scene                          | View datasets | View definition  |
| 32 | fs2_ms_CSR_general       | FS2_MS     | R1M        | CSRortho     | blue, green, red, nir, pixel_qa, Solar_Azimuth, S...   | FS2 processed using MSGPS. Resampled to 6m ...   | View datasets | View definition  |

Showing 1 to 10 of 10 entries

Previous 1 Next