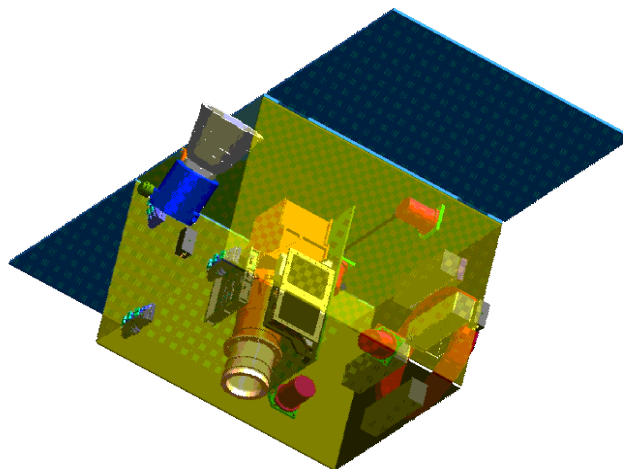




NUS
National University
of Singapore



CRISP

National University of Singapore

Regional Disaster Monitoring at CRISP with XSAT

CHIA Aik Song

Associate Scientist, CRISP

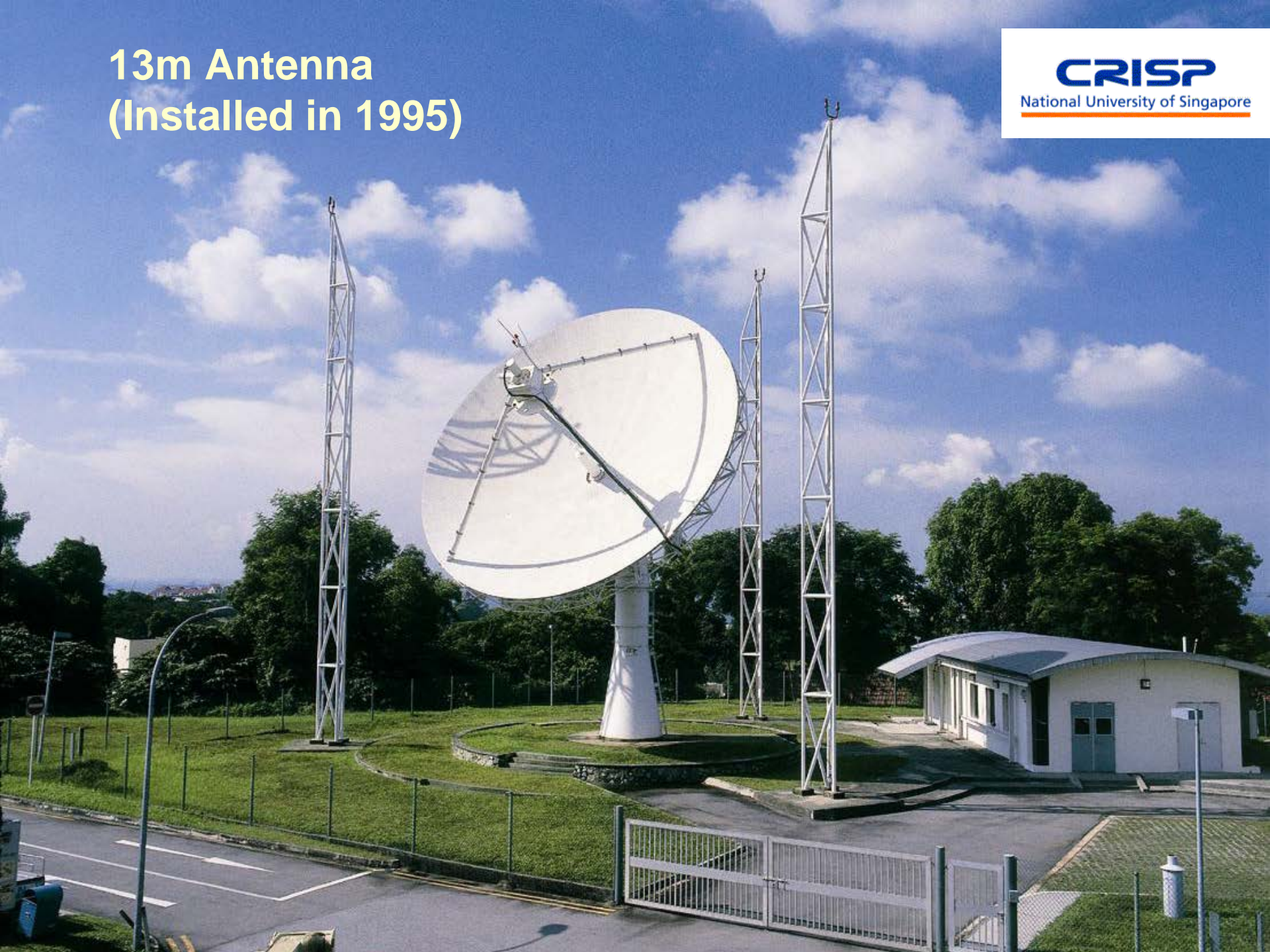


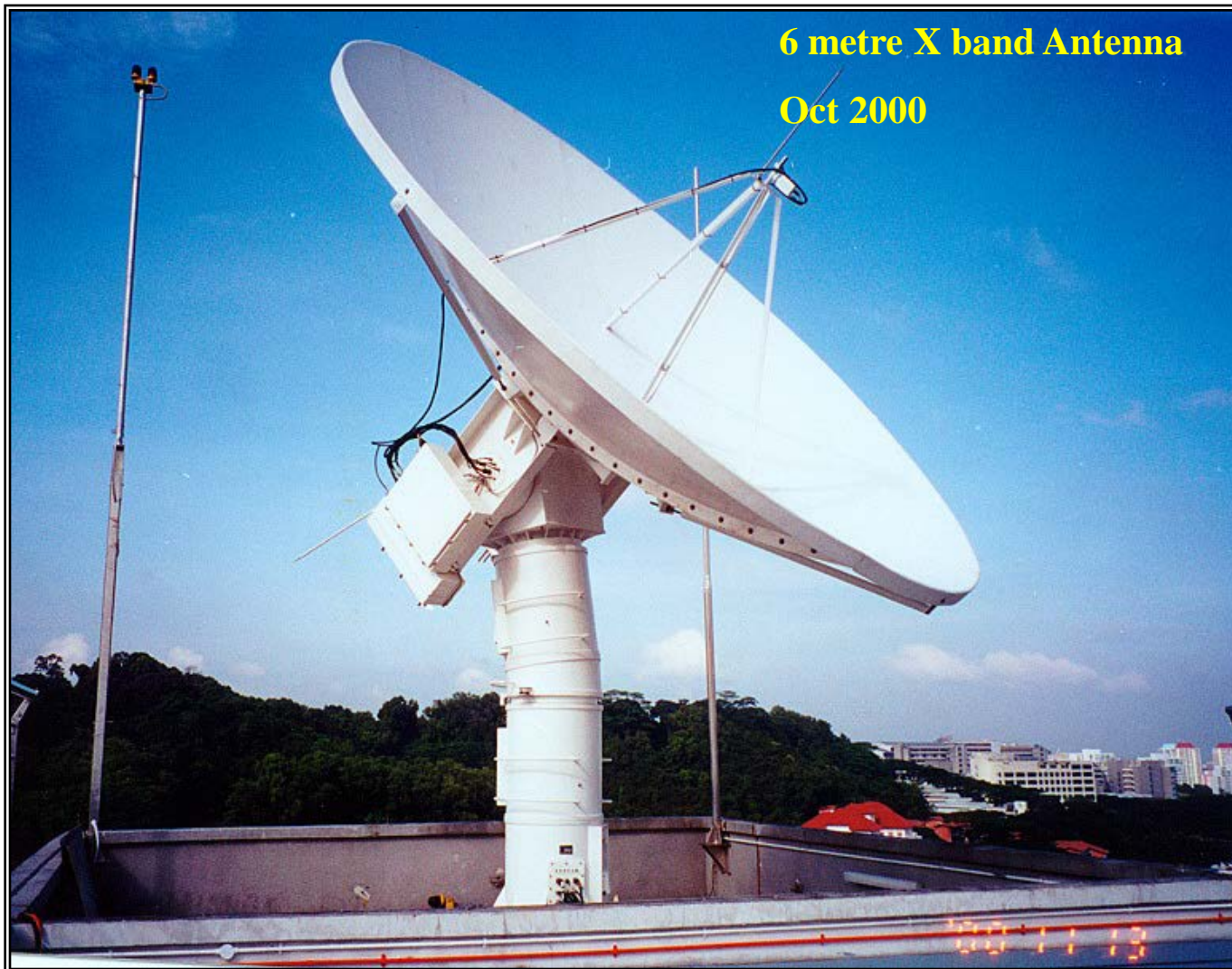
1st Joint Project Team Meeting for Sentinel Asia Step-3 (JPTM 2013)
27th – 29th November , Bangkok, Thailand

Centre for Remote Imaging, Sensing and Processing (CRISP)

- A university level research centre of the National University of Singapore
- Established in late 1992 with funding from the Agency for Science, Technology and Research (A*STAR)
- Started operation in September 1995 with the completion of the satellite receiving ground station.
- CRISP's Mission:
 - to develop an advanced capability in remote sensing to meet the scientific, operational and business requirements of Singapore and the region.

13m Antenna (Installed in 1995)





8.5 m X-band
antenna

Feb 2009



Satellite data received at CRISP

- High Resolution Optical Data
 - SPOT 1, 2, 4, 5
 - IKONOS
 - GeoEye-1
 - WorldView-1, 2
 - XSat
- Meteorological / Environmental Satellite Data
 - Suomi NPP
 - Terra and Aqua / MODIS
 - NOAA / AVHRR
- Geostationary Satellite Data
 - MTSAT
 - FY2
- SAR Satellite Data
 - ERS 1, 2
 - RADARSAT

CRISP Ground Station Coverage





XSAT (eXperimental SATellite)

Singapore's first earth observation satellite.

Launched 20 April 2011, with two other satellites by India's Polar Satellite Launch Vehicle (PSLV-C16).

Sun-synchronous near-polar low earth orbit

XSat is a developmental project undertaken by CREST (Centre For Research in Satellite Technologies) with participation from various schools in NTU, as well as partners such as CRISP (Centre for Remote Imaging, Sensing and Processing, NUS), and overseas collaborators (SaTReCi, ISRO and DLR).

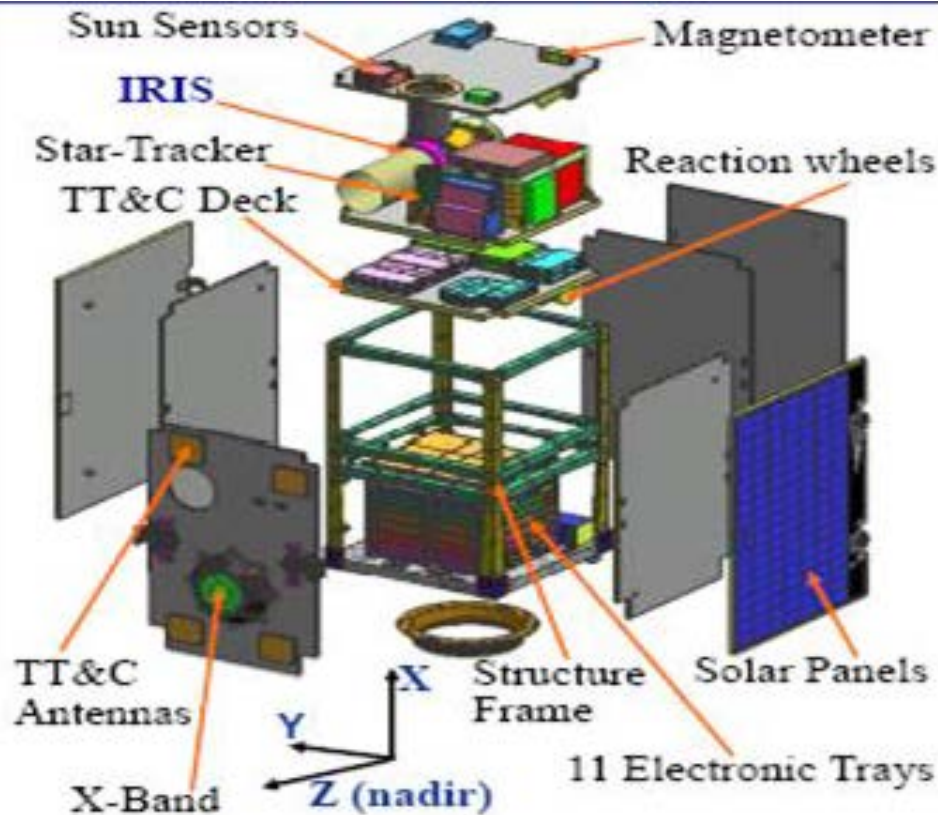
Space segment

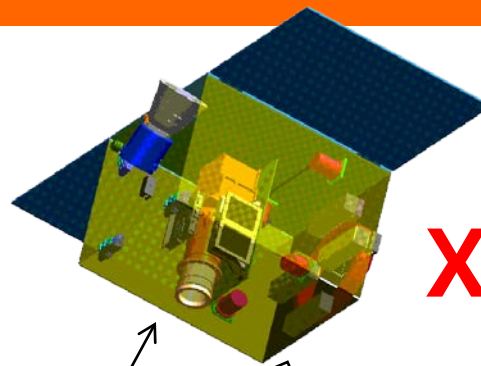
- 105 kg micro-satellite
- Low earth orbit (817 km)
- Polar, sun-synchronous
- Payload – multispectral 10m GSD optical camera (Red, Green, NIR)
- Swath – 50km
- Launched on 20th April 2011 on ISRO's PSLV C-16
- Developed by Centre for Research in Satellite Technology (CREST)/ Satellite Research Centre (SaRC) at Nanyang Technological University (NTU), Singapore

Ground segment

- S-band TT&C, X-band data downlink
- Data reception and processing system – developed by CRISP at National University of Singapore (NUS)
- TT&C at NTU (CRISP as backup)
- Data downlink at CRISP

XSAT

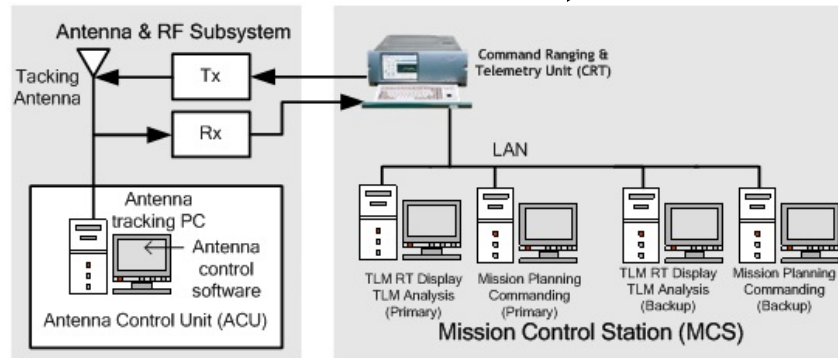




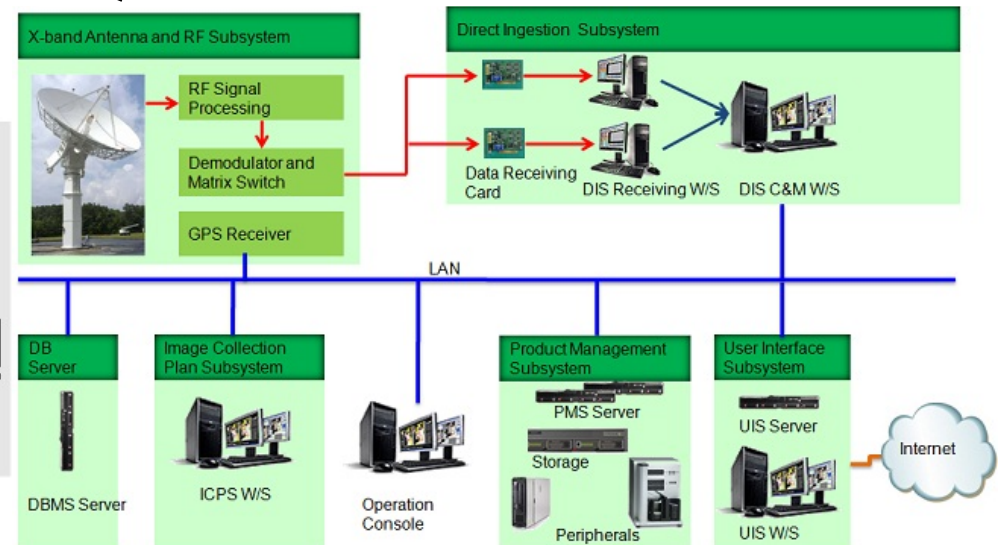
XSAT

S band
Up/down
link

X band downlink
(50 Mbps)



6m S-band Antenna
and MCS @
CREST/NTU

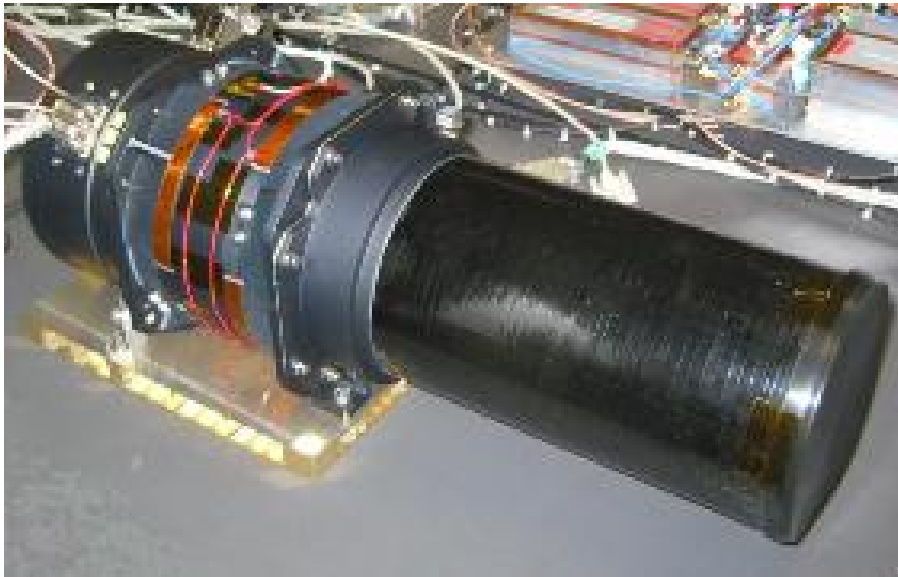


8.5m X band Antenna
and IRPS @
CRISP/NUS

(Also Backup MCS)

Image
request

XSat Imaging Payload - IRIS



Pushbroom sensor array

3 spectral bands:

Green (520 – 600 nm)

Red (630 – 690 nm)

NIR (760 – 890 nm)

Ground pixel width: 10 m

Swath width: ~ 50 km

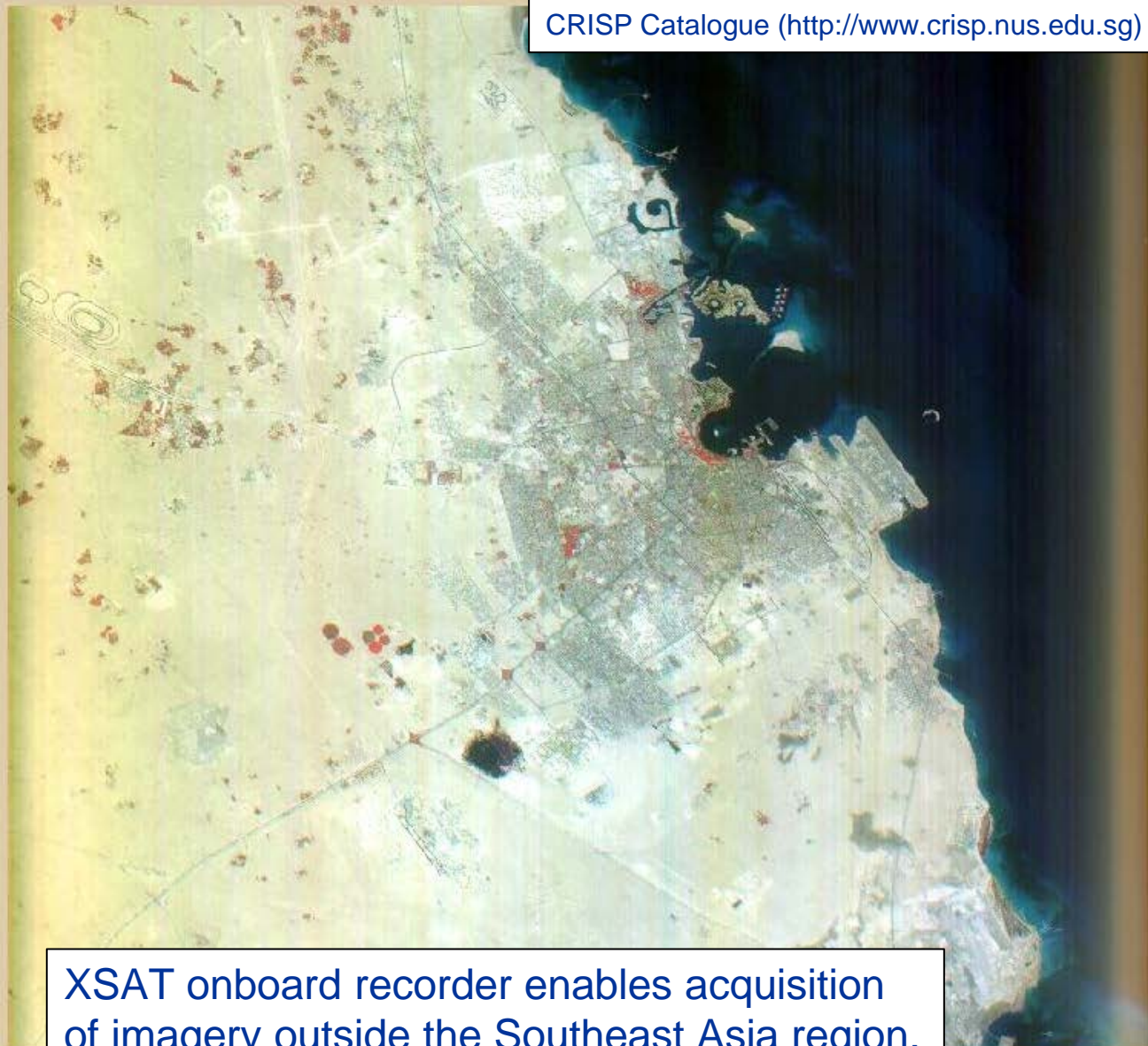
Telescope aperture: 12.0 cm

F-number: 4

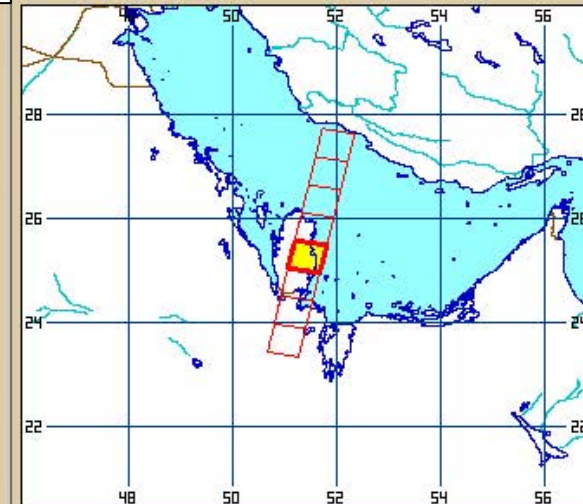
XSat images are received and processed by CRISP's ground station

XSAT coverage

CRISP Catalogue (<http://www.crisp.nus.edu.sg>)



XSAT onboard recorder enables acquisition of imagery outside the Southeast Asia region.



Date/Time : 2013-01-05_07:27:43
Sat Name : XSAT1

Latitude/Longitude

Centre : 25°15'47" / 51°26'52"
Top Left : 25°34'28" / 51°12'36"
Top Right: 25°29'05" / 51°49'12"
Bott Left : 25°02'30" / 51°04'37"
Bott Right: 24°57'03" / 51°41'02"

Cloud Cover: (0,0,0,0)
Cloud Avg : 0

Look Elev : 78.92
Look Az : 303.81

Attitude
(p,r,y) : (-4.01,-6.75,-0.05)

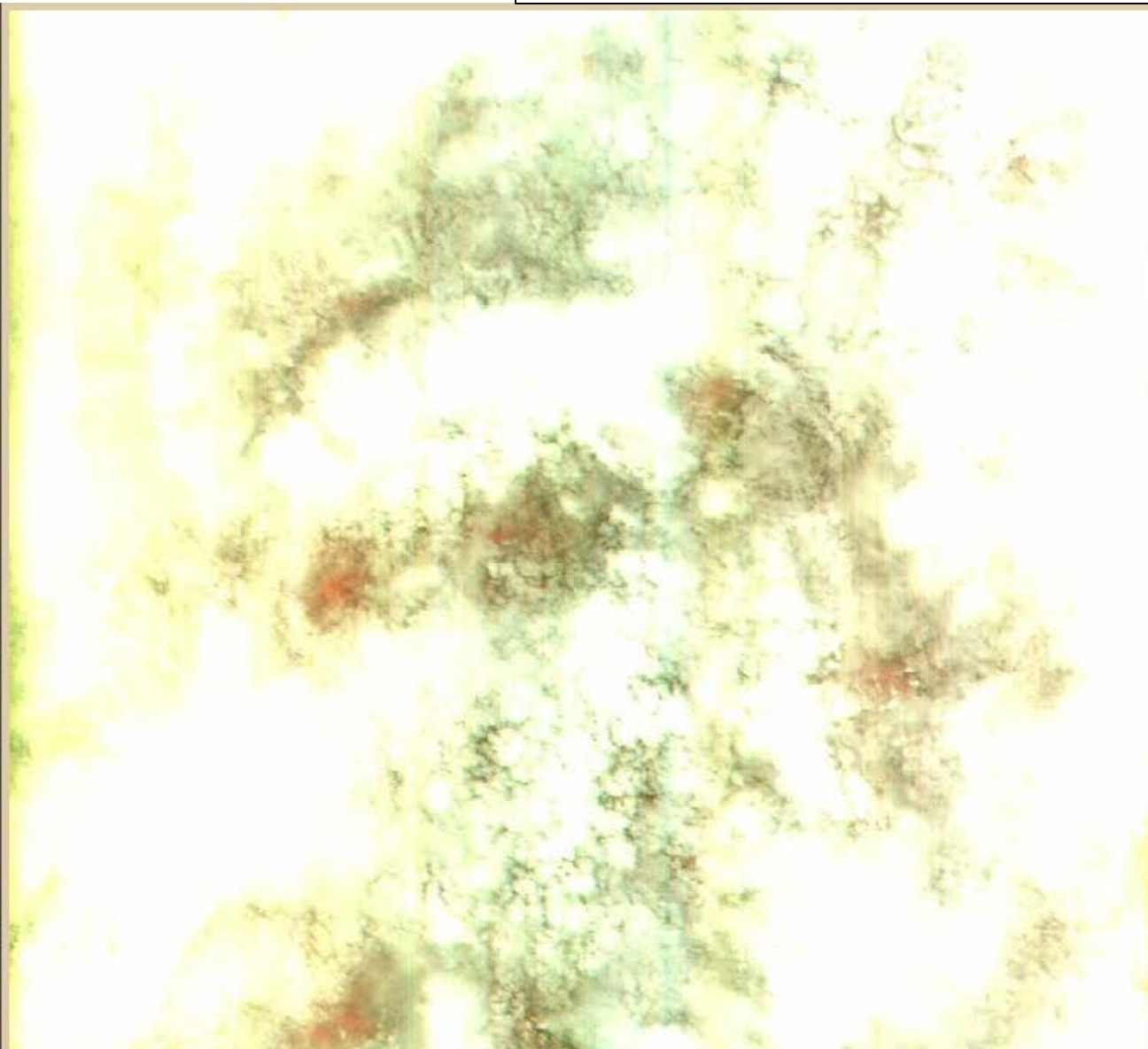
Remark : QA_Doha

XSAT image
Doha, Qatar
5th January 2013



XSAT support for Sentinel Asia in 2013

SA Request ID	Date	Location of Disaster	Nature of Disaster	Date of imaging attempt	Location of imaging attempt	Lat	Lon	Cloud conditions
Z SA DPN 00054, 56, 59	20131109	Central Visayas, Philippines	Flood, Landslide, Storm	20131112	Samar, Philippines	11.44	125.26	All cloud
				20131116	Samar, Philippines	11.38	125.18	All cloud
				20131119	Samar, Philippines	11.35	125.05	Cloudy
Z SA DPN 00030	20130819	Metro Manila	Flood, Landslide, Storm	20130824	Metro Manila	14.54	121.14	Cloudy
				20130825	Metro Manila	14.54	121.14	All cloud
Z SA DPN 00029	20130813	Myanmar	Flooding	20130816	Myanmar	15.60	98.05	All cloud
				20130821	Myanmar	15.60	98.05	All cloud
Z SA DPN 00025	20130723	Chanthaburi, Thailand	Flooding	20130804	Chanthaburi, Thailand	12.56	102.04	All cloud
Z SA DPN 00017	20130621	Kedarnath Uttarakhand, India	Flood, Landslide	20130626	Uttarakhand, India	30.73	79.07	All cloud
				20130630	Himachal Pradesh, India	31.12	77.49	Cloudy
				20130705	Uttarakhand, India	29.78	78.57	All cloud
Z SA DPN 00013, 14	20130618	Khalanga, Darchula, Nepal	Flood, Landslide	20130619	Khalanga, Darchula, Nepal	29.70	80.75	All cloud
				20130623	Khalanga, Darchula, Nepal	30.00	80.00	All cloud
				20130627	Khalanga, Darchula, Nepal	29.92	80.34	All cloud
				20130701	Khalanga, Darchula, Nepal	29.89	80.31	All cloud
Z SA DPN 00008	20130420	Sichuan, China	Earthquake	20130422	Sichuan, China	103.67	60.24	All cloud
				20130423	Sichuan, China	102.34	69.19	All cloud
Z SA DPN 00002	20130221	Manado, Indonesia	Landslide	20130226	Manado, Indonesia	1.45	124.95	All cloud



Date/Time : 2013-06-27_05:38:16
Sat Name : XSAT1

Latitude/Longitude

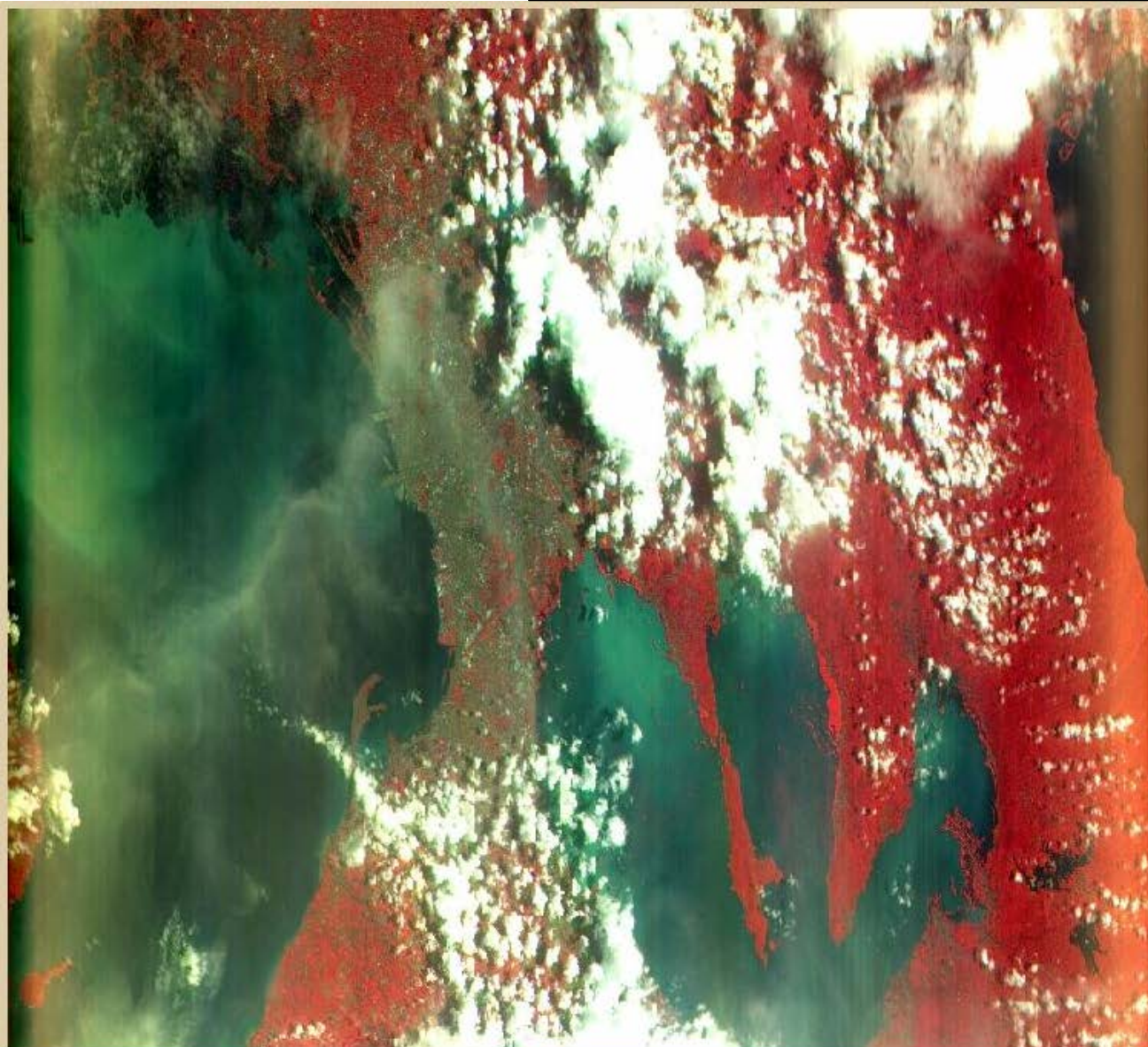
Centre : 29°39'31" / 80°23'36"
Top Left : 29°57'17" / 80°09'03"
Top Right: 29°52'59" / 80°46'44"
Bott Left : 29°26'30" / 80°00'38"
Bott Right: 29°21'19" / 80°37'58"

Cloud Cover: (0,0,0,0)
Cloud Avg : 0

Look Elev : 77.88
Look Az : 250.80

Attitude
(p,r,y) : (5.11,-7.40,-1.25)

Remark : India_Nepal



Date/Time : 2013-08-24_03:16:01
Sat Name : XSAT1

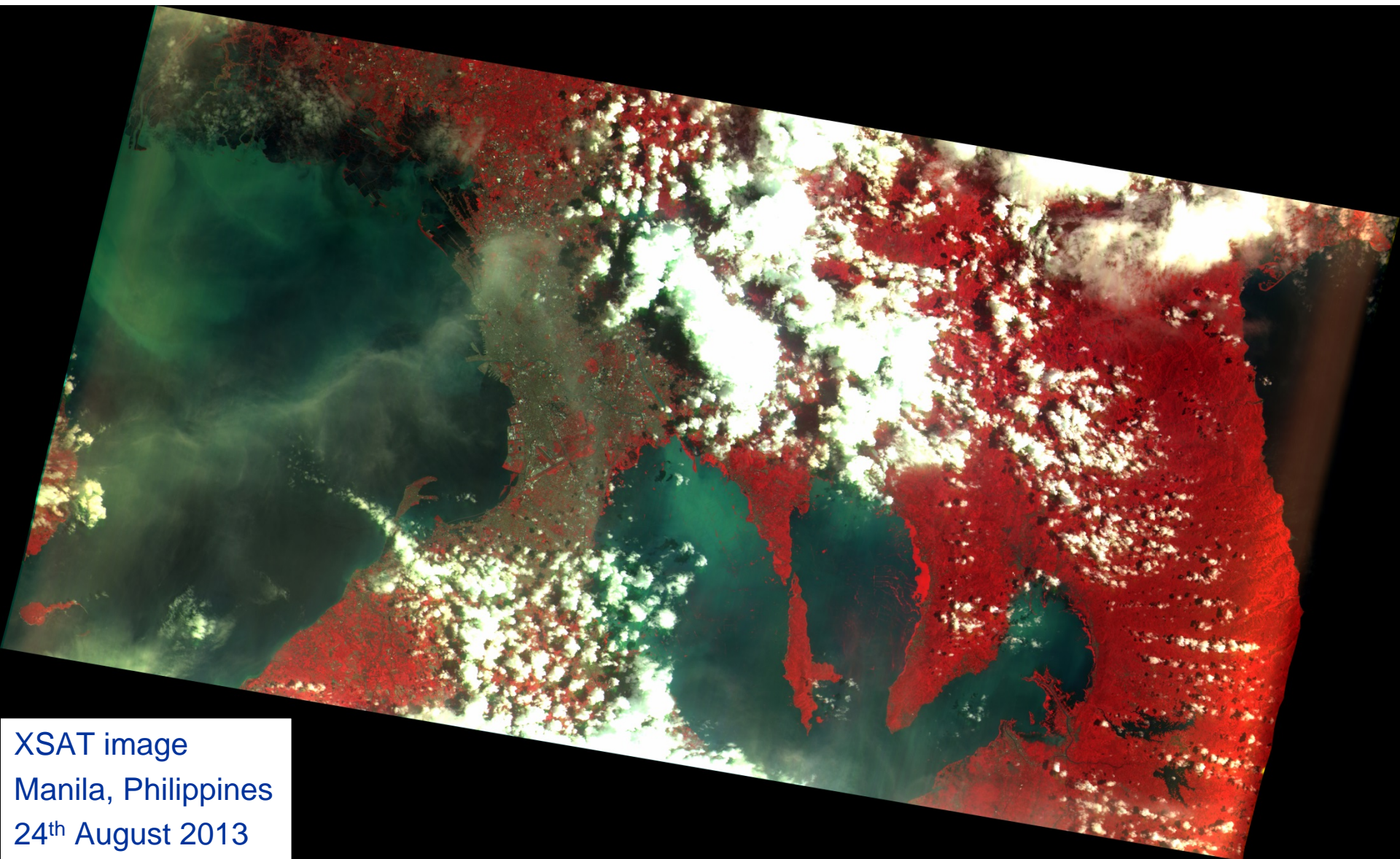
Latitude/Longitude
Centre : 14°32'17" / 121°08'35"
Top Left : 14°53'26" / 120°40'23"
Top Right: 14°43'06" / 121°44'20"
Bott Left : 14°21'14" / 120°32'46"
Bott Right: 14°11'21" / 121°36'49"

Cloud Cover: (0,0,0,0)
Cloud Avg : 0

Look Elev : 47.48
Look Az : 96.36

Attitude
(p,r,y) : (-2.18,38.84,-1.15)

Remark : Philippines_Manila



XSAT image
Manila, Philippines
24th August 2013

June 2013 Haze, from fires in Sumatra

- During the 2nd half of June 2013, haze from fires in Sumatra affected a number of areas in Southeast Asia, primarily Riau in Sumatra, Peninsular Malaysia and Singapore.
- In Singapore, the 3hr PSI hit a record 401 (in the hazardous range) on 21st June.

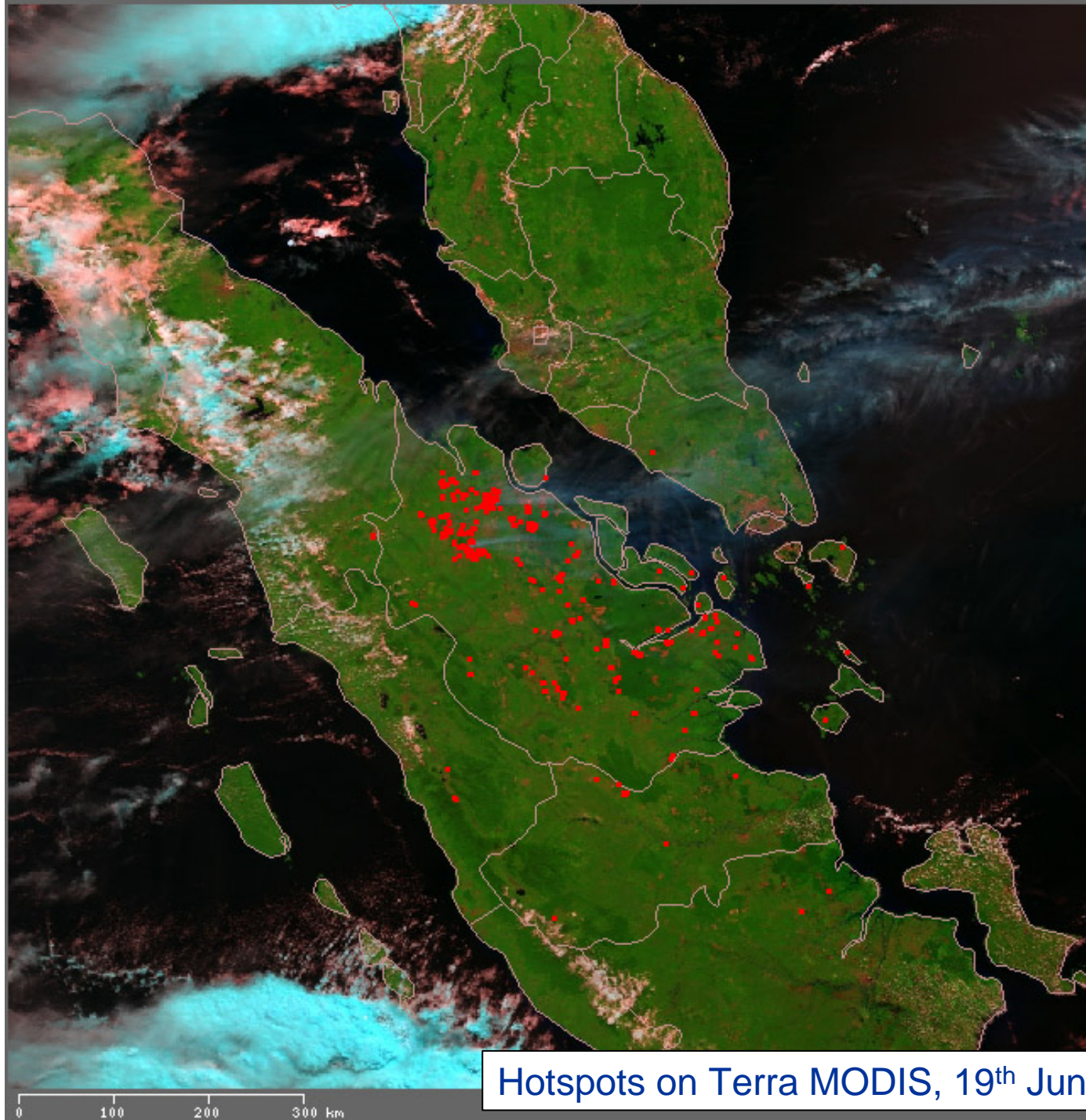
Date	Singapore Max. 3hr PSI	Malaysia Max 24hr API	
	Singapore	Muar	Port Klang
17 June, 2013	155	71	73
18 June, 2013	145	70	85
19 June, 2013	321	172	98
20 June, 2013	371	383	70
21 June, 2013	401	273	94
22 June, 2013	326	373	145
23 June, 2013	106	746	214
24 June, 2013	82	148	319

Singapore, Marina Bay area

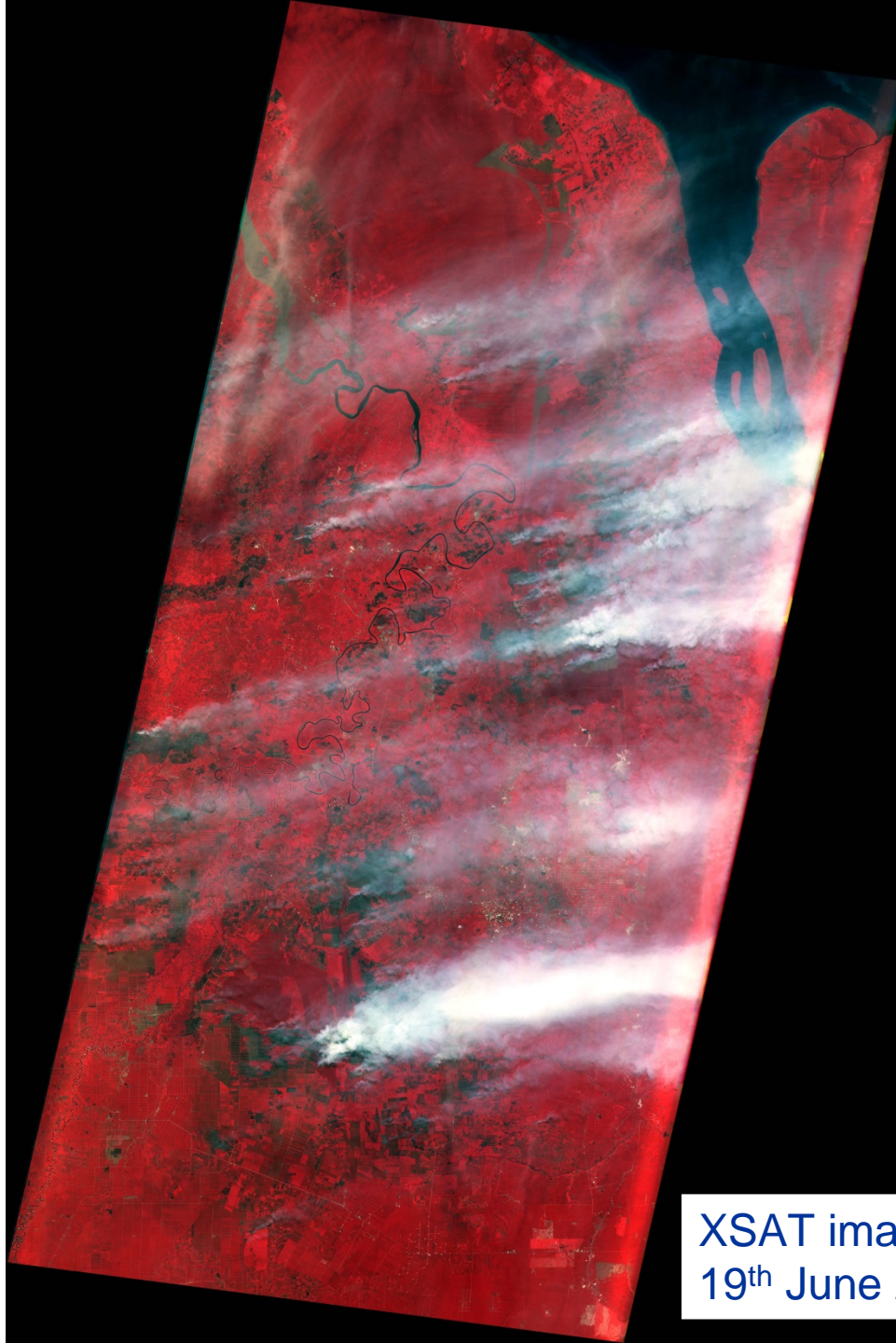
Normal, sunny day



Haze, around noon,
21st June 2013

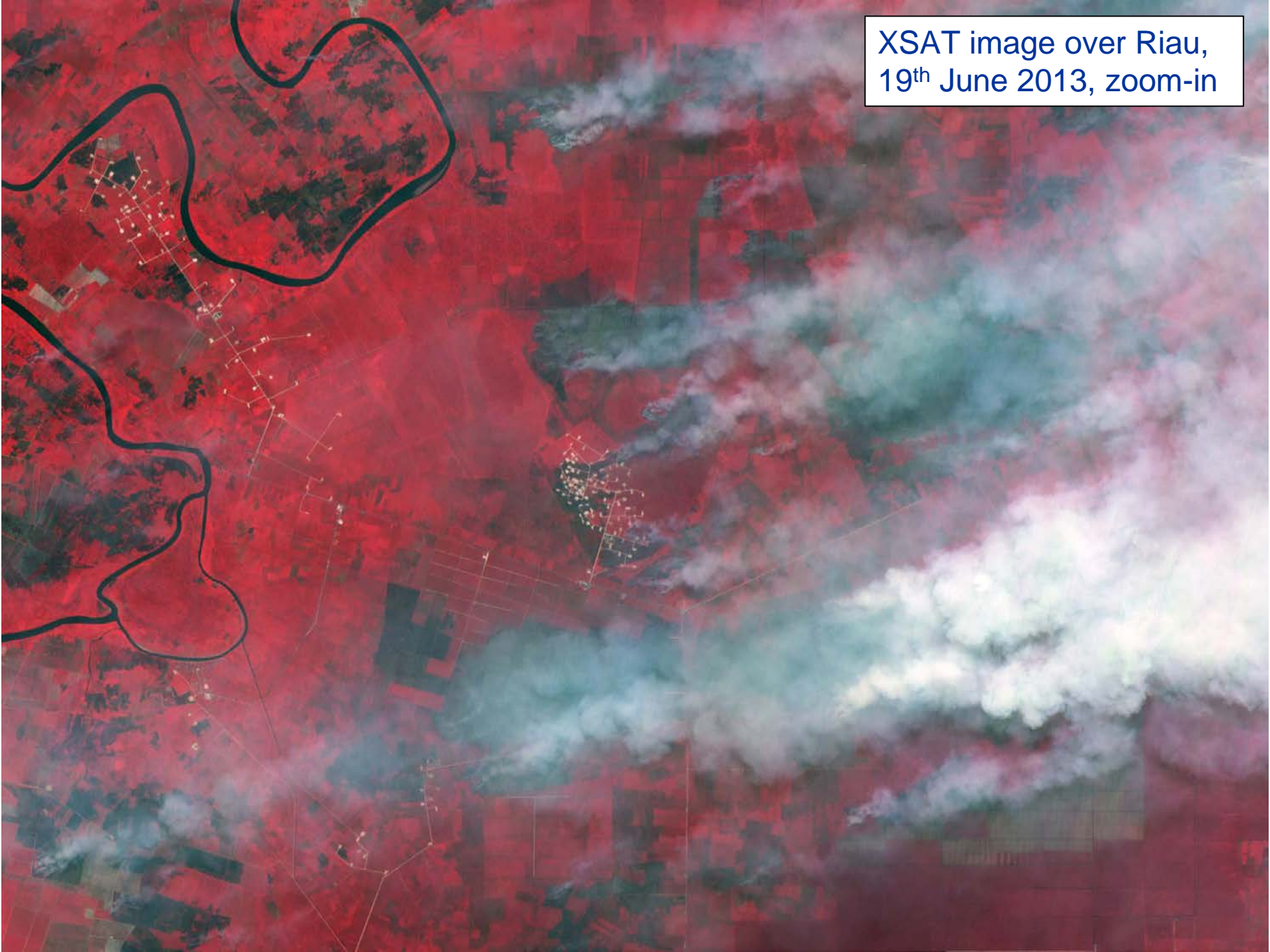


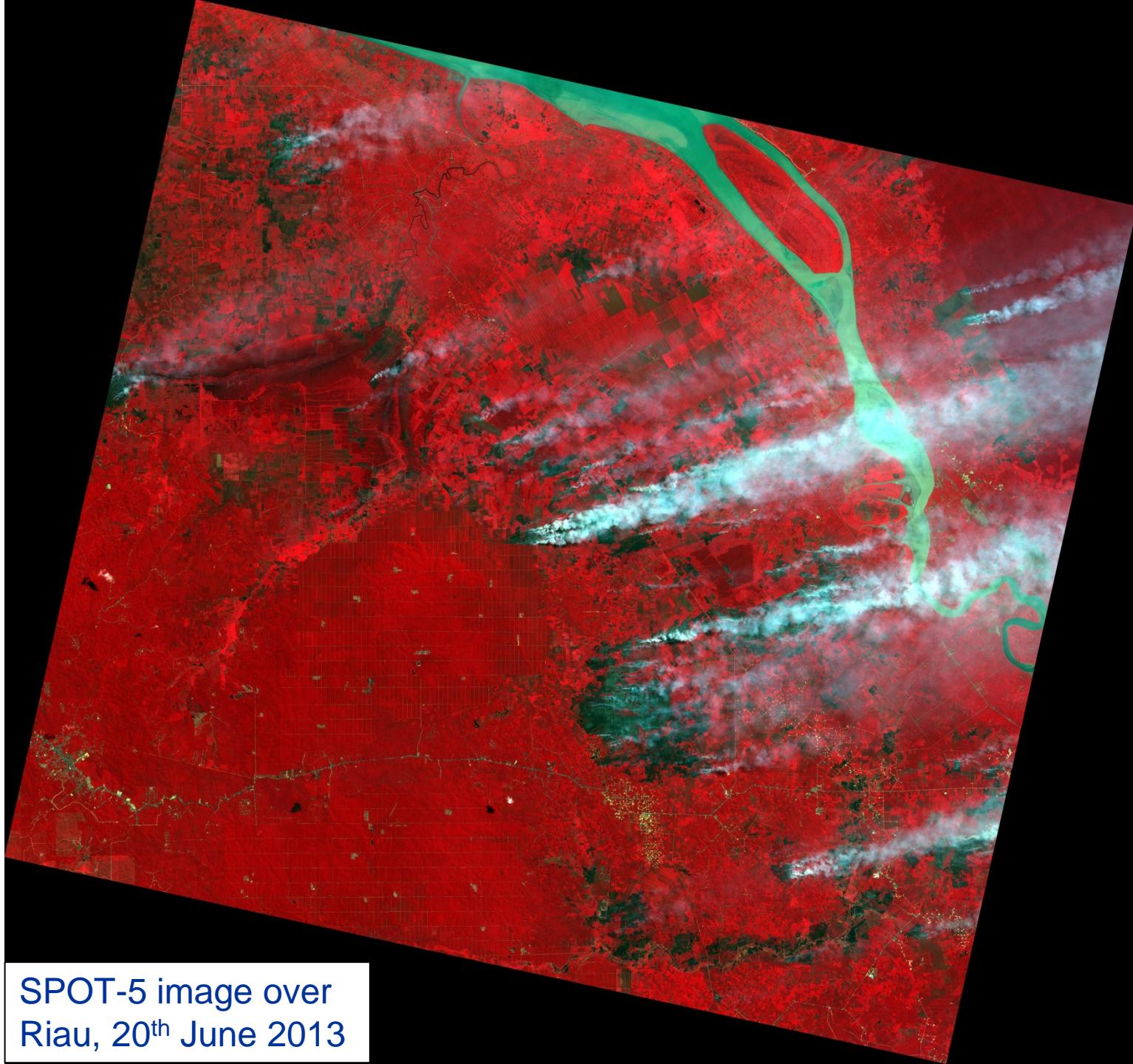
Hotspots on Terra MODIS, 19th June 2013



XSAT image over Riau,
19th June 2013

XSAT image over Riau,
19th June 2013, zoom-in





SPOT-5 image over
Riau, 20th June 2013

Upcoming Satellites

TeLEOS-1

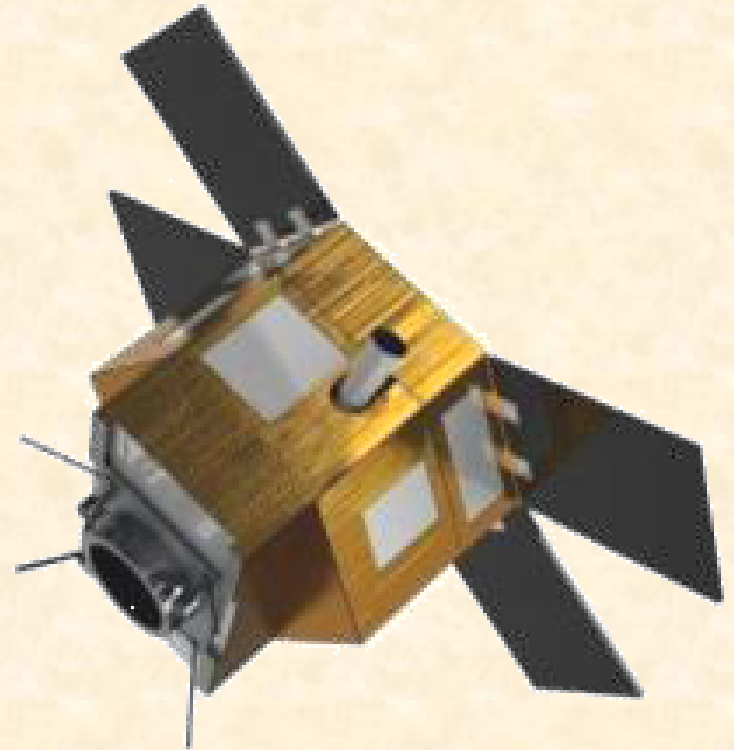
- Launch Date: 2nd Half 2015
- Designed Life: 5 years
- Orbit: Near Equatorial Orbit (10° to 15° Inclination)
- Orbital height: 550km
- Mass: About 400kg

Imaging & Collection Specifications

- Mean Revisit Time: 12 to 16 hours
- Resolution: 1m nominal at nadir
- Swath width: 12km
- Dynamic Range: 10bits per pixel
- Slew Rate: 2.5 deg/sec

Image Reception and Processing System (Ground Station)

- In-house development of CRISP



NUS Kent Ridge-1 (KR-1) ***(Hyperspectral Imaging Microsatellite)***

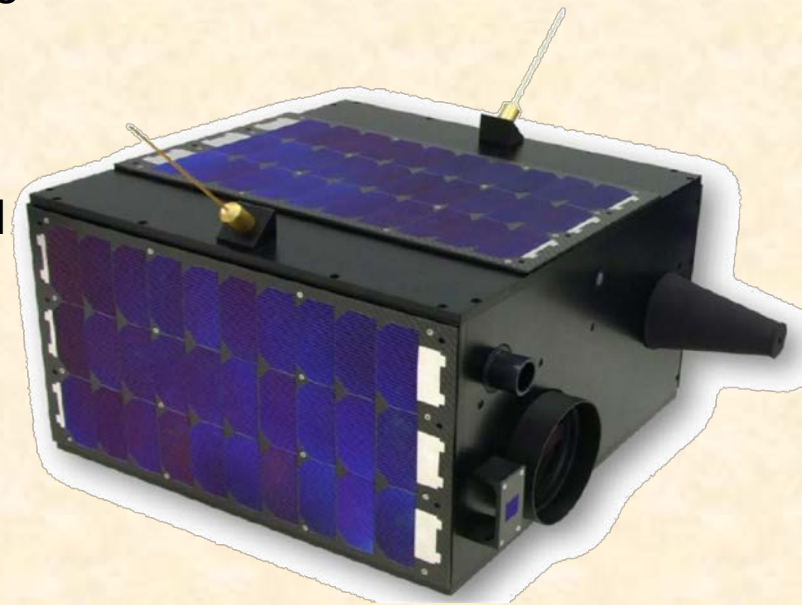
Collaboration with Berlin Space Technologies

Weight : ~50 kg

Payload

- (Main) Singapore developed hyperspectral camera
 - 30~50 bands from Blue to NIR (SWIR being developed)
 - resolution: ~ 50m
 - swath width : ~ 50 km
- (Secondary) Video camera
 - resolution: ~15m
 - swath : 10km

Planned launch in 2015 with TeLEOS-1



Thank you