


Satellite Remote Sensing: A useful tool for rapid geomorphological analysis of large rivers

Regional Workshop on Discharge and Sediment Monitoring and Geomorphological Tools for the Lower-Mekong Basin,
Mekong River Commission, Vientiane, Lao PDR, 21 – 22 October 2008

Satellite Remote Sensing: A useful tool for rapid geomorphological analysis of large rivers

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Satellite Remote Sensing

- Earth observation satellites provide
 - synoptic views of the area of interest
 - frequent and repetitive coverage
- A very useful tool that enables
 - Rapid assessment
 - Wide area coverage
 - Temporal change study

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Types of satellites

- Geostationary satellites
 - Mostly for telecommunication and meteorology
- Environmental satellites
 - Typically coarse resolution but wide coverage
- Earth resource satellites
 - “High” resolution, a few m to tens of m
- Very high resolution satellites
 - 1-m and finer resolution, almost like aerial photography

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MODIS (MODerate resolution Imaging Spectrometer) on Terra and Aqua Satellites

TERRA **AQUA**



Wide coverage (over 2500 km) but low resolution (250 m to 1 km)
36 spectral bands; For observation and retrieval of environmental parameters of land, atmosphere and ocean


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Landsat Satellites (NASA, USA)


- First Landsat satellite was launched July 1972, terminated on 6 Jan 1978
 - MSS sensor, 4 bands, 80m spatial resolution
- Landsat-2, 3, 4, and 5 were launched in 1975, 1978, 1982, and 1984 respectively
 - TM (Thematic Mapper sensor) on Landsat 4 and 5
 - Blue, Green, red, NIR, two SWIR, one thermal IR bands
 - 30 m resolution, except thermal IR (90 m resolution)
- Landsat-6 was launched on October 1993 but the satellite failed to obtain orbit.
- Landsat-7 was launched on 15 April 1999.
 - ETM+ (Enhanced TM+)
 - Similar spectral bands as TM, plus one panchromatic band (15m resolution)
 - Resolution of thermal IR band improved to 60 m
- 31 May 2003, ETM+ on Landsat 7 malfunctioned.



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SPOT Satellites (France)

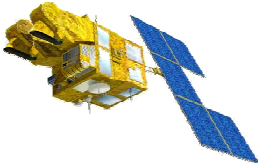
- SPOT-1 (22 Feb 1986), SPOT-2 (22 Jan 1990), SPOT-3 (26 Sep 1993 - 14 Nov 1996)
 - HRV sensor
 - 20 m resolution (green, red, NIR)
 - 10 m resolution (panchromatic)
- SPOT-4 (24 Mar 1998)
 - Additional SWIR band
- SPOT-5 (3 May 2002)
 - 10 m resolution (green, red, NIR)
 - 20 m resolution (SWIR)
 - 5 m and 2.5 m resolution (panchromatic)




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SPOT Satellites

SPOT-5

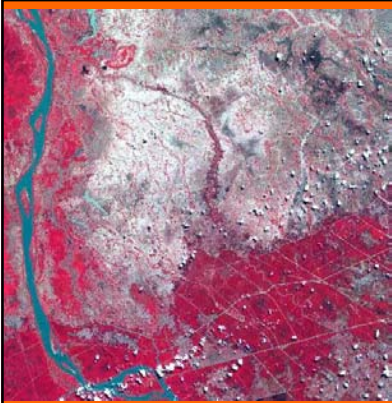


SPOT-2, 4



High resolution satellites (2.5 m to 20 m, depending on spectral bands)
4 spectral bands: Green, Red, NIR, SWIR; Swath width = 60 km;

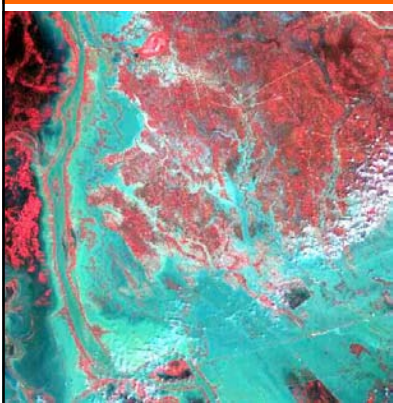
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Mekong River
(at border of Vietnam and Cambodia)
18 Jun 1997

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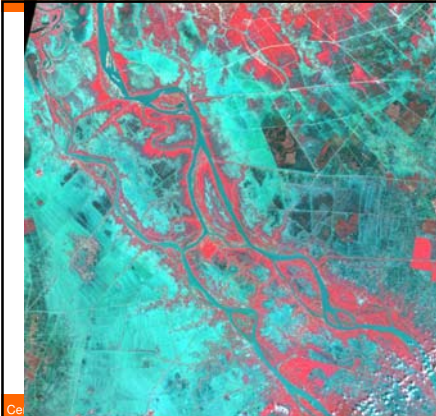
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Mekong River
(at border of Vietnam and Cambodia)
07 Nov 1997

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Mekong Delta
13 Dec, 1998

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Very High Resolution Satellites

- IKONOS
 - Launched 24 Sep 1999, first commercial VHR satellite
 - 1 panchromatic band (1 m resolution)
 - 4 multispectral bands (4 m resolution)
- QuickBird2
 - Launched 18 Oct 2001
 - 1 panchromatic band (0.62 m resolution)
 - 4 multispectral bands (2.5 m resolution)
- Orbview3
 - Launched 26 Jun 2003
 - Similar resolution as IKONOS
- GeoEye-1
 - Recently launched
 - 0.41 m resolution (panchromatic band)
 - 1.6 m resolution (multispectral bands)

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Radar Remote Sensing

A radar pulse is transmitted from the antenna to the ground

The radar pulse is scattered by the ground targets back to the antenna.

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Microwave scattering

A smooth surface acts like a mirror for the incident radar pulse. Most of the incident radar energy is reflected away according to the law of specular reflection. Very little energy is scattered back to the radar sensor. The surface appears dark.

A rough surface reflects the incident radar pulse in all directions. Part of the radar energy is scattered back to the radar sensor. The surface appears bright.

Corner Reflection: When two smooth surfaces form a right angle facing the radar beam, the beam bounces twice off the surfaces and most of the radar energy is reflected back to the radar sensor. The reflector appears very bright.

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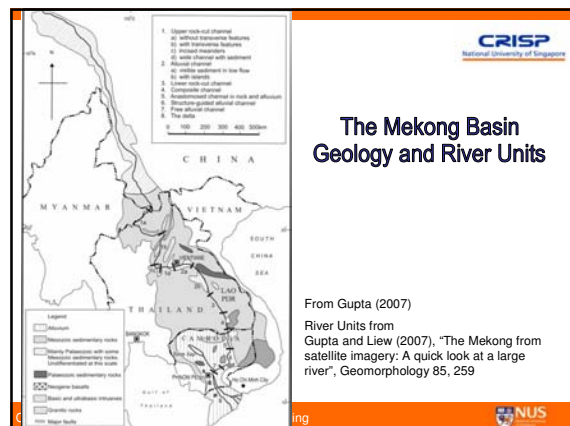
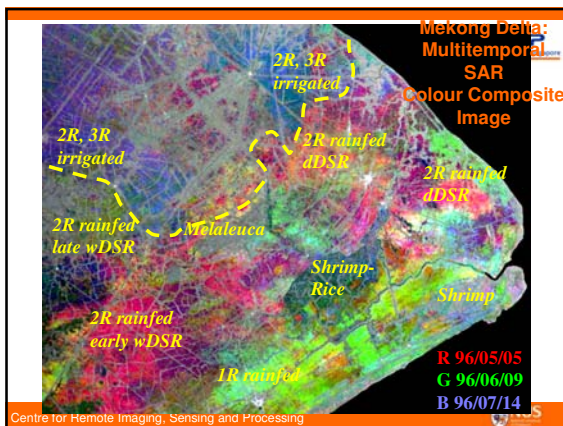
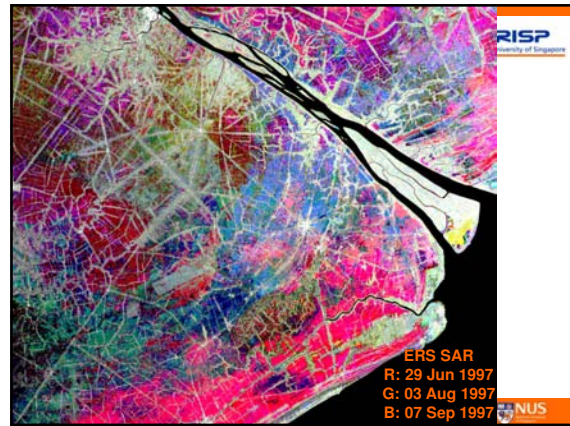
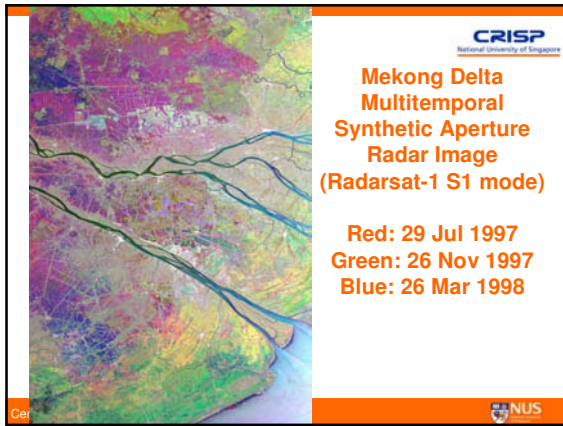
Synthetic aperture radar (SAR) Satellites

- SeaSat (USA)
 - Jun 28 – Oct 10 1978
- ERS-1, 2 (European Space Agency)
 - 1991, 1995
- JERS-1 (Japan)
- RADARSAT-1 (Canada)
- ENVISAT (European Space Agency)
- ALOS “Daichi” (Japan)
 - 24 Jan 2006
- TerraSAR-X (Germany)
 - 15 Jun 2007
- RADARSAT-2 (Canada)
 - 14 Dec 2007

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A typical SAR scene

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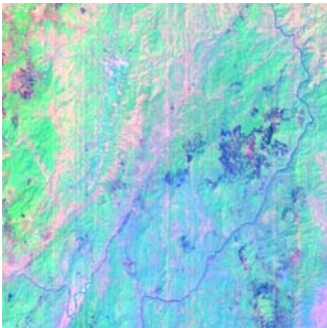


Mekong: River Units


1. Upper rock-cut channel (China border to 5 km upstream of Vientiane)
2. Alluvial channel (5 km upstream of Vientiane to Savannakhet)
3. Lower rock-cut channel (Savannakhet to Khong Chiam)
4. Composite channel (Khong Chiam to 4000 Islands)
5. Anastomosed channel in rock and alluvium (4000 Islands to Sambor)
6. Structure-guided alluvial channel (Sambor to Khum Angkor Ban)
7. Free alluvial channel (Khum Angkor Ban to Phnom Penh)
8. The delta (Phnom Penh to the sea)

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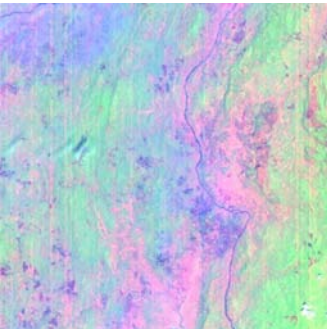


SPOT 5 Browse image
2007-03-06
Unit 1a: rock-cut channel
without transverse features




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SPOT 5 Browse image
2006-03-28
Unit 1b: rock-cut channel
with transverse features



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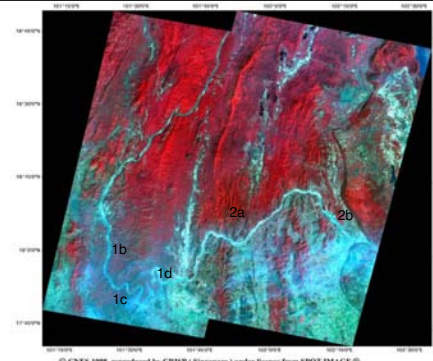


**The Mekong in
rock, Lao PDR.**
SPOT 5 (c) CNES

Note U-bend,
inner channel
and rock ribs

Unit 1B

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SPOT
image
mosaic

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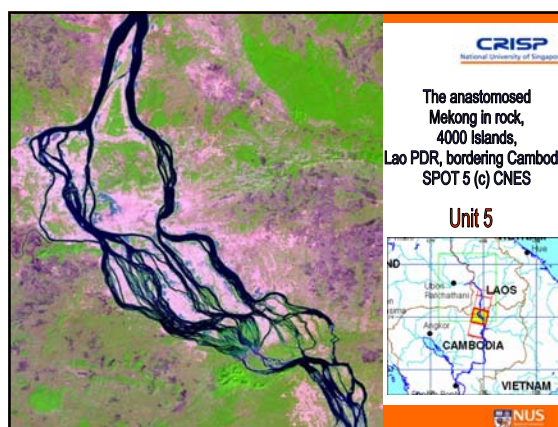
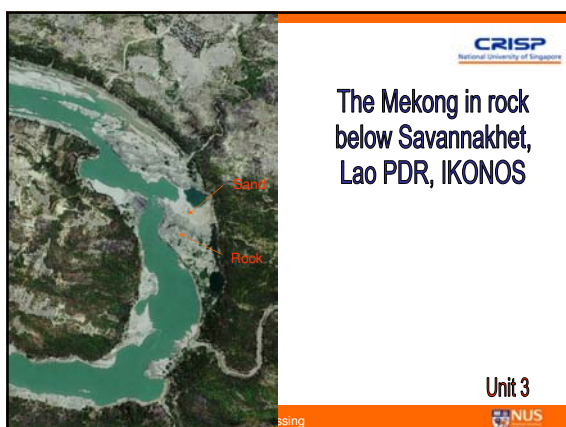
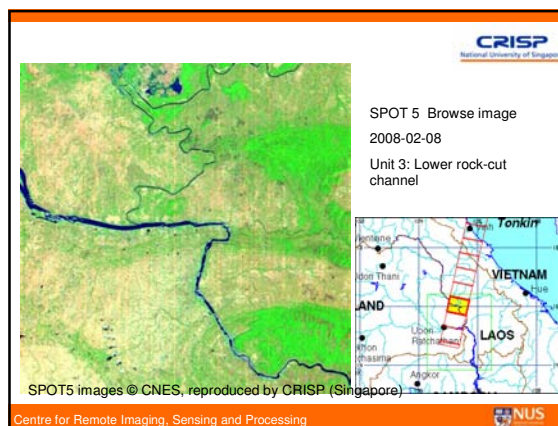
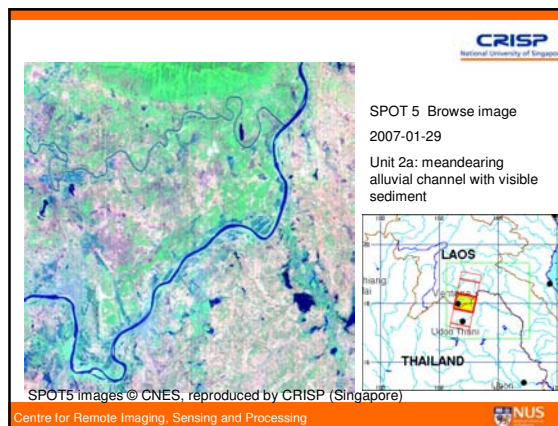
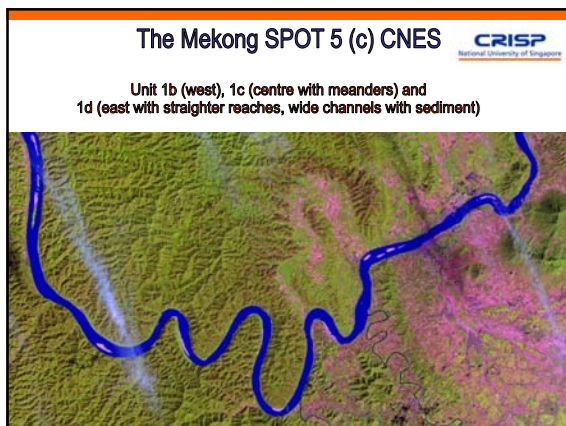
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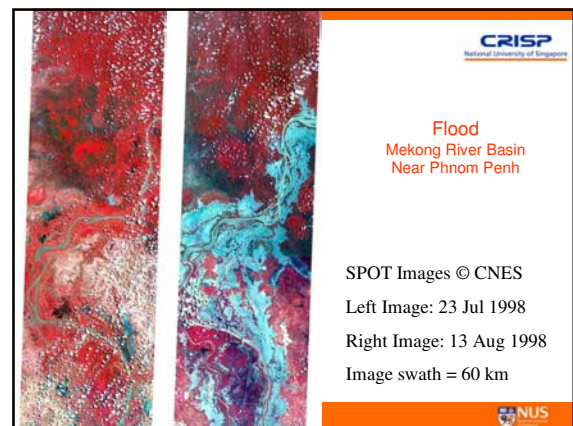
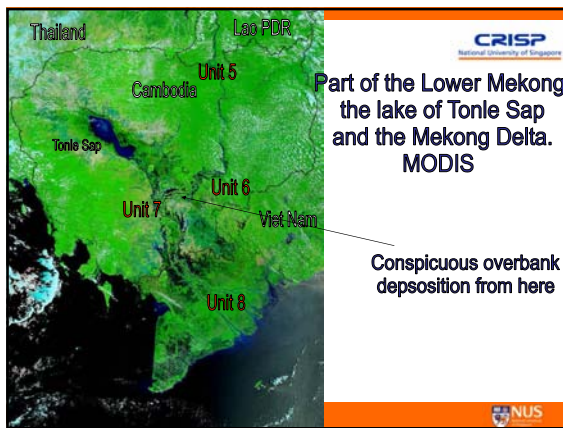
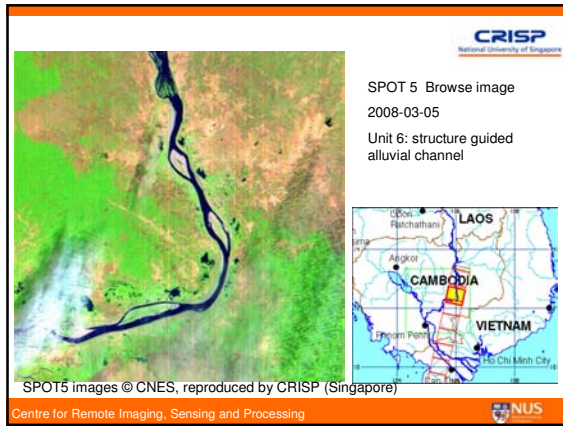


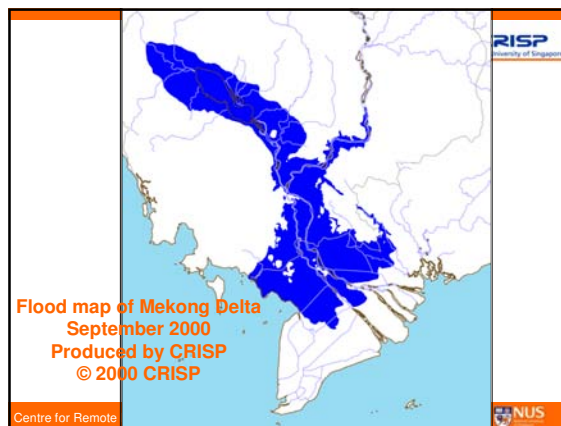
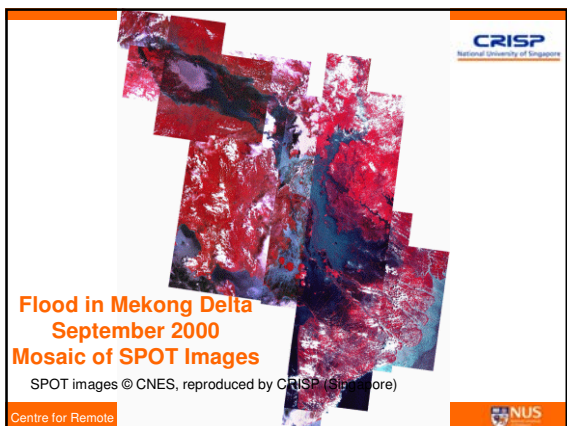
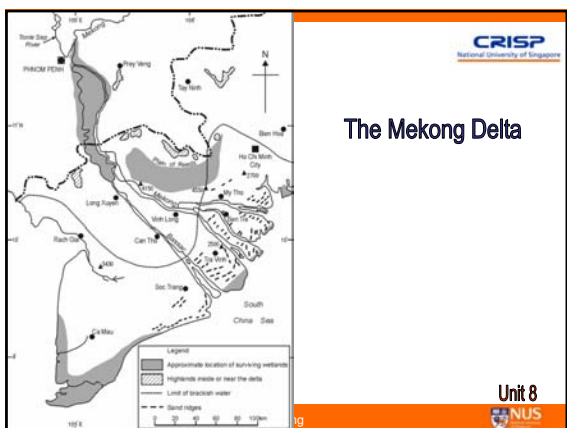
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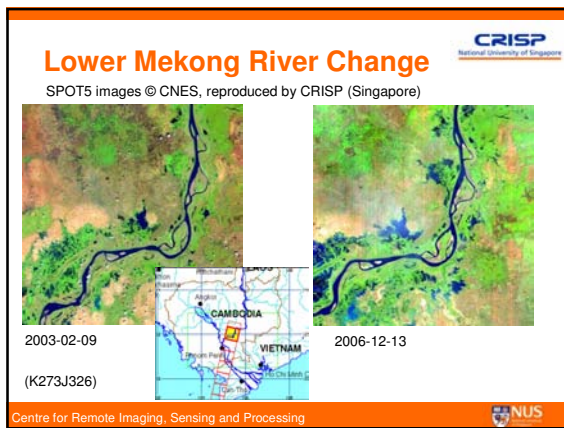
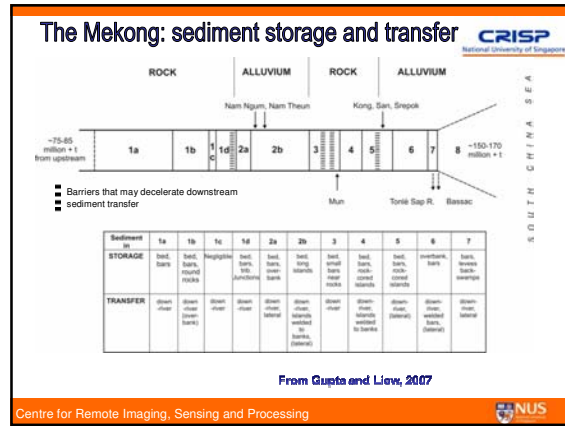
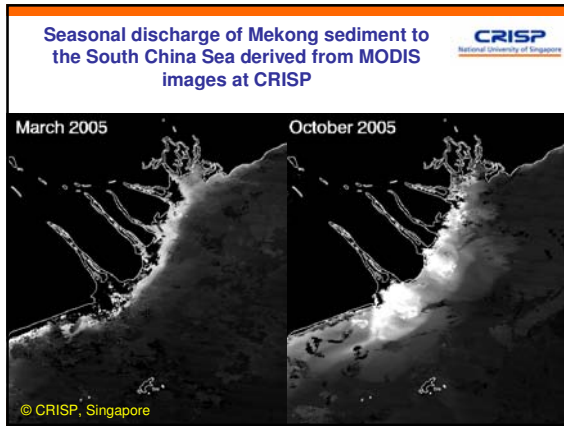
Seasonal change, Mekong Basin in Lao PDR, SPOT 2 (c) CNES

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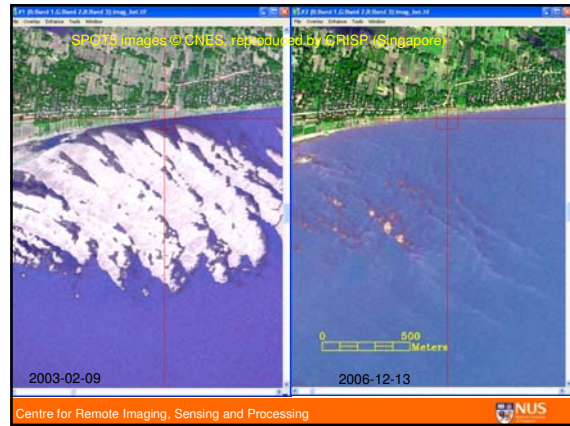








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- Satellite remote sensing is a useful tool for rapid analysis of large river geomorphology.
- Temporal change studies can be conducted using archived images.
- Reconnaissance studies at this scale are otherwise extremely difficult and demanding in resources and time.
- This technique is not a replacement for the usual field investigations.

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