Guidelines on uses of EO techniques for management water related disasters and water resources:

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Outline

- WATER RELATED DISASTERS

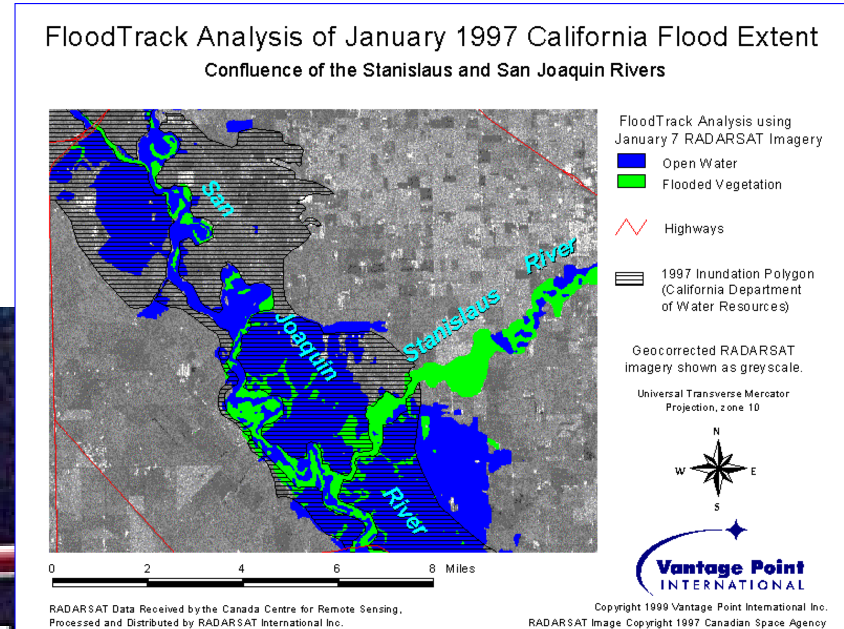
  -EO techniques and guidelines for Flood Mapping (flood plains and coastal floods/tsunami)

  -EO techniques and guidelines for Coastal Erosion

  -EO techniques and guidelines for rainfall triggered landslides
- WATER RESOURCES:

  -EO techniqies and guidelines

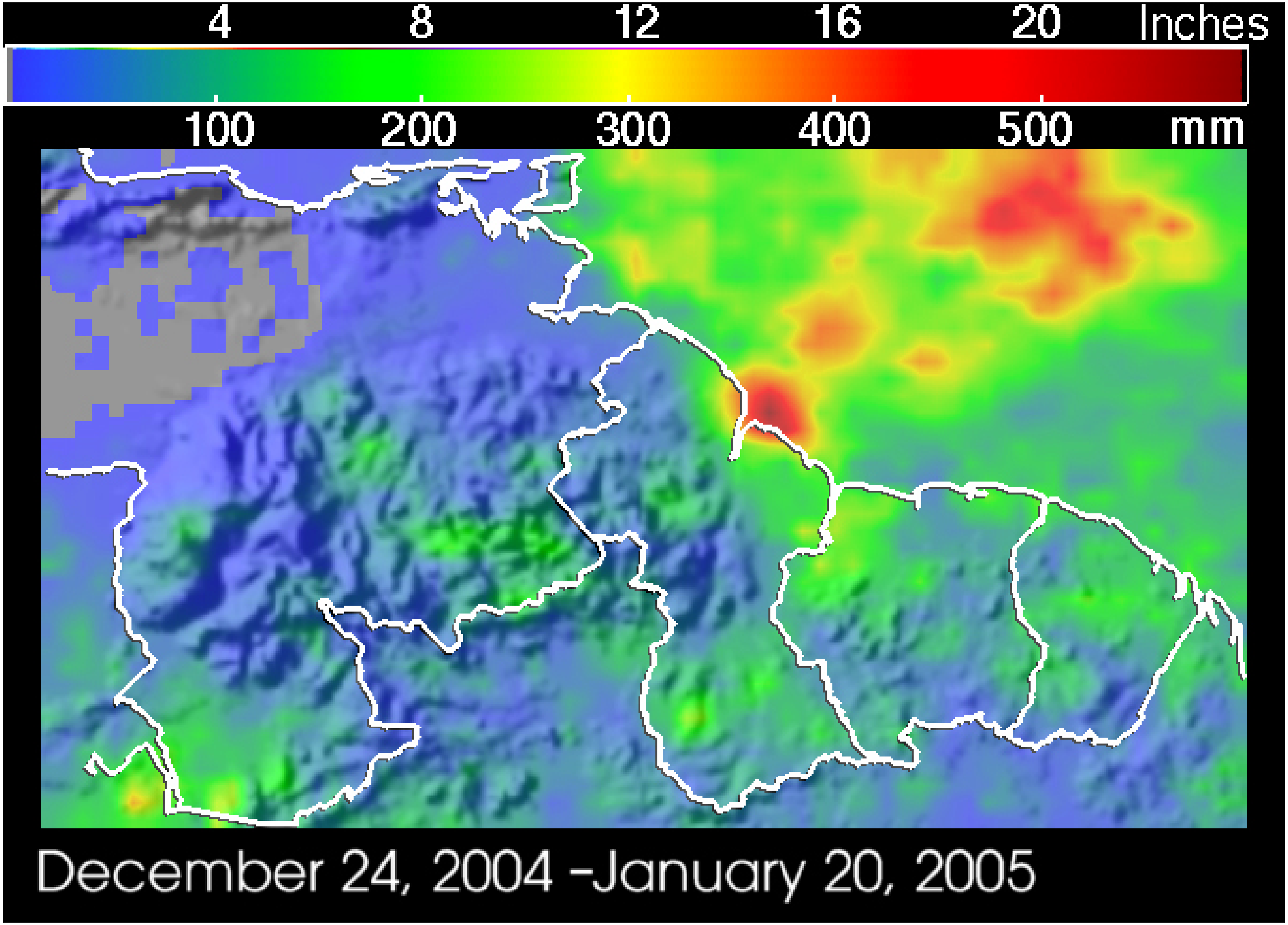
Flood Extent Mapping



River Floods, Coastal floods and Tsunami: Spatial Resolution Requirements

Application	Phase	Threshold	Optimum	Sensor Type
Land Use	Pre-flood Post-flood	30 m	4-5 m	MSI
Infrastructure Status	Pre-flood Post-flood	5 m	<= 1 m	PanVis
Vegetation	Pre-flood Post-flood	<= 250 m	<= 30 m	MSI/HIS
Soil Moisture	Pre-flood	1 km	100 m	SAR/PM
Snow pack	Pre-flood	1 km	100 m	SAR/PM
DEM (vertical)	Pre-flood Post-flood	1-3 m	.10-.15 m	InSAR/ PanVis/lidar
Flood development and flood peak	During flood Post flood	<= 30 m	<= 5 m	SAR/MSI/ PanVis
Damage Assessment	Post-flood	2-5 m	.3 m	MSI/PanVis/ SAR
Bathymetry (near shore)	Pre-flood	< 1 km	90 m	SAR/MSI/HIS

MSI = Multi-Spectral Imagery PanVis = Panchromatic Visible InSAR = Interferometric SAR
HIS = Hyper-Spectral Imagery SAR = Synthetic Aperture Radar PM = Passive Microwave


4
8
12
16
20
Inches
100
200
300
400
500
mm
December 24, 2004 -January 20, 2005

Quickbird Imagery Applied to Flood Monitoring

Damage caused by hurricane Katrina in New Orleans August 2005

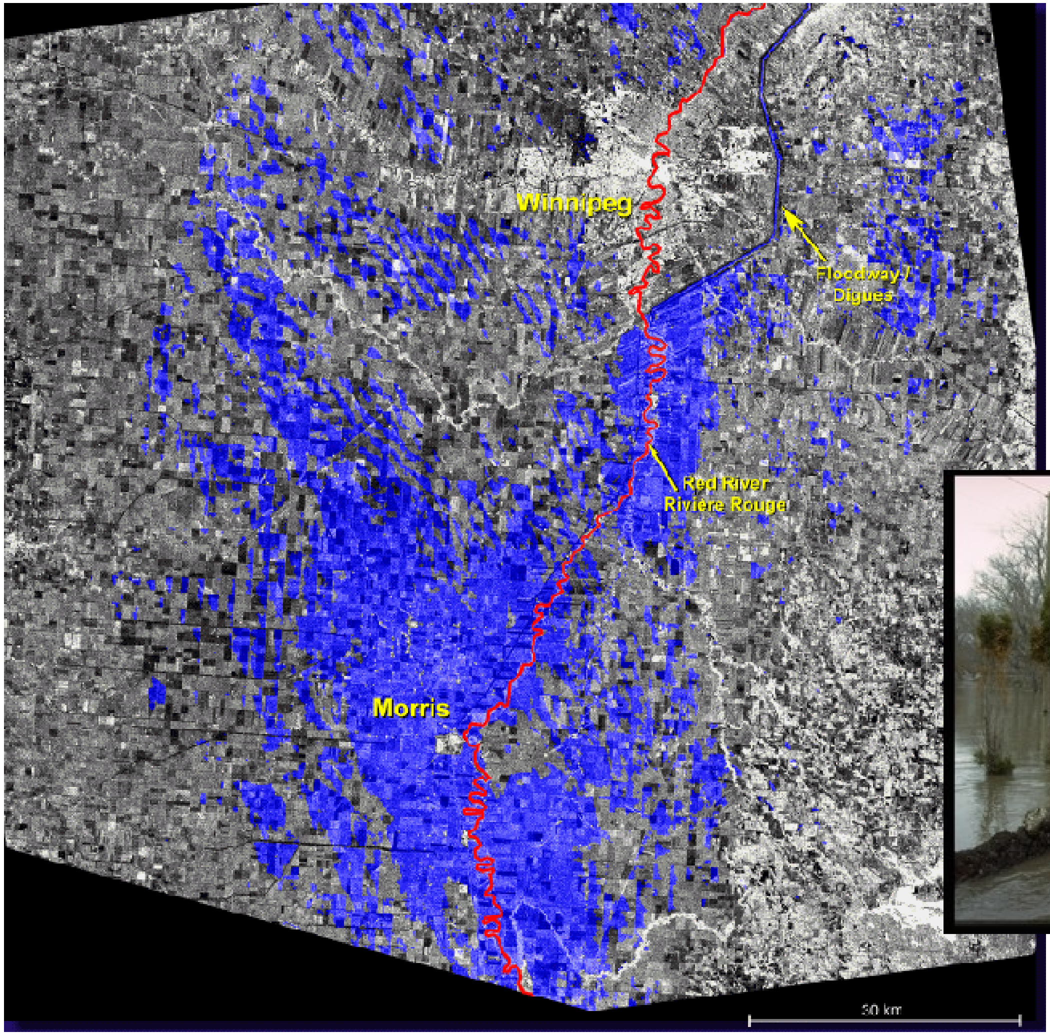
Before **March 9, 2004**

Quickbird Imagery Applied to Flood Monitoring

Damage caused by hurricane Katrina in New Orleans August 2005

After **August 31, 2005**

RADARSAT-1 Spring flood monitoring

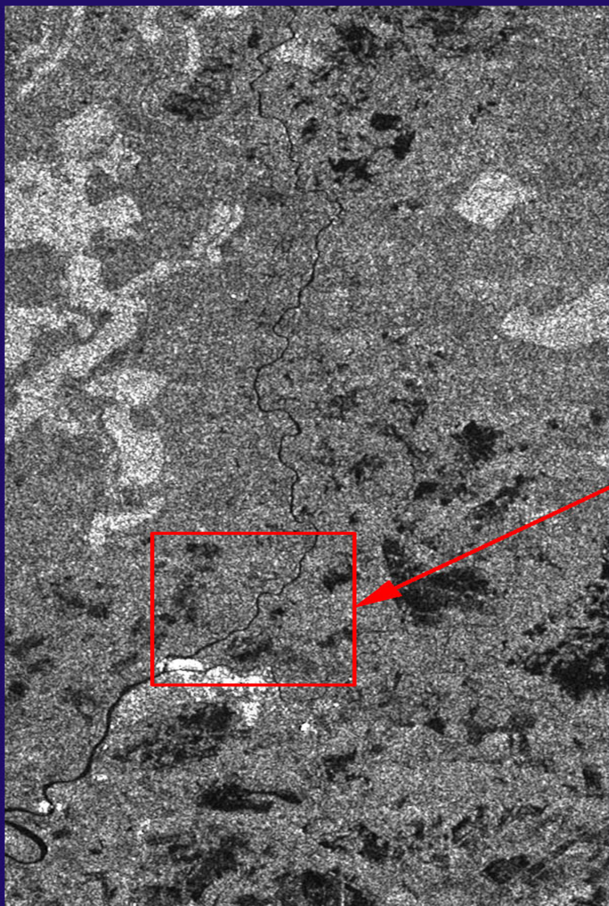


Courtesy City of Winnipeg

Red River, Manitoba, Canada, April 27, 1997

Effects of El Nino in Ecuador

RADARSAT-1 W2 and SCN images

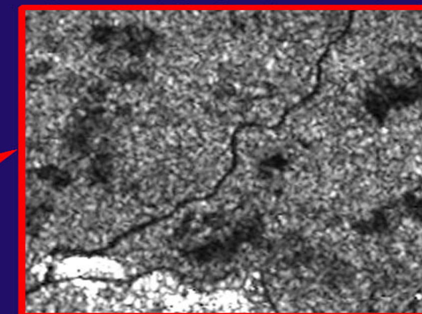


ScanSAR Narrow (W2 S5 S6)
04-MAR-97
Orbit 6944, Desc.
Resolution : 50 m (Rg.) x 73 m (Az.)
Incidence: 31 - 46 deg.

0 km 5

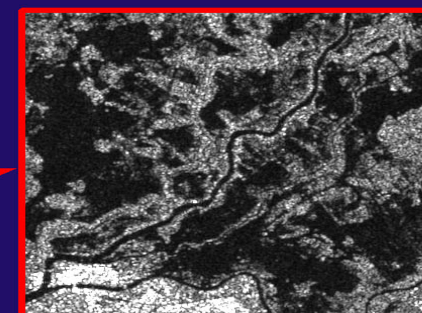
Wide 2
10-DEC-97
Orbit 10960, Desc.
Resolution : 26.6 m (Rg.) x27 m (Az.)
Incidence: 31 - 39 deg.

FULL RESOLUTION IMAGES



SCN2

0 km 1



W2

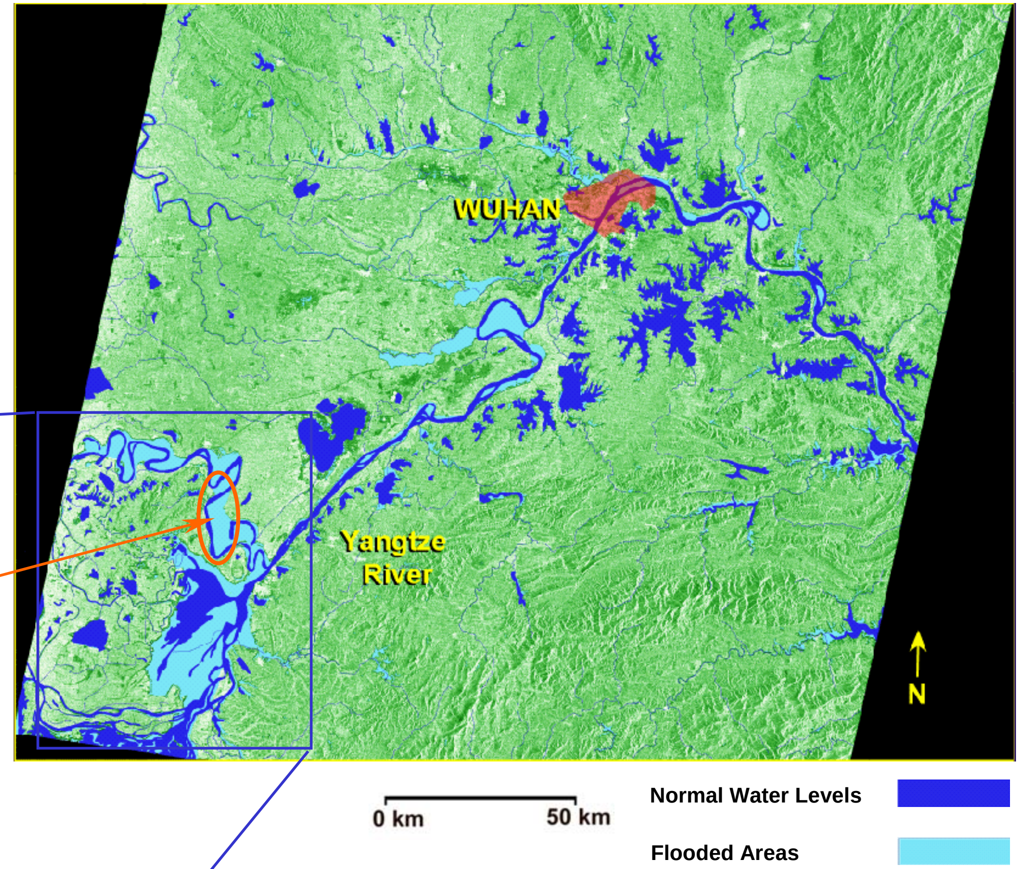
Surface ponding caused by an elevation of the water table

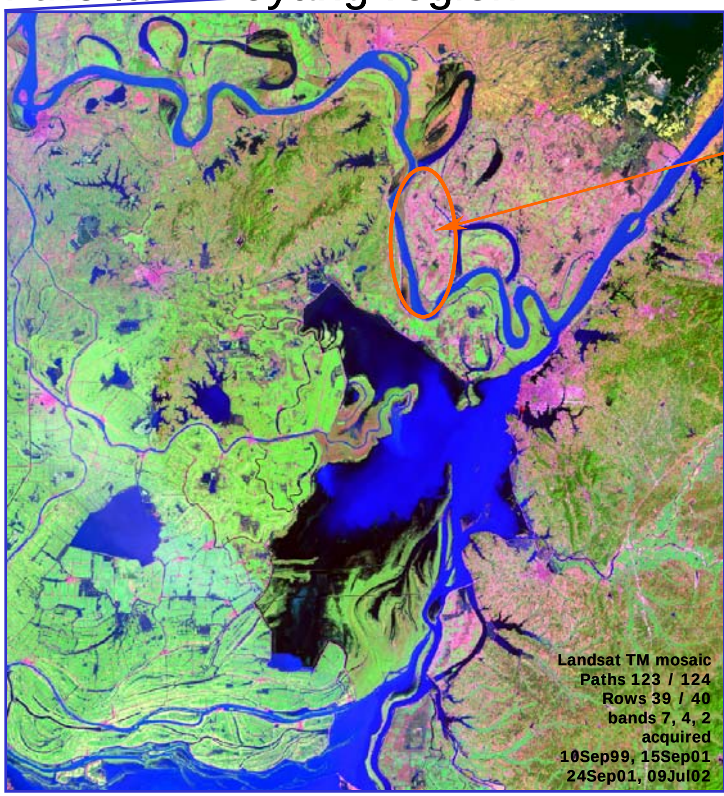
Look
Orbit

RADARSAT-1 Flood Monitoring

Yangtze River, China, August 12, 1998

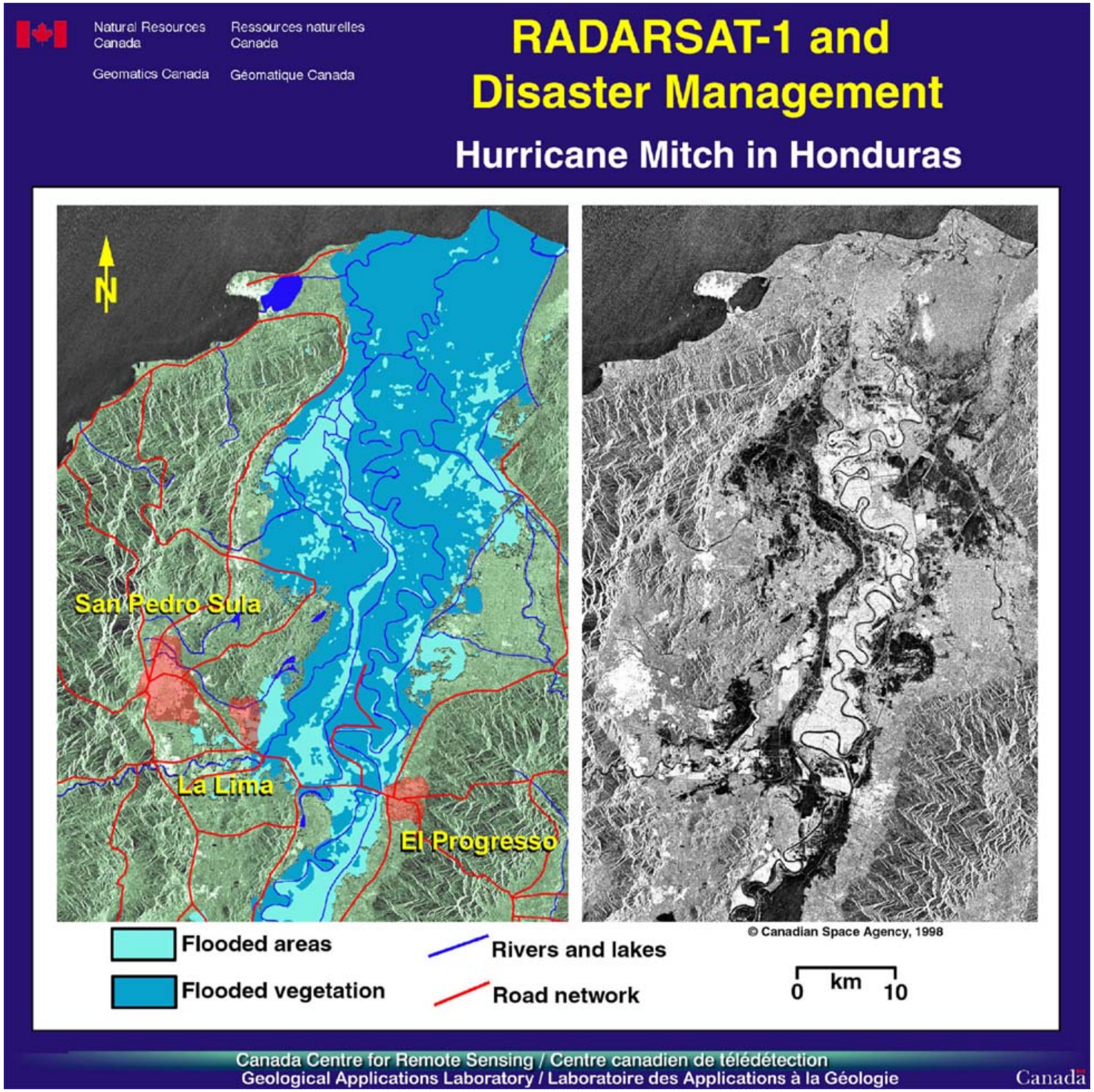
This Yangtze River flood has affected 240 million people and caused 16000 deaths. The image below shows a comparison a TM image of the shows the areal extent of the flooded areas in the lake Poyang region.





Comparison of Landsat TM and RADARSAT data to assess flood extent.

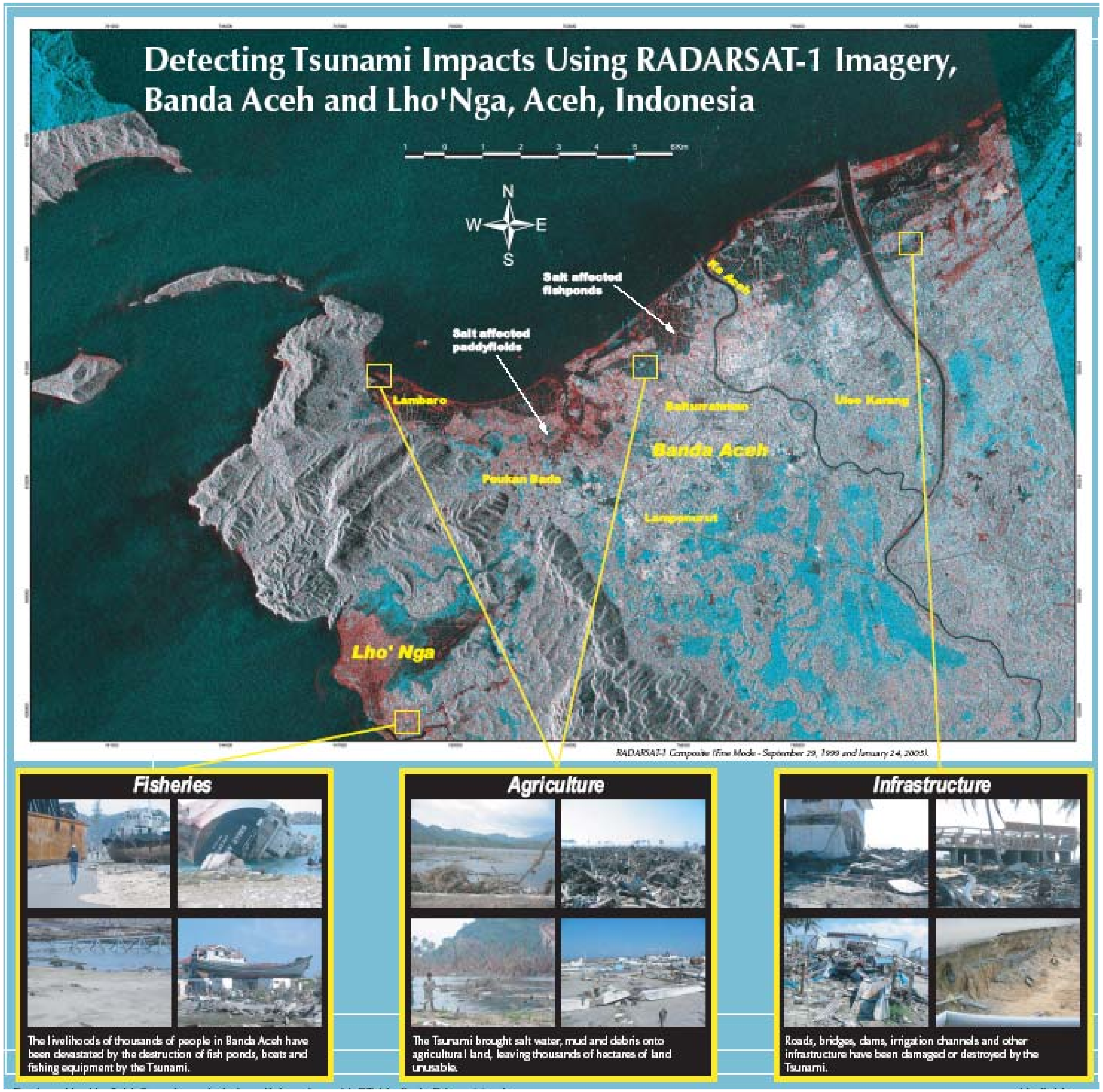
RADARSAT-1 Flood monitoring



Chamelecon River, Honduras, October 30, 1998

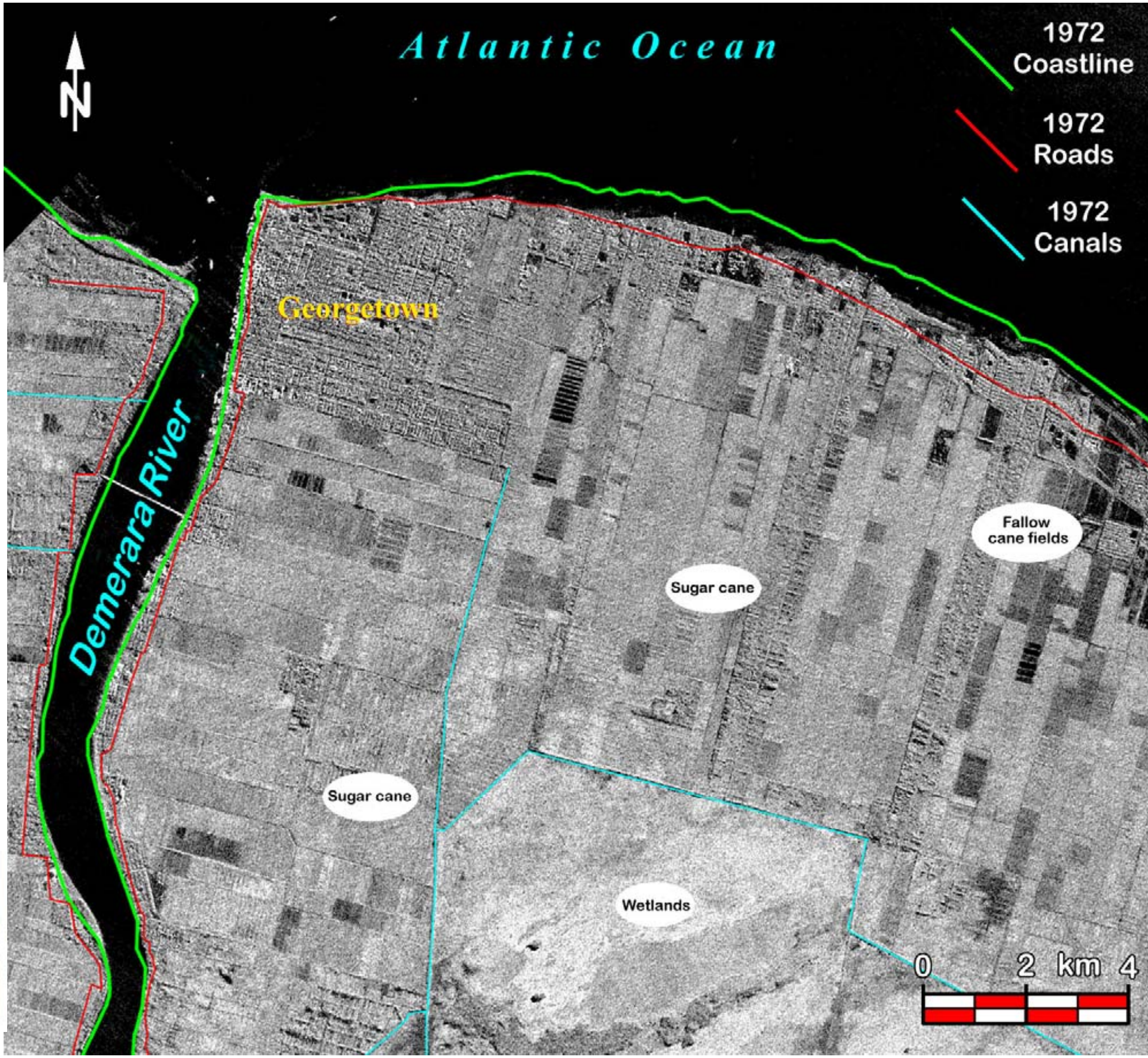
Banda Ache June 23/04- Dec 28/04 Quickbird 1m

RADARSAT-1 applied to tsunami damage assessment



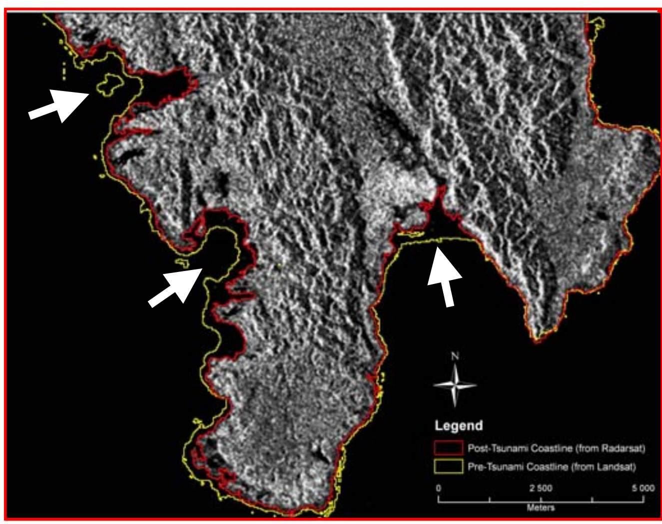
Courtesy Hatfield Consultants Ltd.

Coastal Erosion: Guyana

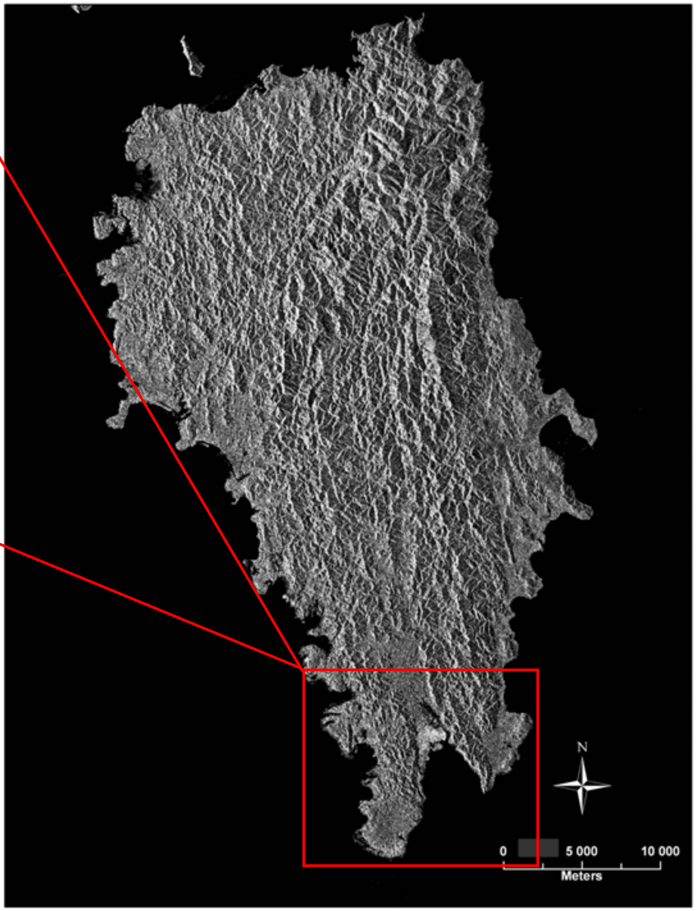


RADARSAT-1 applied to tsunami damage assessment

Pre-tsunami Landsat TM image with post-tsunami coastline vector (in red) overlaid.



Post-tsunami RADARSAT-1 image with pre-tsunami coastline vector (in yellow) overlaid. Arrows mark submersed islands and other flooded coastal areas.



RADARSAT-1 image showing Great-Nicobar Island (India) following the tsunami (31-Dec-2004)

Coastal Erosion: Spatial Resolution Requirements

Application	Phase	Threshold	Optimum	Sensor Type
Coastal Land Use	All	30 m	4-5 m	MSI/SAR
Infrastructure Status	Pre &Post	5 m	<= 1 m	PanVis
Mangroves	All	<= 250 m	<= 30 m	MSI/HIS
Coastline types Geomorphology	All	30m	1-10m	SAR/PM/MSI (stereo& fusion)
DEM (vertical)	All	1-3 m	.10-.15 m	InSAR/ PanVis/lidar
Shoreline maps	Pre/Post	<= 30 m (1:100K)	<= 5 m 1:20K)	SAR/MSI/ PanVis (stereo)
Damage Assessment	Post	2-5 m	.3 m	MSI/PanVis/ SAR
Bathymetry (near shore)	Pre	< 1 km	90 m	SAR/MSI/HIS

MSI = Multi-Spectral Imagery PanVis = Panchromatic Visible InSAR = Interferometric SAR
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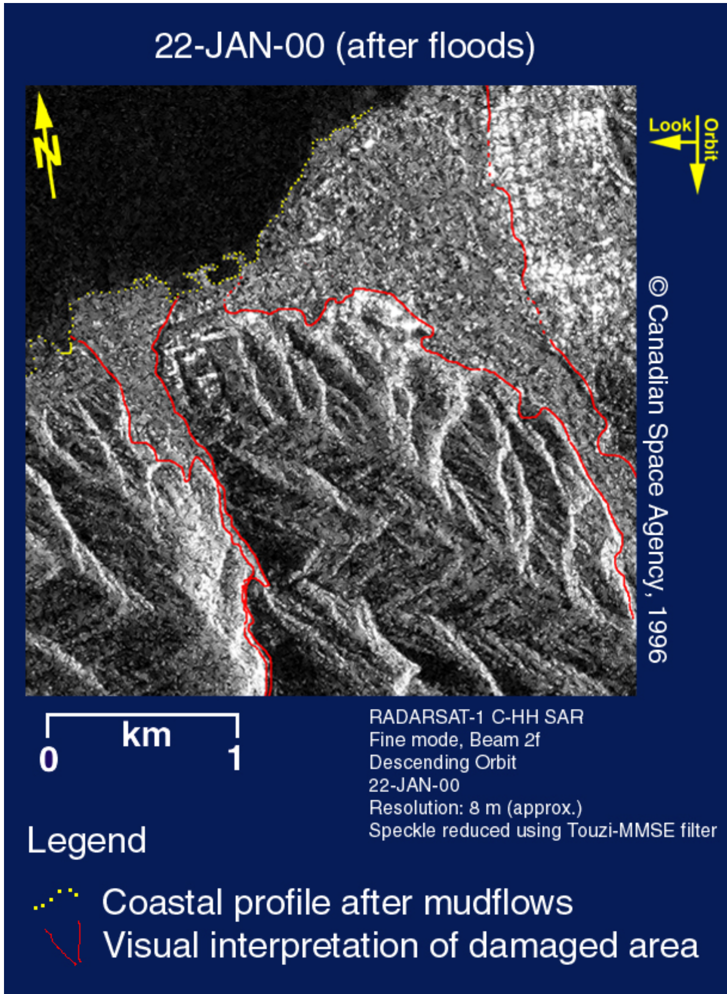
Rainfall triggered Landslides in Venezuela

- High res (8m) SAR images were used to estimate aerial extent of damages by debris flow resulting from long duration high intensity rainfall in the Dec 1999 Venezuela disasters, which resulted in aprox 50,000 deaths and billions pesos in damages: (San Julian)



Rainfall triggered Debris Flows: Coastal Venezuela

Water triggered Landslides: Spatial Resolution Requirements

Application	Phase	Threshold	Optimum	Sensor Type
Land Use	All	30 m (1:100k)	4-5 m (1:20k)	MSI/SAR
Infrastructure Status	All	5 m	<= 1 m	PanVis
Slope Vegetation	All	<= 250 m	<= 30 m	MSI/HIS
Soil Moisture	All	30m	3-5m	SAR/PM
DEM (vertical)	All	1-3 m	.10-.15 m	InSAR/ PanVis/lidar
Landslide Inventory Maps	Pre	<= 30 m (1:100K)	<= 5 m (1:10K)	MSI/PanVis SAR(stereo)
Damage Assessment	Post	2-5 m	.3 m	MSI/PanVis/ SAR
Landslide motion	all	30m (cm)	3-8m	InSAR (C&L) (motion-cm)

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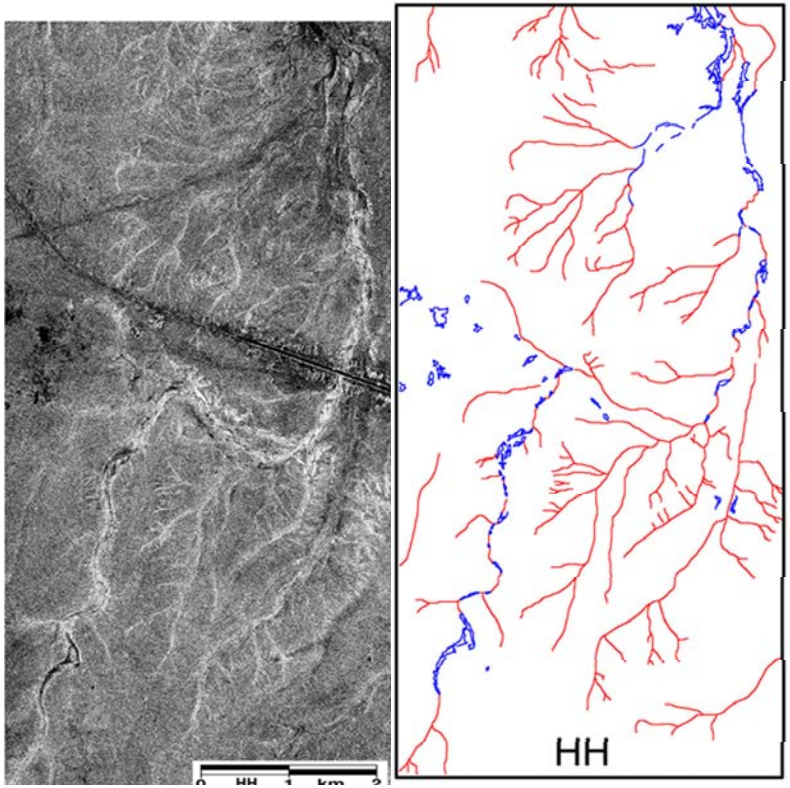
Guidelines on the uses SAR/Optical for Groundwater exploration

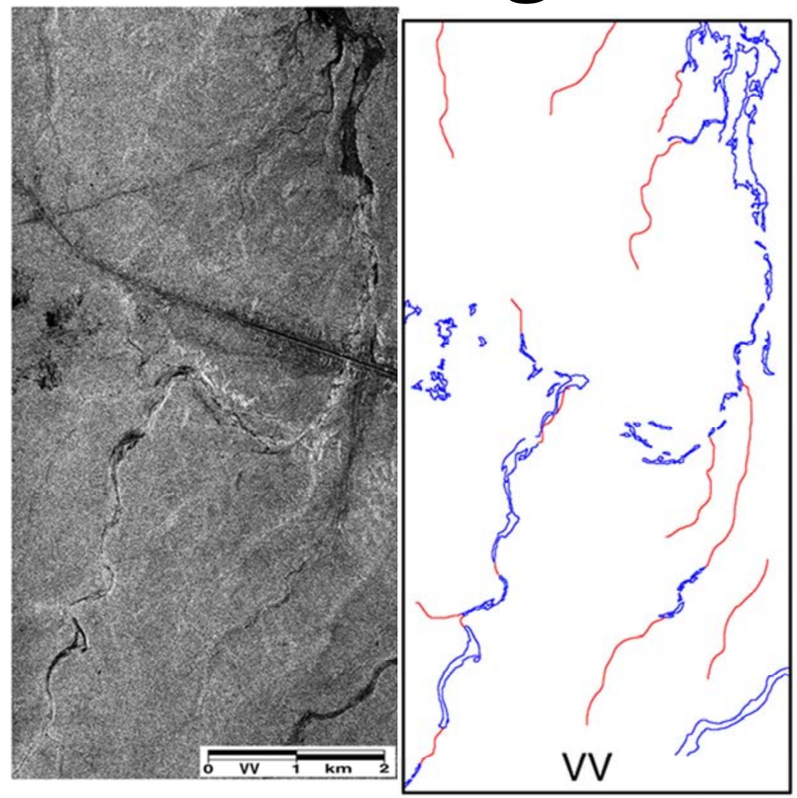
- Classification of Wadi surface, and channel roughness drainage. Some wadi surfaces are used for farming (SAR) HV is the most useful for sediment texture.
- Drainage density and subsurface drainage (SAR HV and HH)
- Mapping of rock types and surficial materials for aquifer storage potential. (SAR/Optical fused images)
- Mapping fractures to target drilling. (SAR HV and HH)
- Classification of Hydrological land use (Optical).
- Monitoring soil moisture and soil permeability to assess groundwater contamination (springtime multi-temporal SAR images)

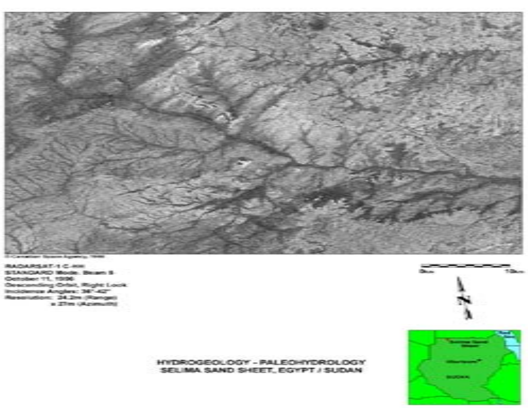
Water Harvesting: Jordan

- Mapping Wadis and Playas

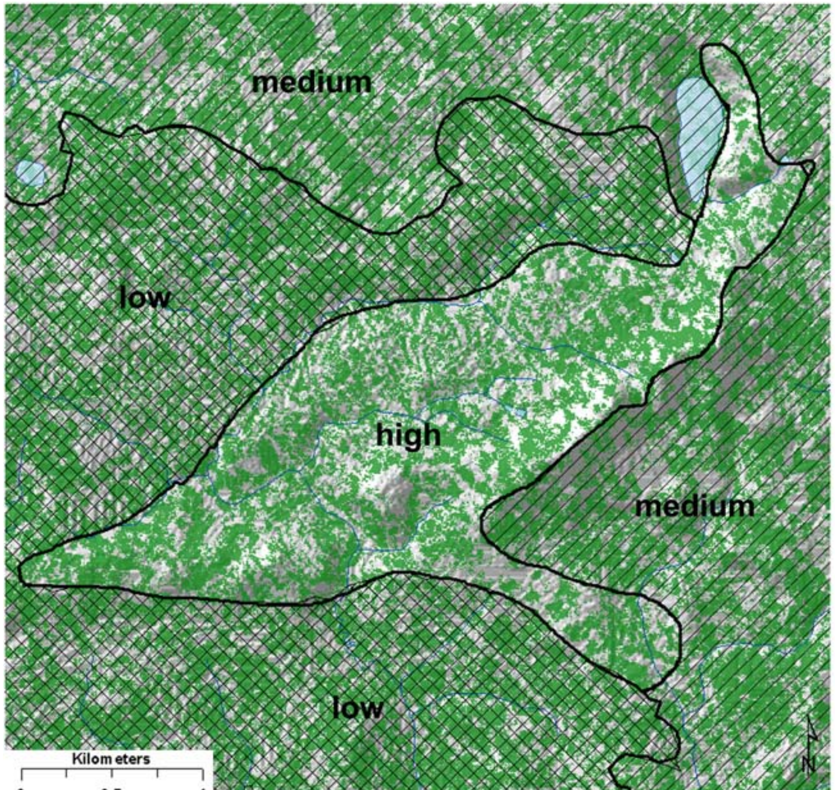
Hydrogeological Mapping



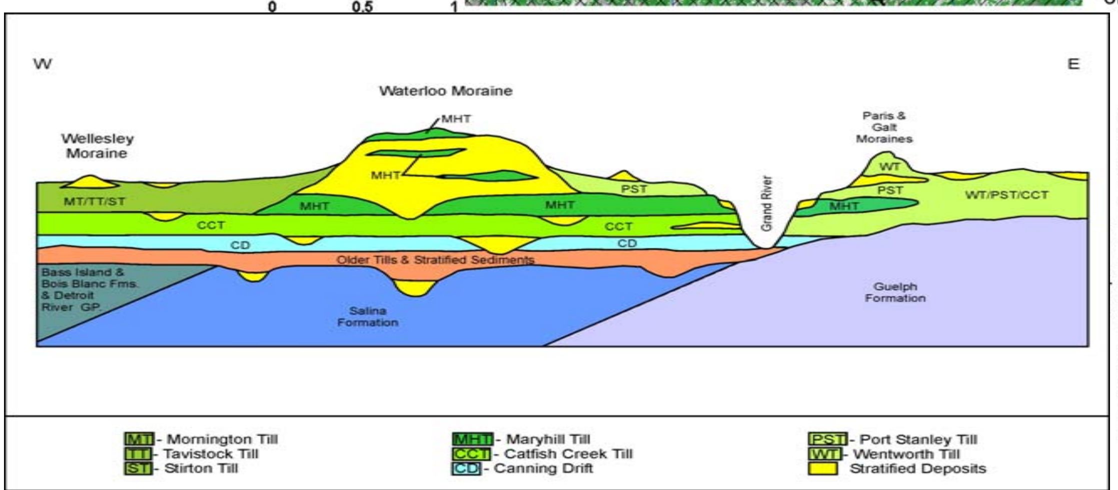


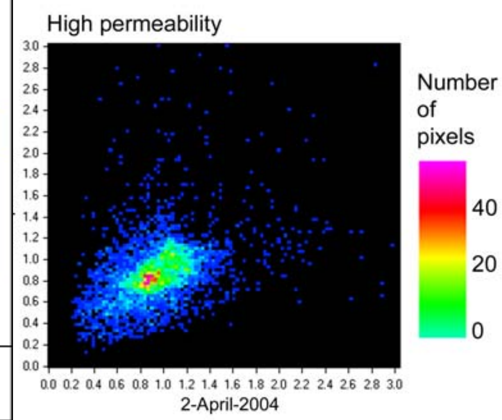


Waterloo Moraine - SAR derived Permeability Map



Data:
RADARSAT-1 Fine Mode, Beam 2
ascending orbit
acquired 2-April-04 and 26-April-04
original pixel spacing: 6.25 m





Water resources: Spatial Resolution Requirements

Application	Season	Threshold	Optimum	Sensor Type
Agri-Land Use Maps	All	30 m (1:100k)	4-5 m (1:20k)	MSI/PanVis SAR
Bedrock Geol Maps	All	30 m (1:100K)	5-10 m 1:50K	SAR PanVis MSI (stereo)
Vegetation	All	<= 250 m	<= 30 m	MSI/HIS
Soil Moisture	Spring/wet	30m	3-8m	SAR/PM
Permeability Maps	Spring/wet	30m (1: 100K)	3-8m (1:20K)	SAR(coherence) (multidate)
DEM (vertical)	All	1-3 m	.10-.15 m	InSAR/ PanVis/lidar
Terrain/surficial materials maps	All	30 m (1;100K)	3-5m (1:20K)	SAR/MSI PanVis, (stereo/fusion)
Structural lineament Maps	All	30 m 1:100K	10-20m (1:50K)	MSI/PanVis/ SAR (stereo)

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Conclusions:

- Examples show that EO images and techniques and techniques can provide important information on managing water related disasters and water resources;
- Guidelines are needed for best practice
- Our challenge is to build the capacity in developing countries.