

International Autumn School

The EGSIM School for Satellite Gravimetry Applications

11 – 15 September 2017

GFZ Helmholtz Centre, Potsdam, Germany

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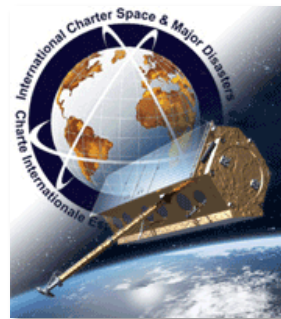
Session: Remote Sensing

Thursday, 14 Sept 2017



Center for Satellite-based Crisis Information (ZKI)

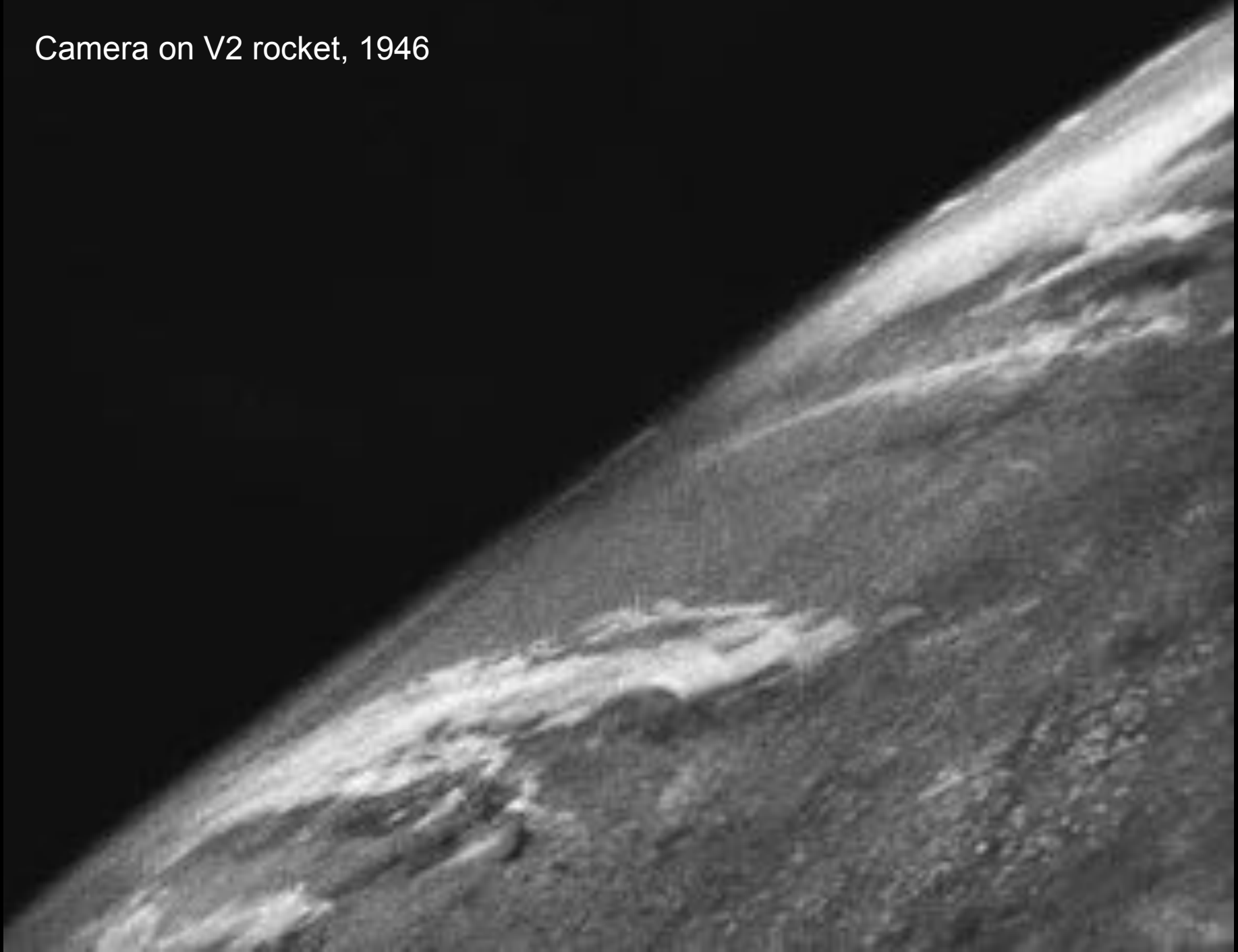
- Operational service of DLR since 2004
- Rapid **provision, processing** and **analysis** of remote sensing data in case of
 - natural and environmental disasters
 - humanitarian relief activities
 - civil security issues
- Activities on national/international level
 - Pre-operational Copernicus Emergency Response Service
 - International Charter Space and Major Disasters
 - ZKI Service for Federal Agencies (ZKI-DE)
 - Copernicus Emergency Management Service – Mapping (EMS)



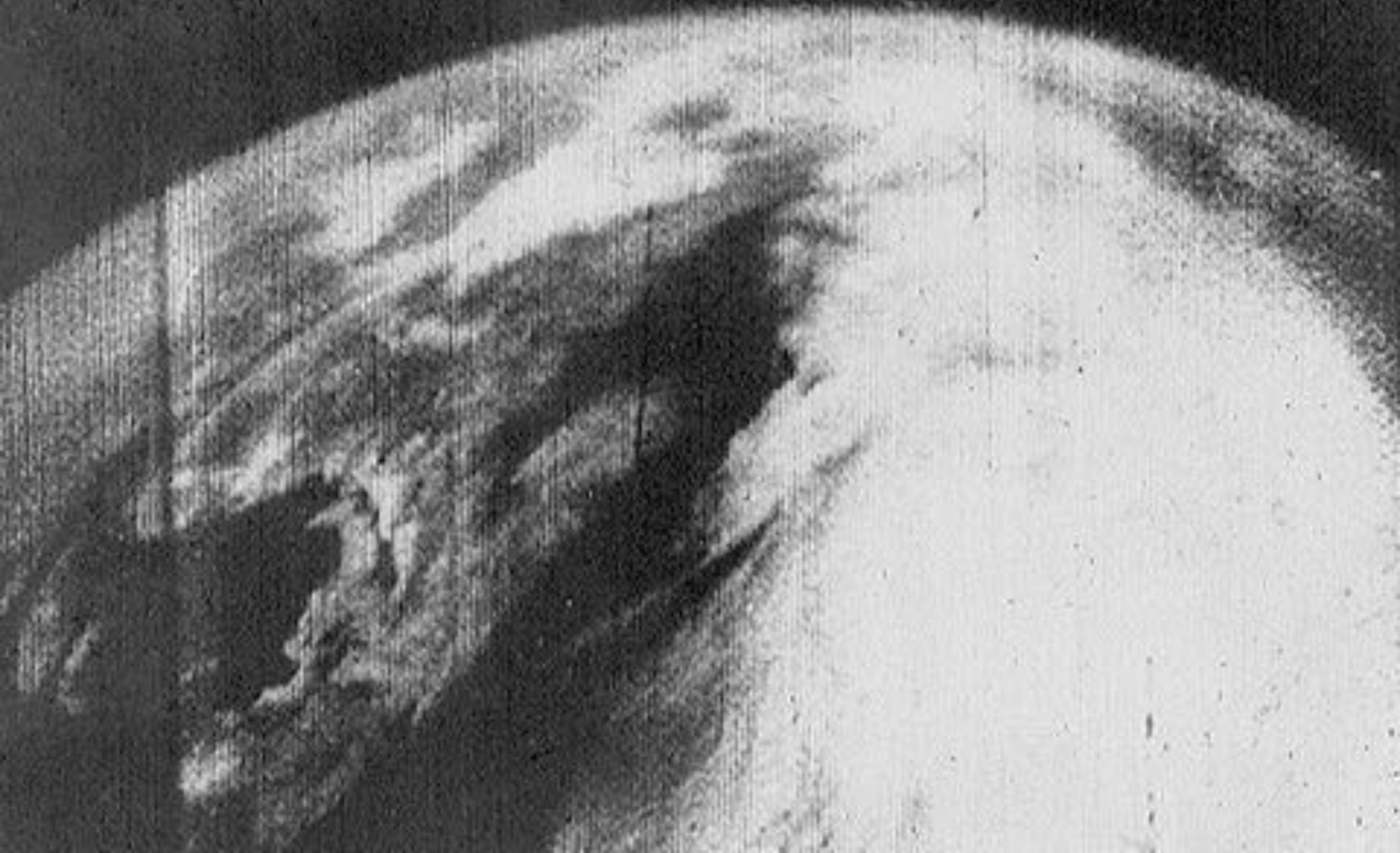
Introduction



Camera on V2 rocket, 1946



1st meteorological satellite (TIROS-1), USA, 1960





Auckland, Port, New Zealand, WorldView-3, 30 cm



Pont-des-Arts bridge,
Paris,
WorldView-3, 30 cm



**Pont-des-Arts-Brücke,
Paris,
WorldView-3, 30 cm**



Remote Sensing

„... is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation.“

„... is used in numerous fields, including geography, land surveying and most Earth Science disciplines; it also has military, intelligence, commercial, economic, planning, and humanitarian applications.

Wikipedia

Categorization

- active vs. passive remote sensing systems
- optical, radar, thermal, hyperspectral





MERIS, forest fires, Greece



TerraSAR-X, dam break, Nepal



SPOT-5, landslide, Tajikistan



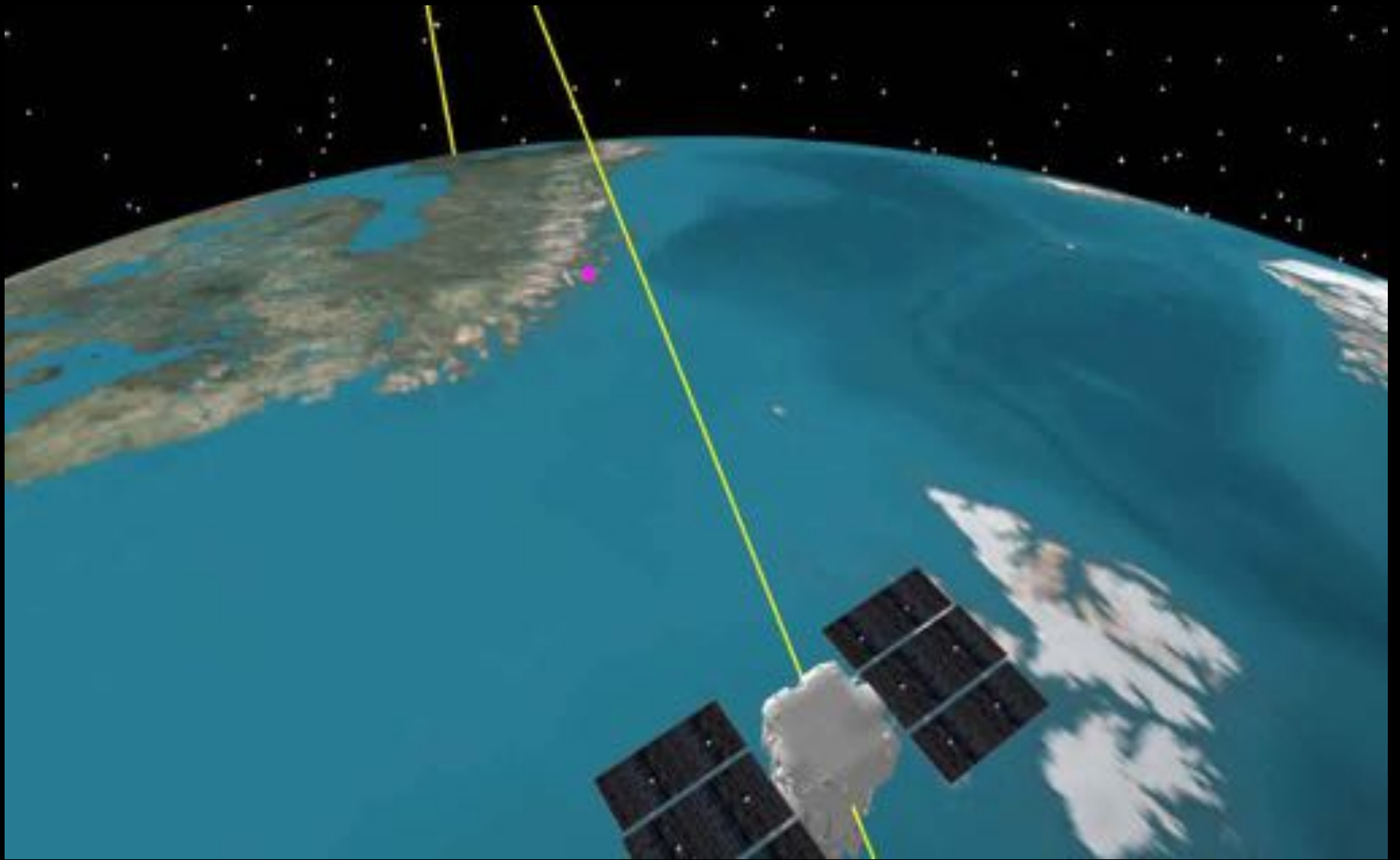
VHR optical, refugee camp, Ethiopia

Determining factors of satellite-based Earth observation

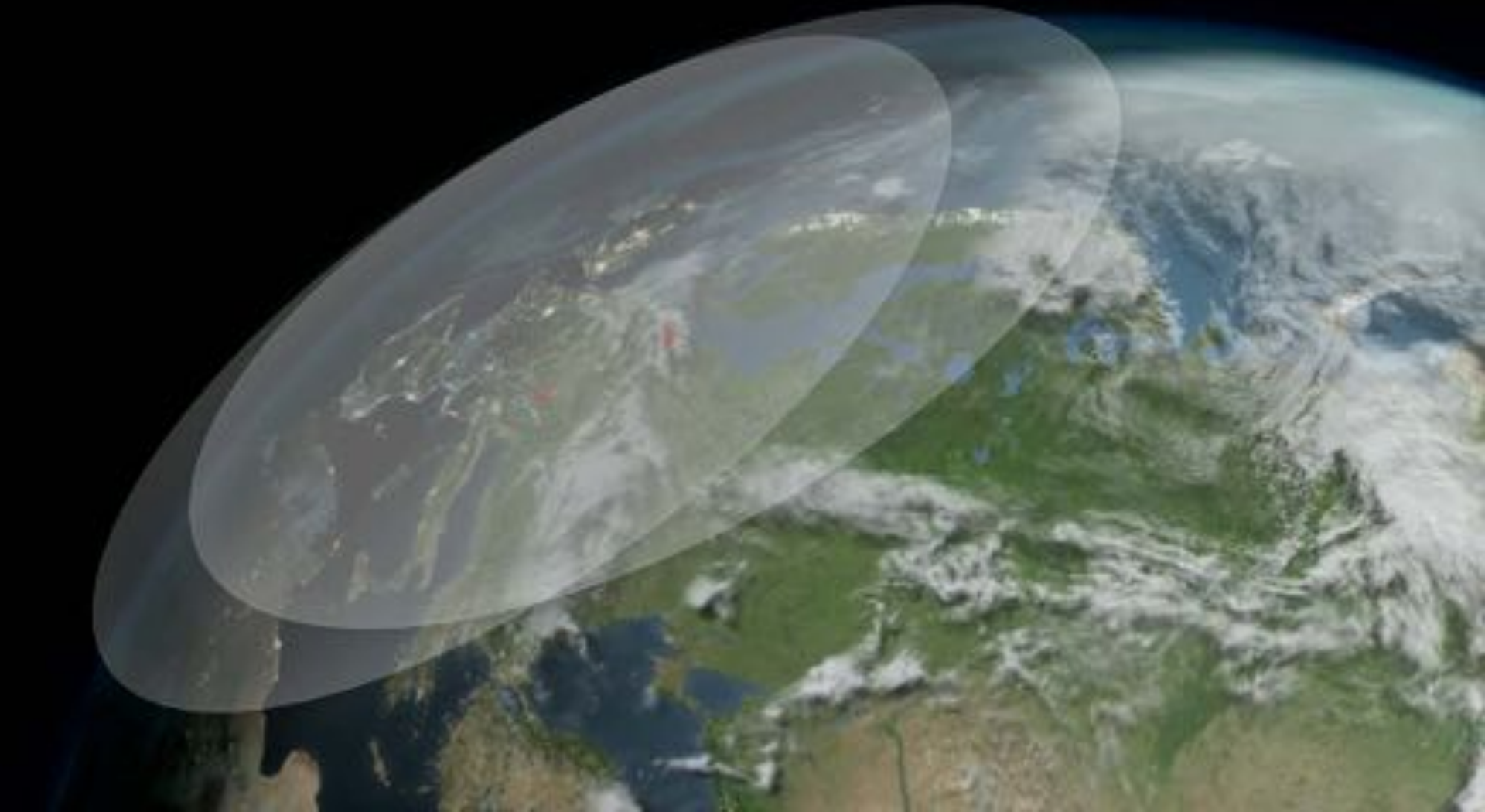
1. Orbits & Ground stations



sun-synchronous orbits



downlink & communication – response time



Determining factors of satellite-based Earth observation

1. Orbits & Ground stations

- field of view
- frequency of overpasses
- data storage
- Downlink time



2. Spatial resolution



LANDSAT-5

30 m



WORLDVIEW-2

0.5 m

South Sudan, Oil refinery



Spatial resolution vs. coverage

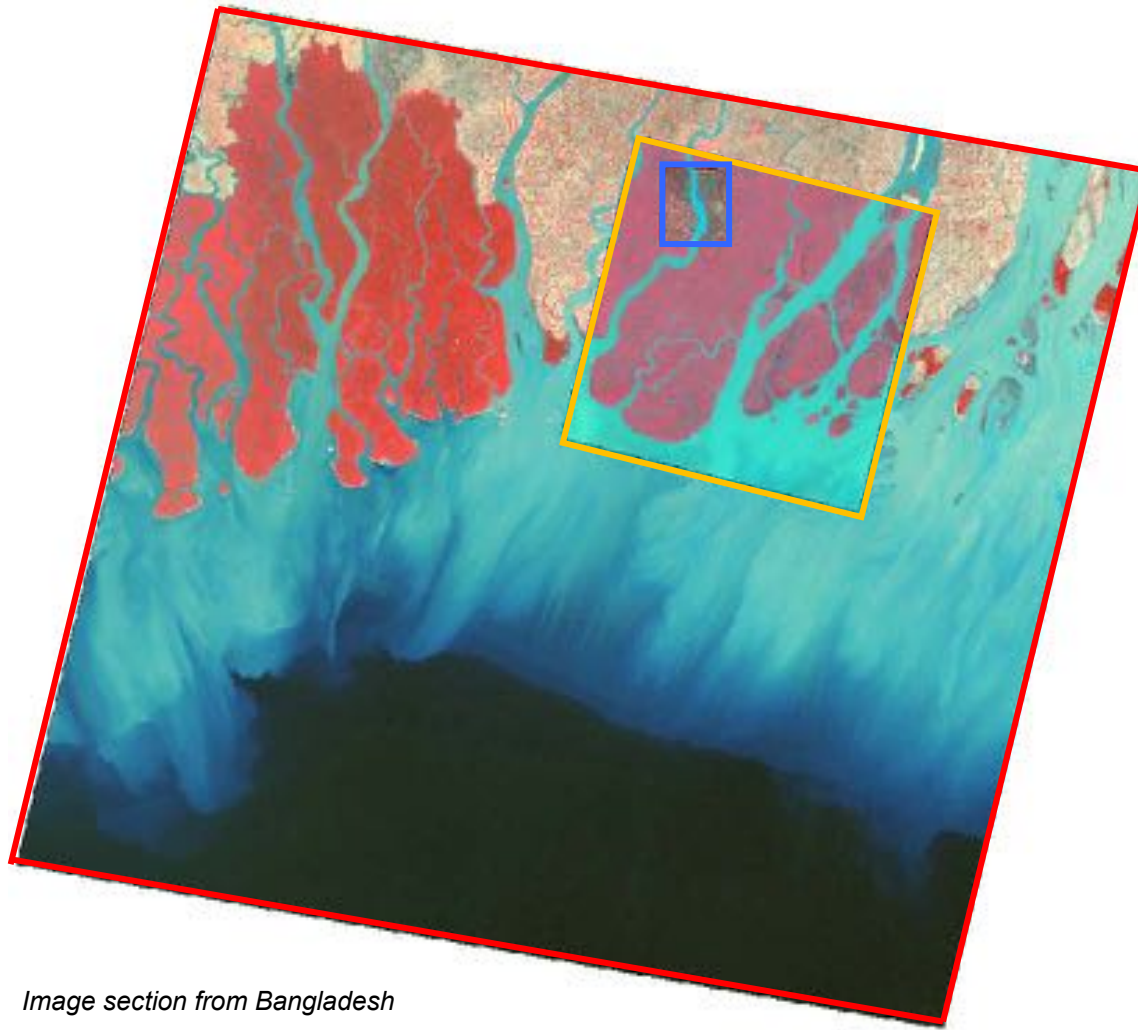


Image section from Bangladesh

IKONOS: 13 x 13 km
Auflösung: 1 m

SPOT: 60 x 60 km
Auflösung: 5 – 10 m

LANDSAT: 170 x 170 km
Auflösung: 30 m



Determining factors of satellite-based Earth observation

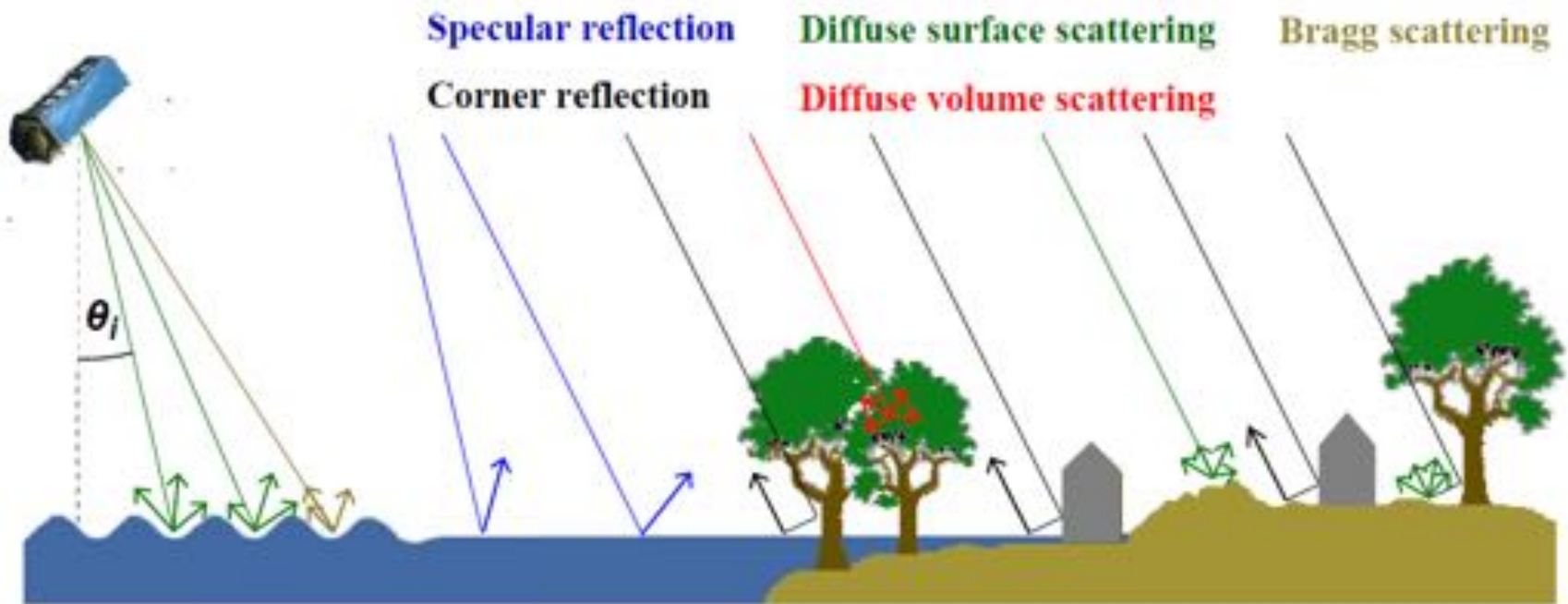
3. Synthetic Aperture Radar (SAR) sensors





Magdeburg, TerraSar-X (8,25 m)

Characteristics of remote sensing with SAR systems

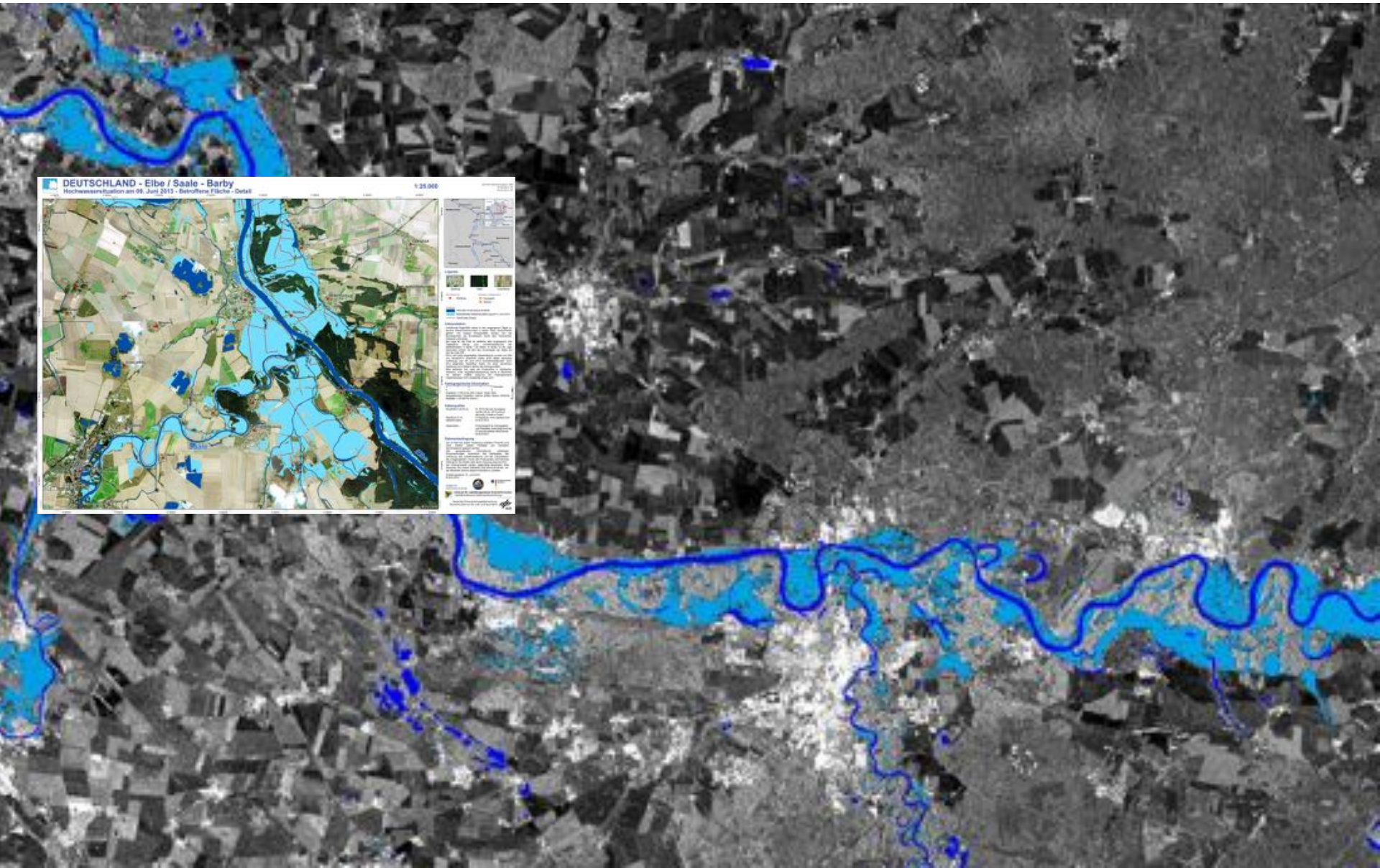


Characteristics of remote sensing with SAR systems

- Active microwave remote sensing method
- Measurement of time from sending out the radar pulse until receiving the backscatter signal
- Acquisitions possible at the night time and through clouds (depending on wave length)
- SAR sensor captures surface roughness, geometry and surface wetness
- Data analysis is more complex than with optical data; not „intuitively“ readable
- Sensors: TerraSAR-X/TanDEM-X, Radarsat-2, Sentinel-1, ALOS-PALSAR-2, Risat-1



ZKI Application: Rapid Flood Mapping, Germany, June 2013

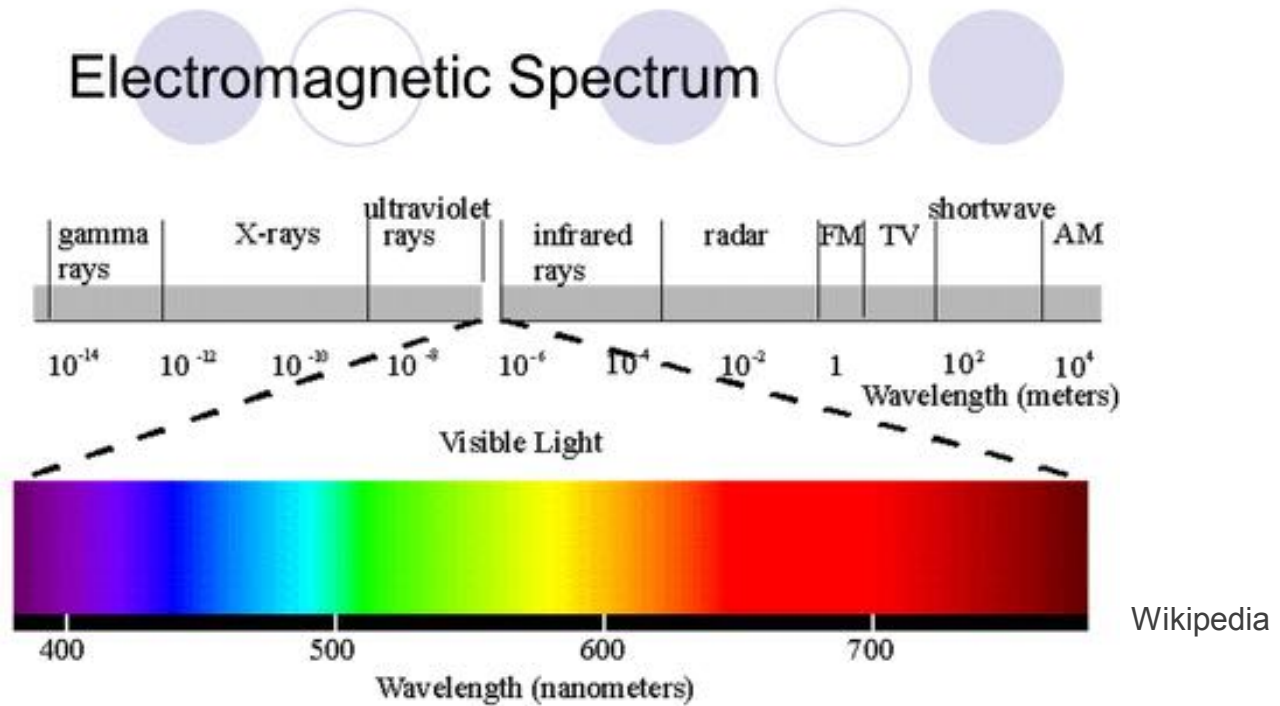


Determining factors of satellite-based Earth observation

4. Characteristics of optical sensors



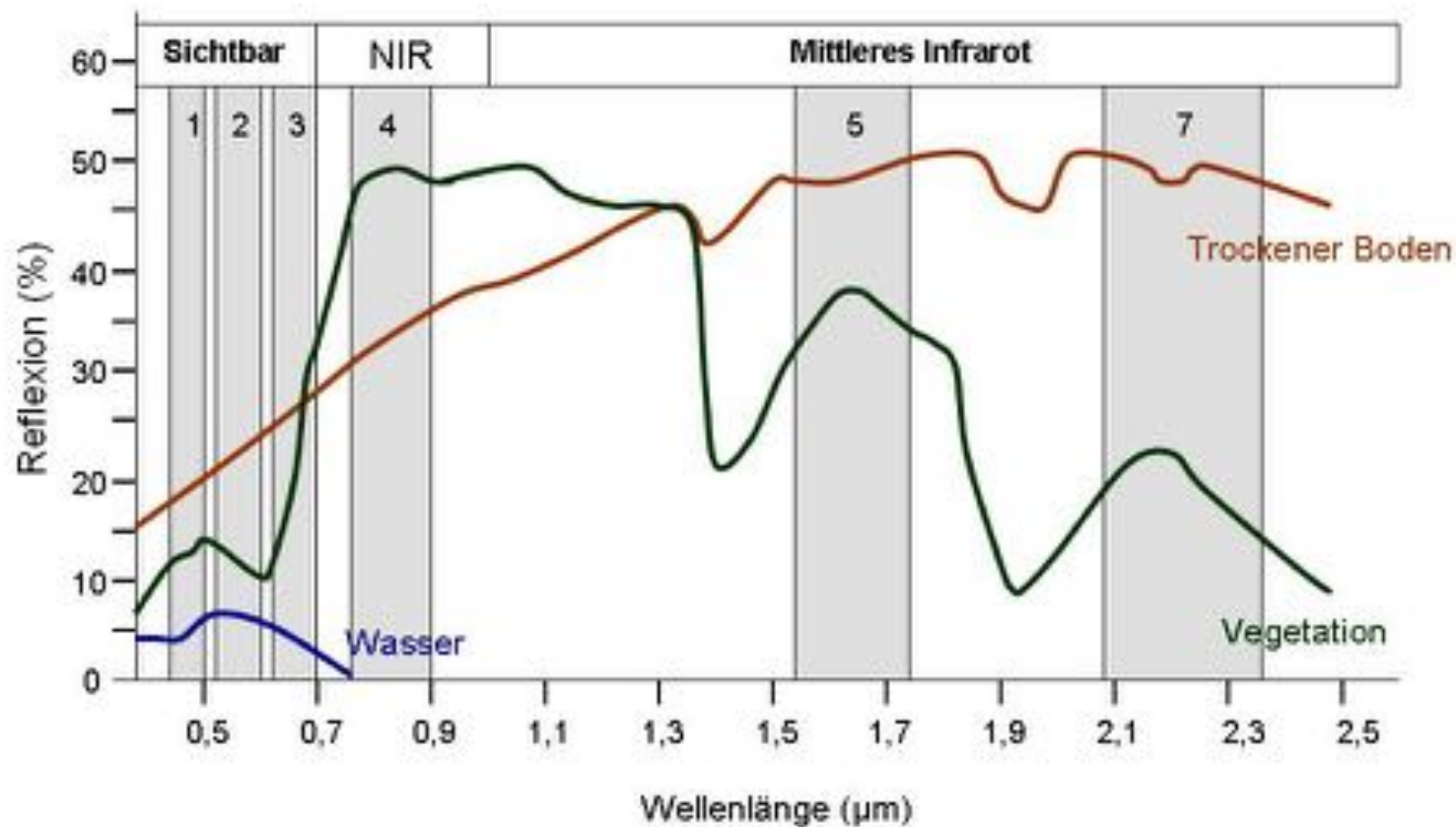
Characteristics of optical sensors



Optical sensors „see“ more
than the human eye!



Spectral signatures



<http://www.seos-project.eu/modules/remotesensing/remotesensing-c01-p05.de.html>



example 1

Football Stadium
Dresden

Satellite
Pléiades (50 cm)

View:
„Flatseats“
→ N, R, G



example 2

South Sudan
(15 km x 19 km)

Satellite
Landsat-7 (15 m)

View:
Mid IR II, Mid IR I, Near IR

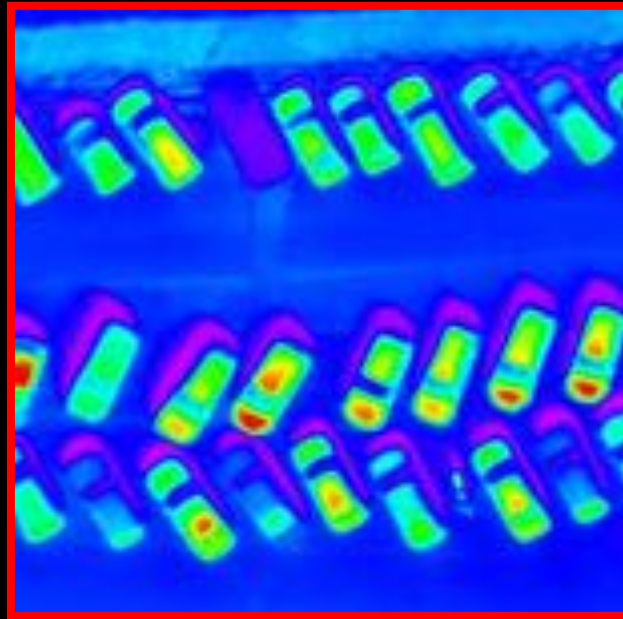


example 3

Thermal information

DLR site,
Oberpfaffenhofen

UAV with camera
FLIR Tau640



cold

warm

Summary

Prospects and limitations of remote sensing



Prospects and Advantages

- Worldwide coverage
- Quick spatial overview, also in inaccessible areas
- Detailed monitoring applications
- Cost-efficient observation of large areas
- Different Sensors and their advantages:
 - SAR
 - Image capture during night time and penetration of clouds
 - Optical
 - Larger electromagnetic spectrum than the human eye (Infrared, Thermal, ...)
 - „False color images“ provide „hidden“ information

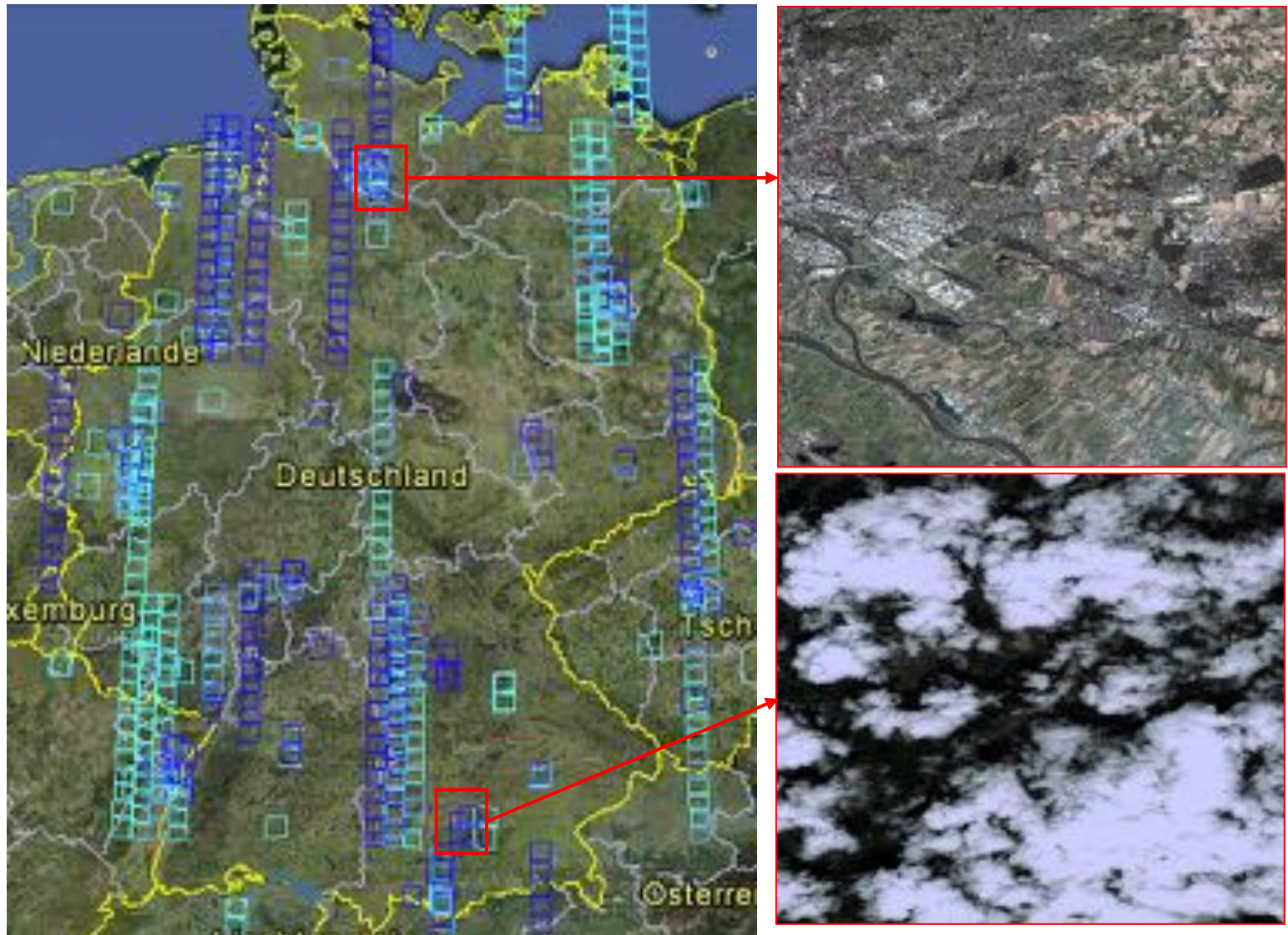


Limitations

- Limited number of available satellites at a certain time
- Limited availability of archive images



Overview of all QuickBird scenes acquired over Germany during the year 2009 (incl. cloudy images)



Limitations

- Limited number of available satellites at a certain time
- Limited availability of archive images
- Weather-induced limitations with optical data (clouds, haze)



Limitations

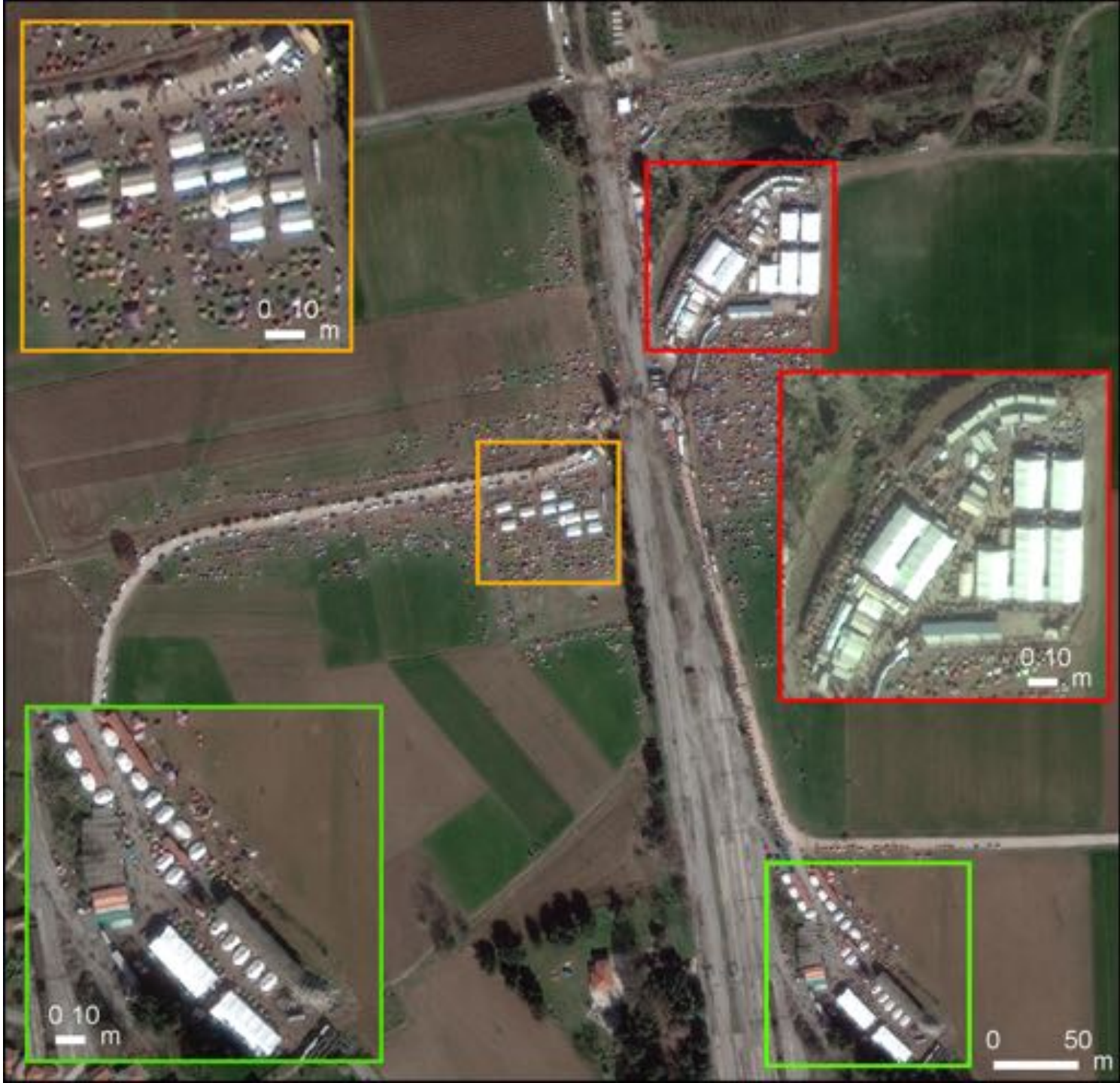
- Begrenzte Anzahl von verfügbaren Satelliten in bestimmtem Zeitraum
- Beschränkte Anzahl von verfügbaren Archivaufnahmen
- Weather-induced limitations with optical data (clouds, haze)
- Compromise between spatial coverage and resolution
- Sometimes there is a significant lead time for new acquisitions



Application in crisis response

Refugees





Application in crisis response

Flooding











Luftbild (0,2 m), 31.05.2011



Satellitenbild (Pixelauflösung 0,5 m), 05.06.2013



[illegible]

Wasserproportionen

Die Wasserzusammensetzung hängt von der Höhe über dem Meeresspiegel ab. In der Regel steigt der Salzgehalt mit zunehmender Höhe an. In der Regel steigt der Salzgehalt mit zunehmender Höhe an. In der Regel steigt der Salzgehalt mit zunehmender Höhe an.

Kartographische Information

0 1 2 Kilometer

Geographisches Institut der Universität Bonn
Geographische Anstalten und Kartographie des Geographischen Instituts
Bonn, 1978. 1 Blatt (A4) 1:50.000

[illegible]

Automatisierung

Die in diesem Seminar behandelte Problematik ist nicht nur einem kleinen Teilgebiet der Informatik vorbehalten, sondern betrifft auch gesellschaftliche, ökonomische, ethische und rechtliche Aspekte. Die Automatisierung wird mit der Automatisierung der Produktion verbunden und ist ein zentraler Bestandteil der Informatik. Die Automatisierung ist ein zentraler Bestandteil der Informatik. Die Automatisierung ist ein zentraler Bestandteil der Informatik.

Informationssysteme 11. April 2015
 Veranstaltungsort: 10. April 2015
 10. April 2015

Journal of Interpersonal Violence
SAGE Publications







Application in crisis response

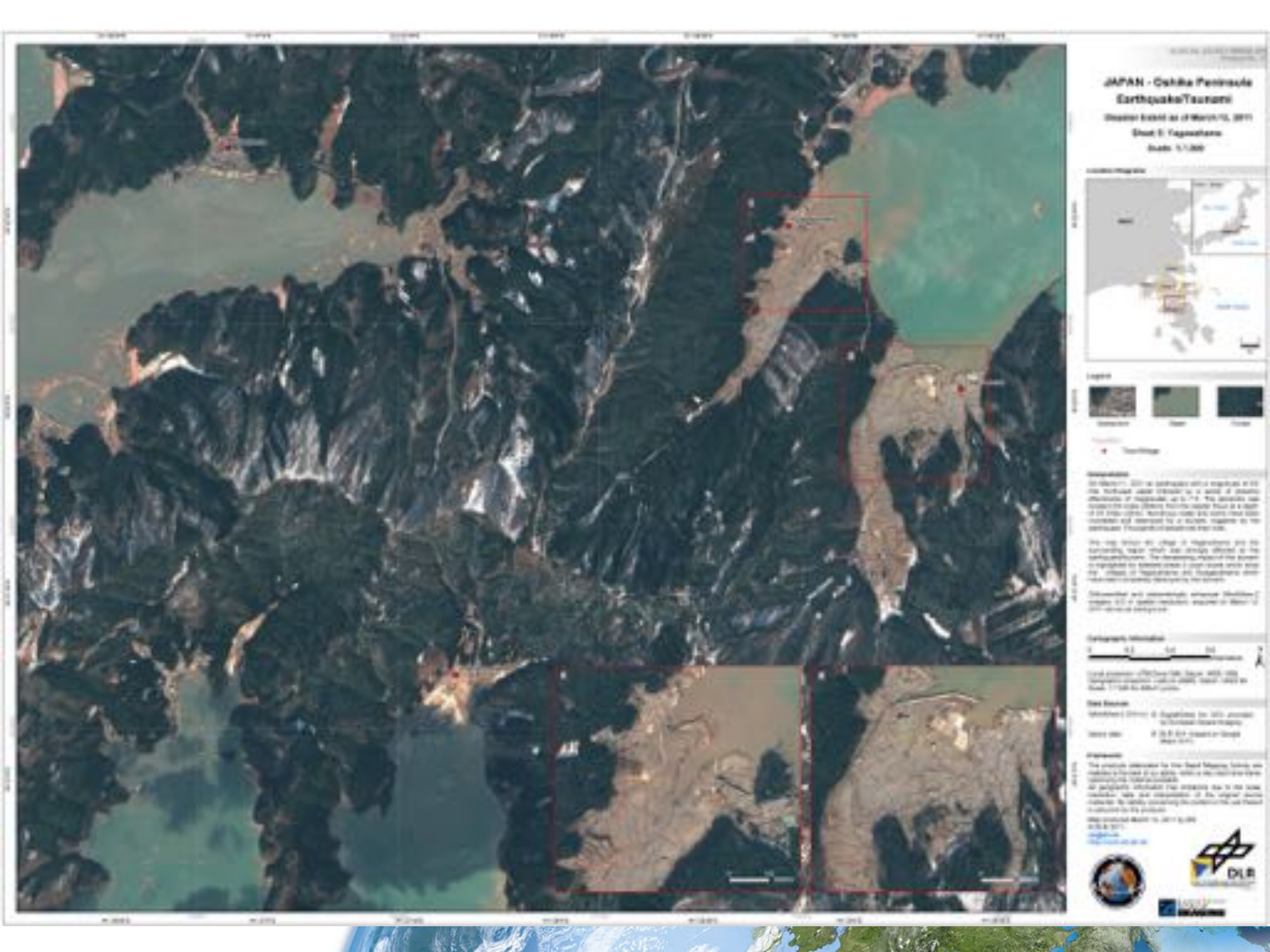
Building damage



1



arth



JAPAN - Oshima Peninsula Earthquake/Tsunami Shelter based as of March 15, 2011 Sheet 5: Capetown Scale 1:1000



Observations
On March 11, 2011 an earthquake with a magnitude of 9.0 hit the northeast coast of Japan in a series of seismic aftershocks of magnitude up to 7.2. The tsunami was triggered by the quake, reaching a height of 10 m (33 ft) in some areas. The tsunami caused significant damage to the coastline and destroyed many buildings and infrastructure.

The map shows the village of Higashimura and the surrounding area. The map shows the coastline and the surrounding area. The map shows the coastline and the surrounding area.

Observations and recommendations
The map shows the coastline and the surrounding area. The map shows the coastline and the surrounding area.

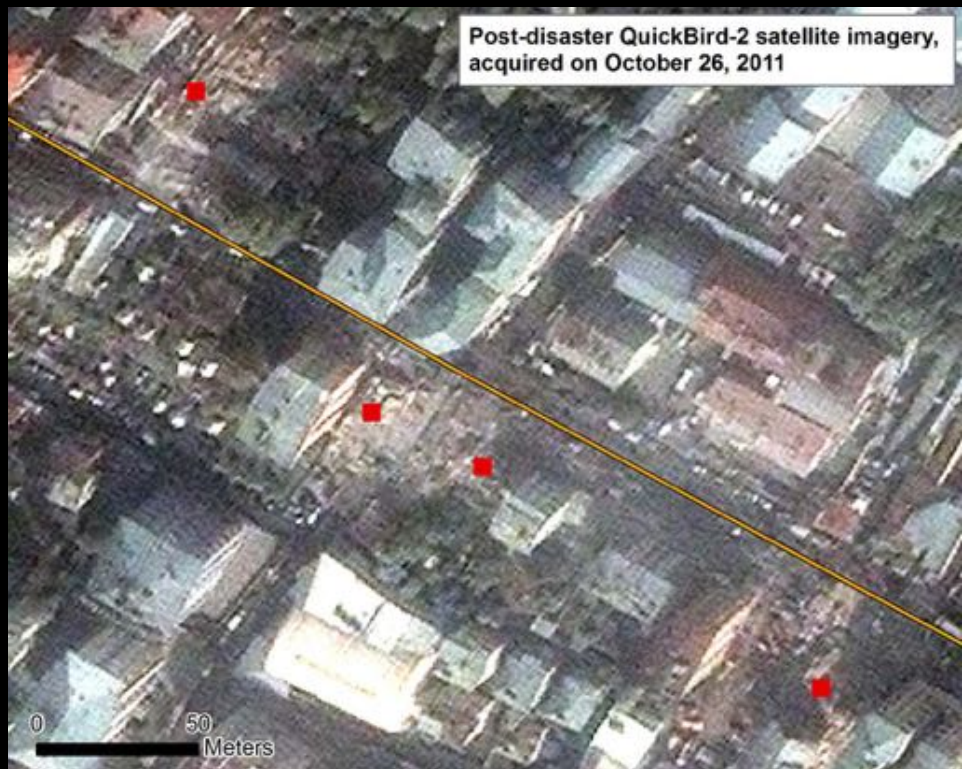
Geographic Information
Scale 1:1000
Scale 1:1000

Data Sources
The map is based on data from the Japanese Ministry of Land, Infrastructure and Transport (MLIT) and the Japanese Ministry of Defense (MOD).

Disclaimer
The map is based on data from the Japanese Ministry of Land, Infrastructure and Transport (MLIT) and the Japanese Ministry of Defense (MOD). The map is not a guarantee of accuracy and is for informational purposes only.

Map Information
The map is based on data from the Japanese Ministry of Land, Infrastructure and Transport (MLIT) and the Japanese Ministry of Defense (MOD). The map is not a guarantee of accuracy and is for informational purposes only.





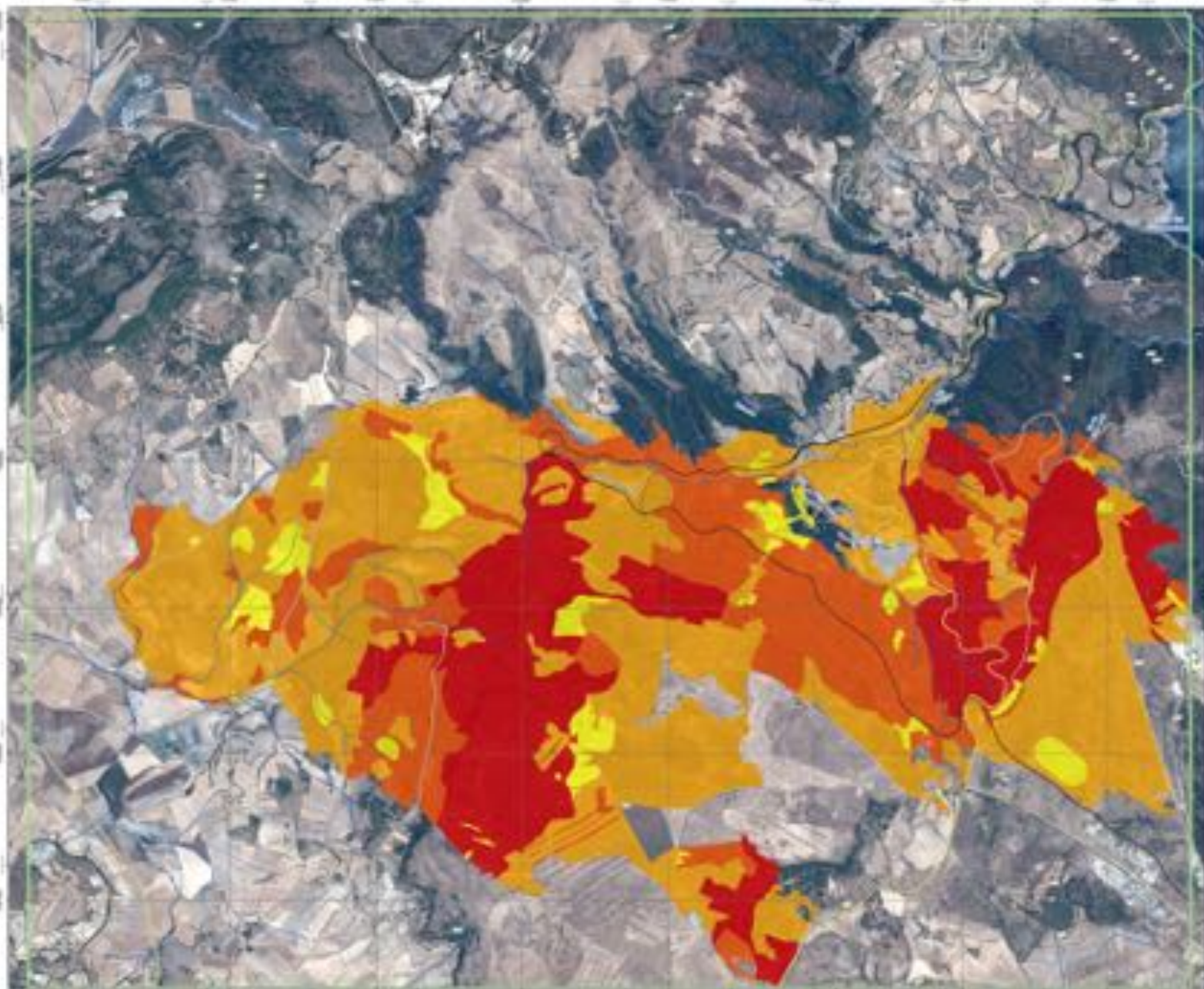


Application in crisis response

Fire







ITALY - ITALY
Fire - Situation as of 26/07/2016
 Coding Map

Geographic Information
 1:100000 Scale 2011 map projection UTM
 EPS: 31466 Datum: ED50 Coordinate system: UTM
 North arrow: North arrow pointing up

Legend

Color	Symbol	Description
Red	Fire	Fire
Orange	Fire	Fire
Yellow	Fire	Fire
Green	Forest	Forest
Blue	Water	Water
Grey	Urban	Urban
White	Other	Other

Scale
 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

Metadata
 Project: Fire - Situation as of 26/07/2016
 Date: 26/07/2016
 Author: [Name]
 Version: 1.0
 License: [License]

Disclaimer
 This map is for informational purposes only. It is not intended for use in legal proceedings or for other purposes where accuracy is critical. The map is based on data provided by the Italian Ministry of the Environment and is subject to change without notice.

Logos
 Copernicus
 European Union



Fire as of January 07, 2012 - Disaster Extent Map

1:50,000

Copyright © 2004
Wiley Periodicals, Inc.



Received 10 January 2011; accepted 10 January 2011
Published online 10 January 2011 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/anie.201100000

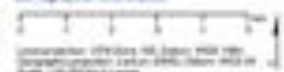
Boundaries of the US are shown.

Downloaded At: 11:53 11 September 2009

© 2005 Blackwell Publishing Ltd, *Journal of Internal Medicine* 258: 103–110

The study was a *Retrospective* study. The inclusion of cases (1992-2002) was included (2002/01/01-2002/12/31) and a 1:4 ratio was used of approximately 100000. The first group was used for the retrospective study on the basis of the study. The second was 100000 and the third was 100000 and the fourth was 100000.

diagnostic interpretation



Early Experiences

Account name	12/20/2017 (Completed) (10/1)
First and last name	12/20/2017 (10/1)
Organization name	12/20/2017 (10/1)

Discussion

As previously mentioned, the three-phase frequency-response method is the basis of our efforts, which is only after this point, continuing the traditional approach:

- for geologists, information has limitations due to the weak, nonsteady-state, poor understanding of the original source materials, the specific monitoring, the context in the real world's environment, the ground;
- the data used and the methods applied. Please note that it is not only the data but also the data source of the problem.

The authors declare that they have no competing financial interests.

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Fires as of August 12, 2016 - Situation Map

1:1,200,000 / 1:250,000

1994-1995 20
1995-1996 20



0.000 - 0.001
 0.001 - 0.002
 0.002 - 0.003
 0.003 - 0.004
 0.004 - 0.005

Keywords: child sexual abuse; disclosure; self-blame

The first group has its roots in 1980s feminist film studies (Gibson 1997) and has been well accepted in English (15, 2002).

The authors report evidence for the role of the amygdala in the processing of emotional information. It is concluded that the amygdala is involved in the processing of emotional information. The amygdala is a subcortical structure that is involved in the processing of emotional information. It is located in the ventral temporal lobe and is involved in the processing of emotional information. It is a subcortical structure that is involved in the processing of emotional information. It is located in the ventral temporal lobe and is involved in the processing of emotional information.

HRF can be administered in either one sitting or over a number of sessions. It is appropriate for children and adults, but there are some considerations for the latter. For the most part, adults will find the HRF easy to learn and the time taken to learn will be reduced compared to children.

Enterogastrointestinal infections

© 1999 Blackwell Science Ltd, *Journal of Internal Medicine* 245: 101–107

Index

Company Name	1234567890
Company Address	1234567890
Company Phone	1234567890

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The present contributions are not reporting strictly pre-validated data but, rather, mainly, exploratory and/or confirmatory. All geographic information has been used in the same manner: data are combinations of two spatial vector systems. In future, concerning the problem of the use of GIS, a distinction has to be introduced.

Received August 16, 2004; accepted August 26, 2004.

[illegible]

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Journal of Internal Medicine 247: 395–401

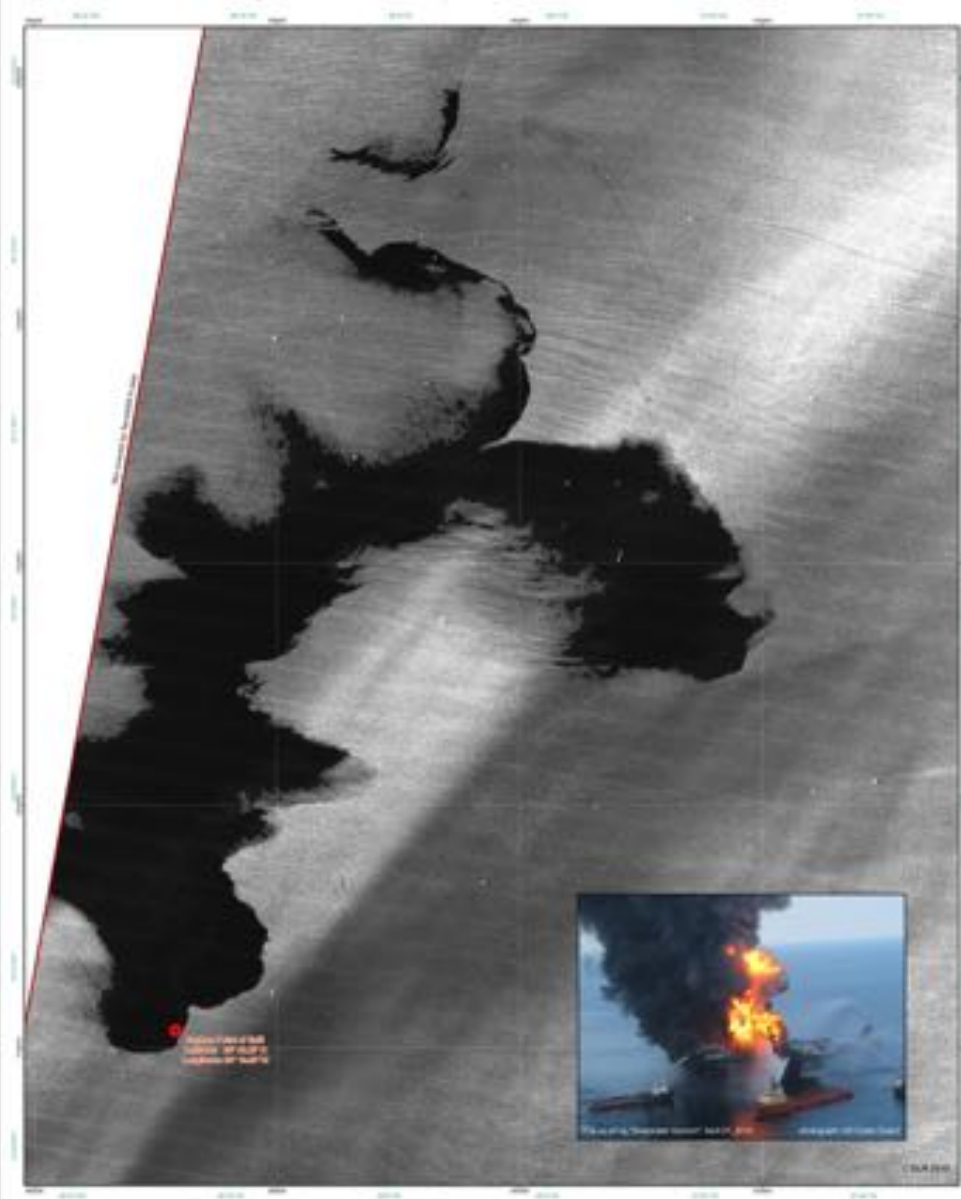


Application in crisis response

Technical accident



1:150,000



Current trends in satellite remote sensing



Current trends in satellite remote sensing

- **Copernicus (EU): Sentinel Missions**

- Sentinel-1 (4 Satellites): SAR (5m – 40m)
- Sentinel-2 (2 Satellites): Optisch (10m, 20m, 60m)
- Sentinel-3 (2 Satellites): Ocean monitoring (300m- 1km)
- Sentinel-4/5: Atmospheric monitoring from 2017/2019

- **UrtheCast (Canada): OptiSAR**

- 16 Satellites: 8 pairs, each with the combination of a SAR and an optical satellite, two orbits (four pairs per orbit)

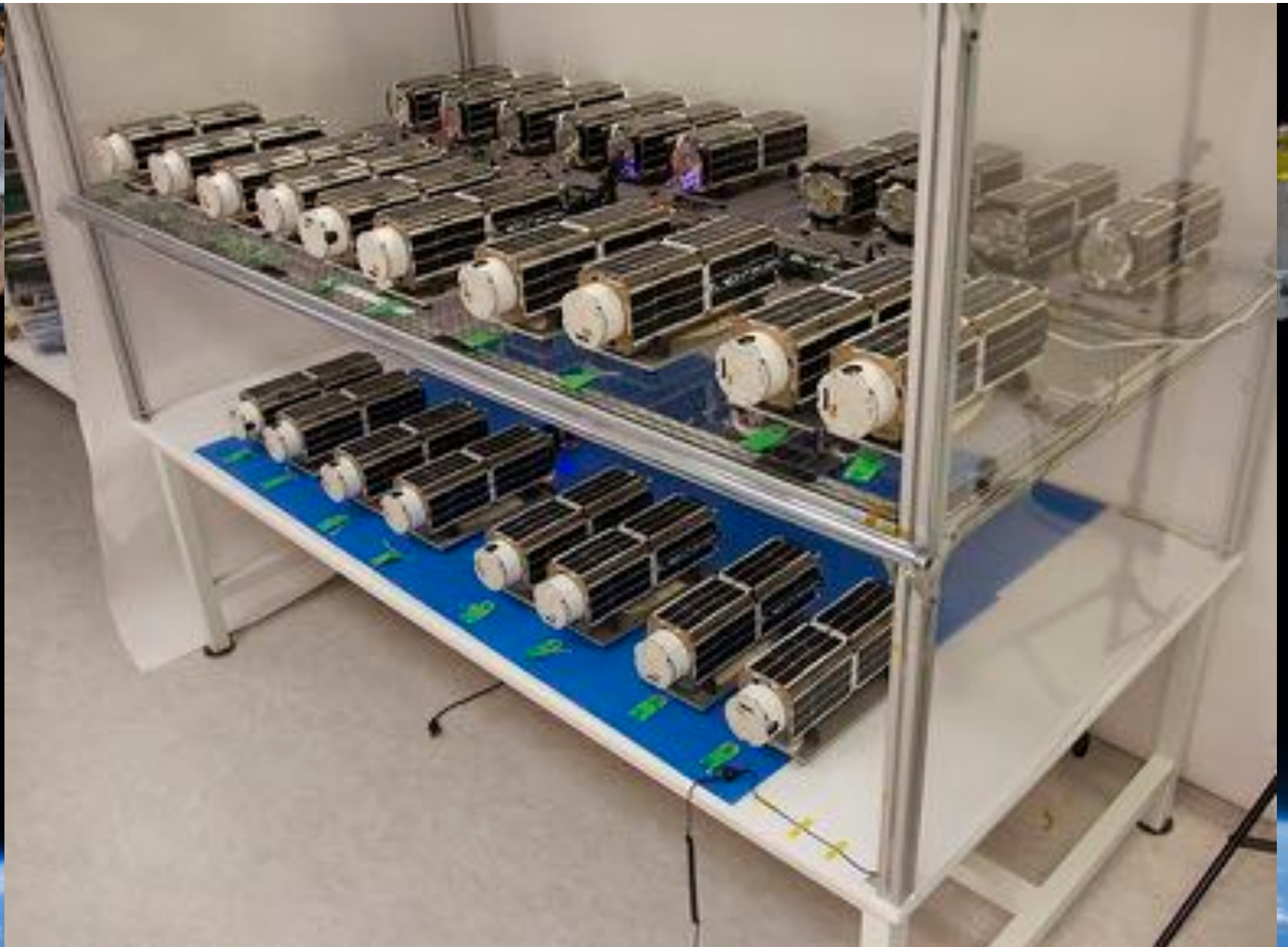
- **BlackSky (USA)**

- planned: 60 micro satellites until 2020, spatial resolution 1 m

- **Planet Labs (USA)**

- Currently ca. 50 micro satellites (CubeSat), spatial resolution 3-5 m





Current trends in satellite remote sensing

- New platforms and sensors (UAV)
- Video (max. 90 seconds) from space: [BellaTerra](#) (Skybox)
- Permanent contact between satellites and ground station: European Data Relay System (EDRS)
- Hyperspectral sensors
- 3D-Modelling
- Person tracking at mass events (e.g. Festivals)



Space-based remote sensing



Schloss Elmau
Pléiades (50 cm)



Remote sensing with air planes



Schloss Elmau
Luftbild 15 cm

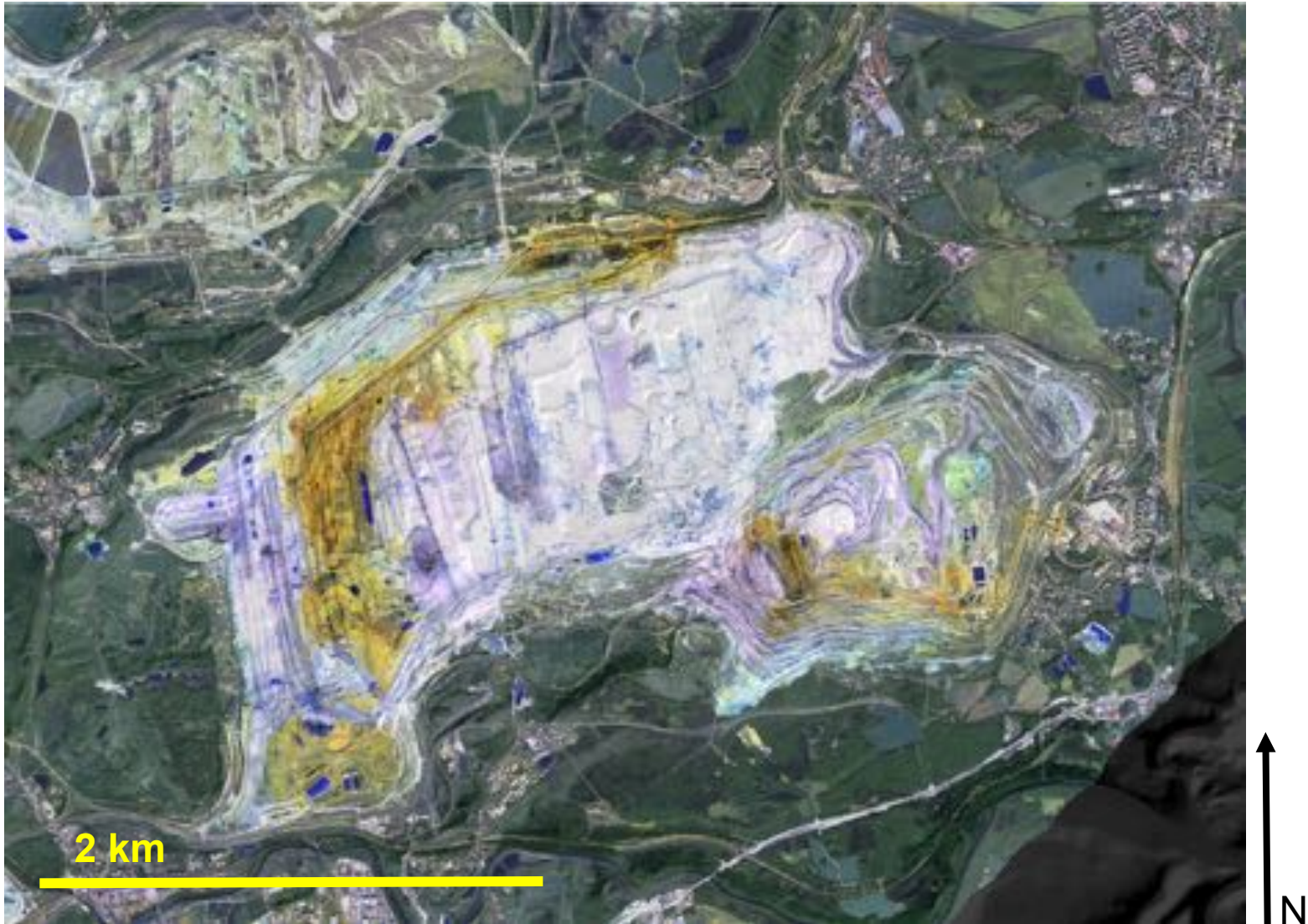


Remote sensing with UAVs/ drones





Air-borne hyperspectral acquisition (Czech Republic)





3D: earthquake Nepal







Person Tracking

- **Goal:** understanding behavioral dynamics of large groups of people can help avoid catastrophes
- **How:** by detecting and tracking individuals in aerial image sequences
- **Method:** Tracking-by-Detection
 - **Detector:** AdaBoost classifier on Haar-like features
 - **Tracker:** Multiple-Hypothesis Tracking
- **Work in progress:** deep-learning methods to improve person detection





The international Charter ,Space and Major Disasters‘





Disaster types supported

The International Charter executes priority tasking of different EO missions in a rapid fashion; it is designed to address requests concerning major disasters caused by:

Natural events

Earthquakes

Floods

Landslides

Tsunamis

Fires

Ice jams

Ocean storms

Volcanic eruptions

Man-made events

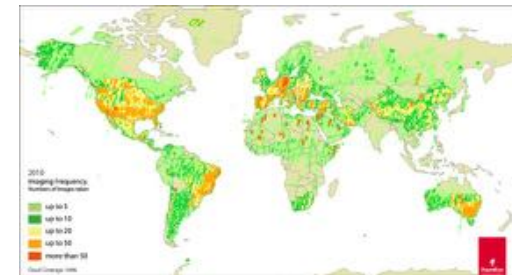
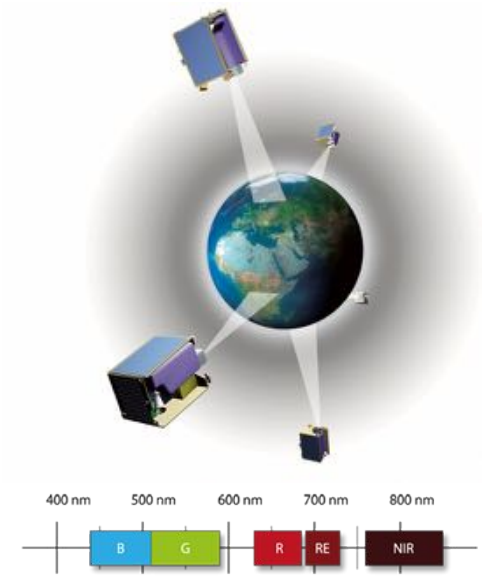
Oil spills

Industrial accidents



RapidEye - characteristics

- constellation of 5 satellites
 - *Quick response time*
- Solar-synchronous orbit in 630 km height
- 5 bands (blue, green, red, Red Edge, NIR)
- GSD 6,5m; pixel size (orthorectified) 5m
- Swath width: 77 km

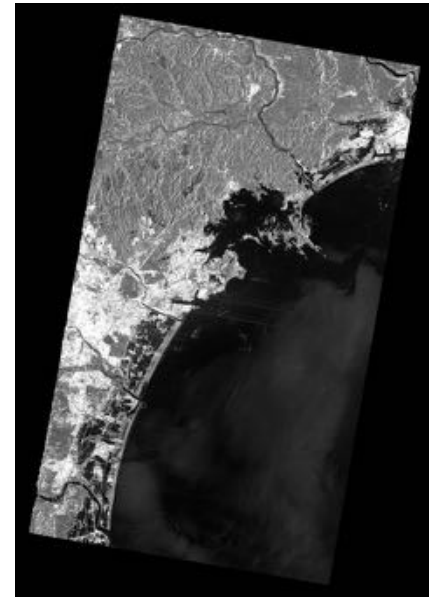


DLR contribution to the Charter

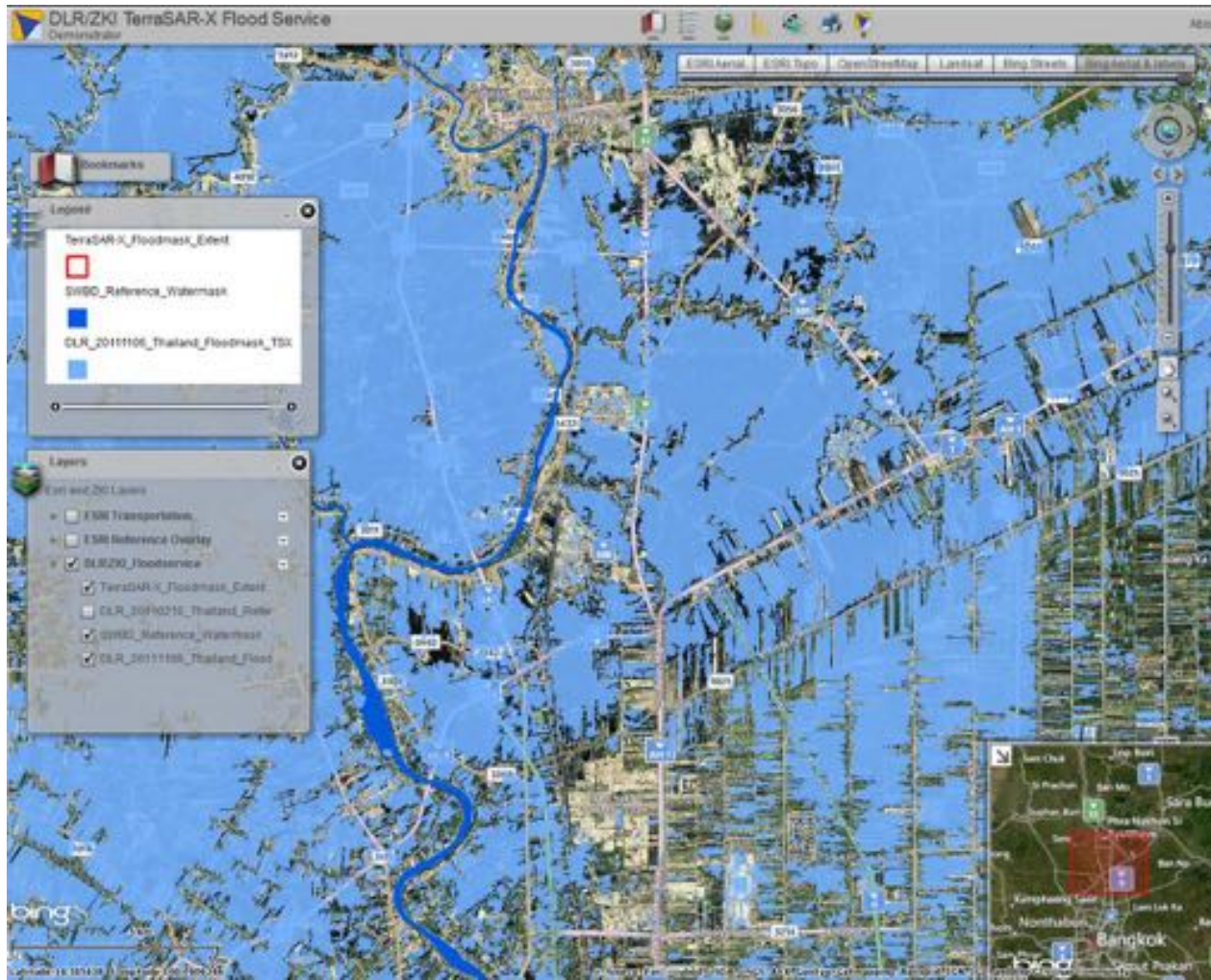
- TerraSAR-X/TanDEM-X standard products

- WideScanSAR (WS)
- ScanSAR (SC)
- StripMap (SM)
- Spotlight (SL)
- HighResSpotlight (HS)

Acquisitions are realized through TerraSAR-X and TanDEM-X (but no DEMs)



TerraSAR-X Flood Service



- Fully automatic service
- TSX resolution: ~0.25-40.0m
- Local to regional scale flood mapping
- On-demand triggering in case of emergencies



Exercise: Flood Mapping

<http://www.un-spider.org/advisory-support/recommended-practices>

