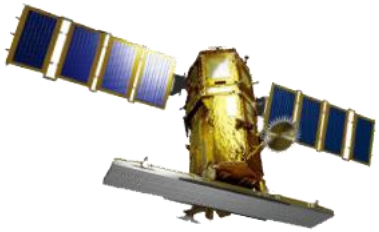
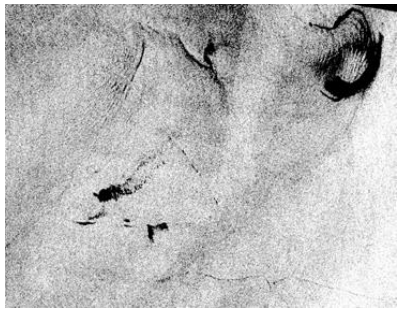
Oil Spill Detection & Monitoring of Abu Dhabi Marine Zone using Kompsat-5 SAR

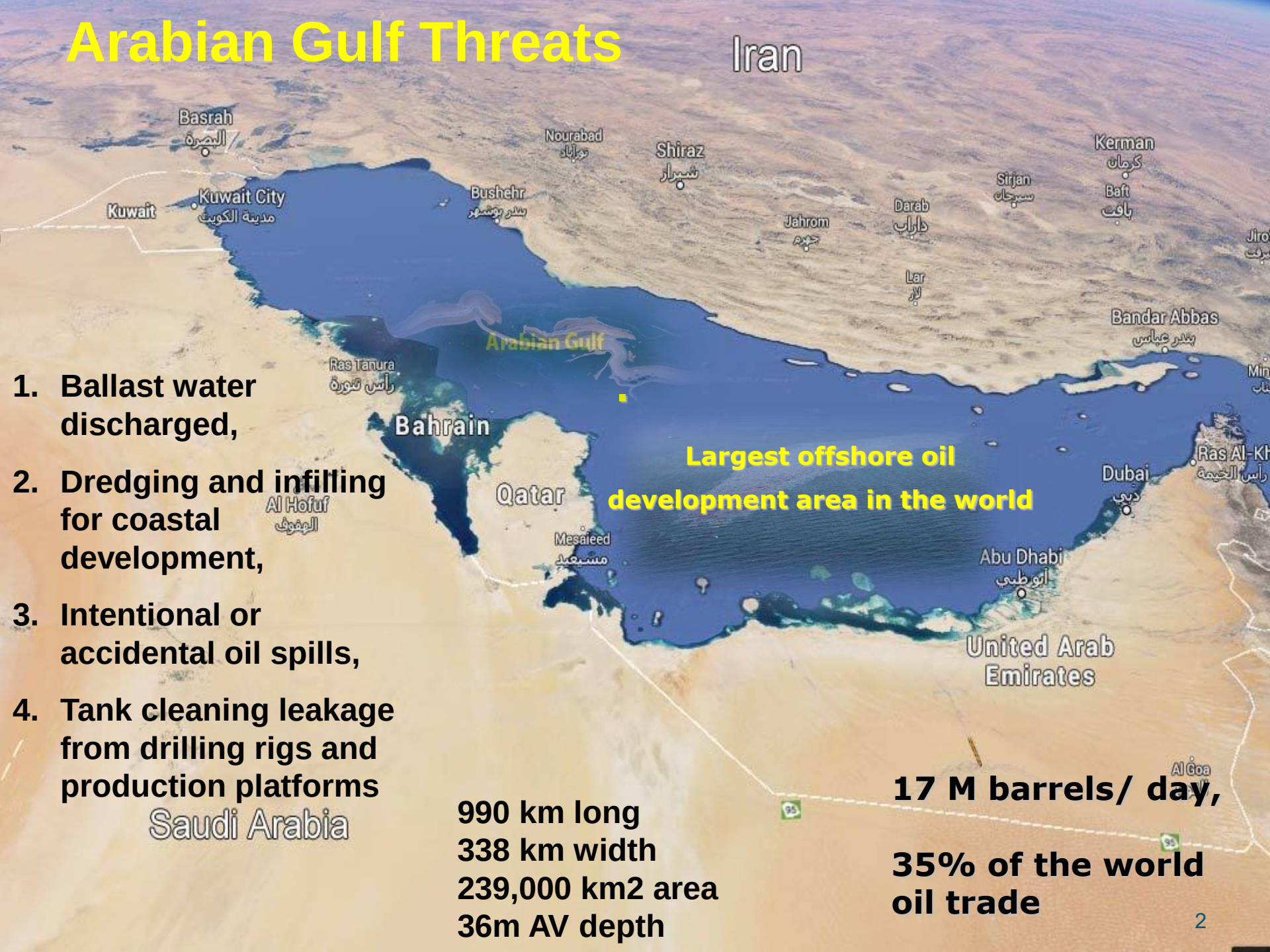
Dr. Hussein Harahsheh





Global Scan Technologies, Dubai, UAE

Arabian Gulf Threats



1. **Ballast water discharged,**
2. **Dredging and infilling for coastal development,**
3. **Intentional or accidental oil spills,**
4. **Tank cleaning leakage from drilling rigs and production platforms**

990 km long
338 km width
239,000 km2 area
36m AV depth

17 M barrels/ day,

35% of the world oil trade

Near Real Time Oil spill Monitoring

The Challenge

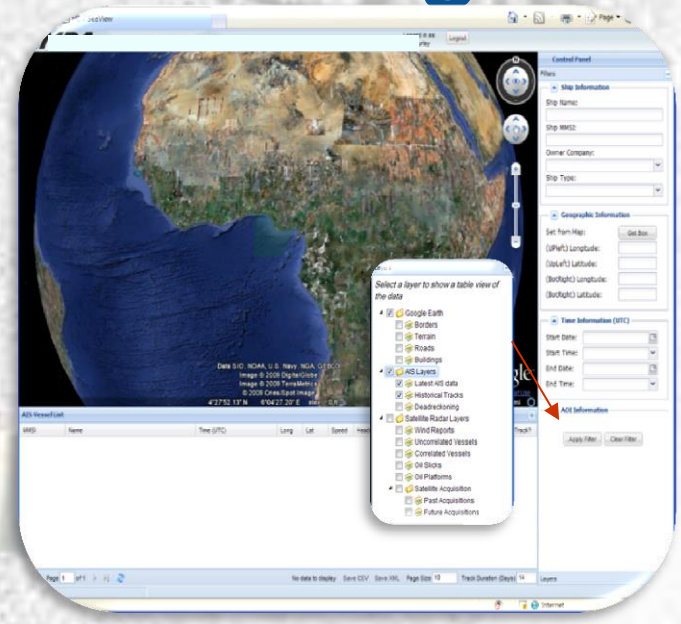
- Detection of oil spills
- Rapid report of above-mentioned oil spills through alerting
- A usable and effective decision support and incident management response solution

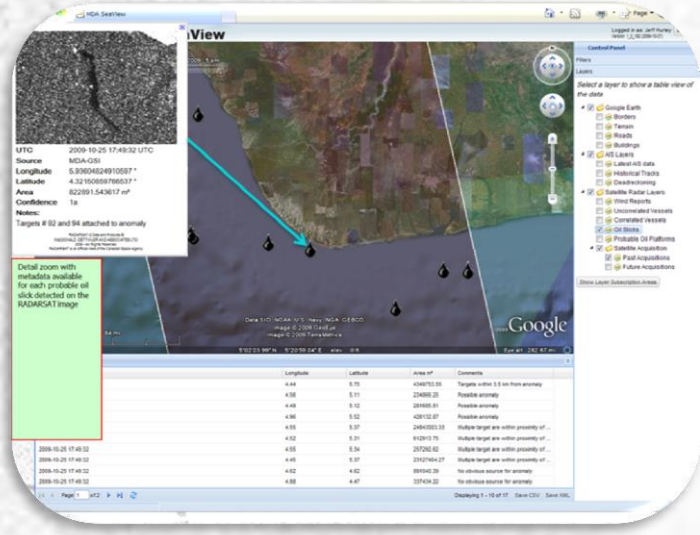
Solution

- A fully managed web based service
- Space-based Synthetic Aperture Radar (SAR)

Advantages

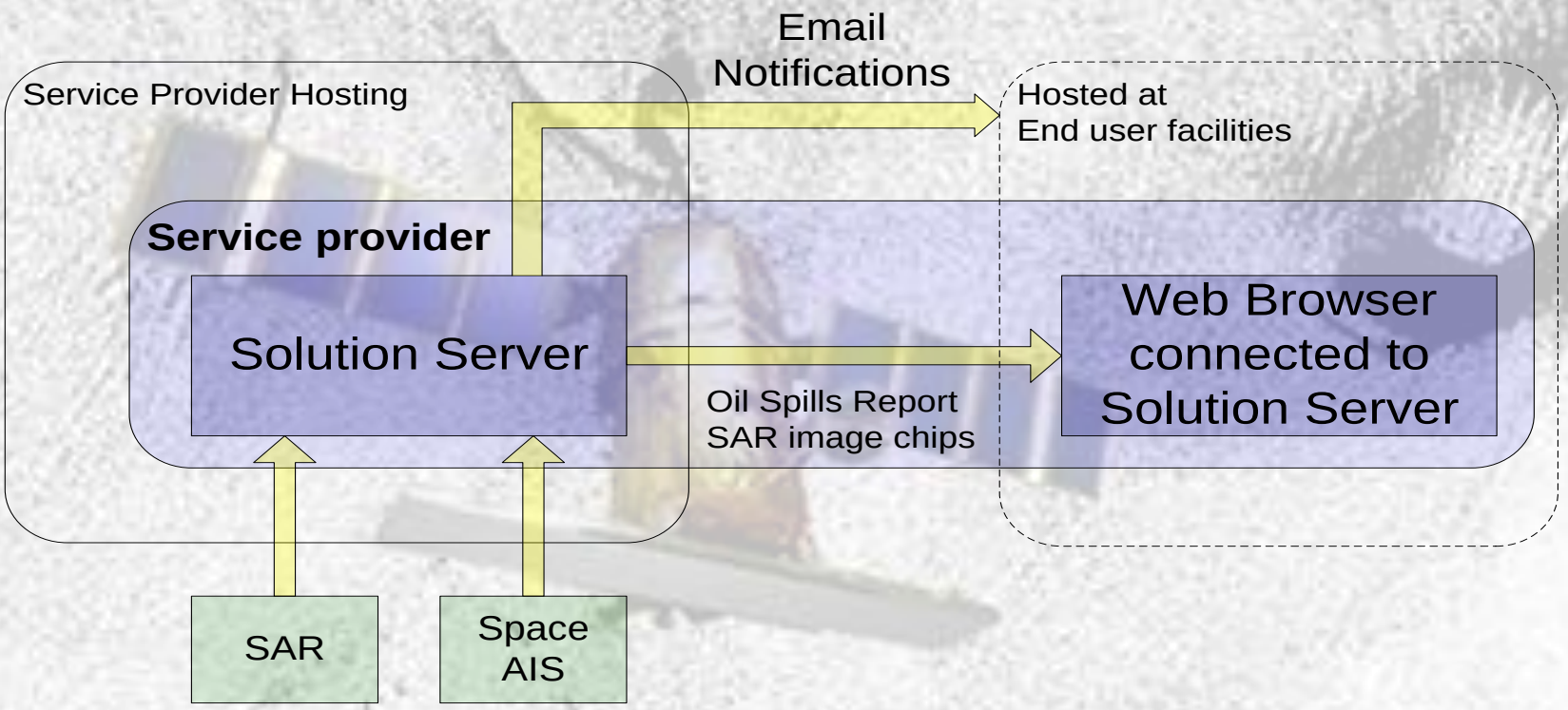
- Broad-area based coverage – a key advantage of SAR satellite imaging
- intuitive & easy to use – with a user friendly interface technology
- High revisit frequency from multiple satellites

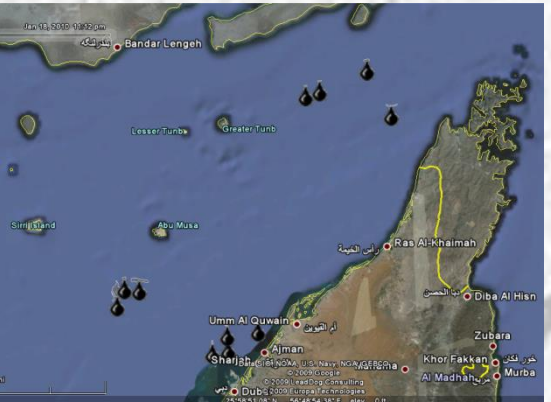


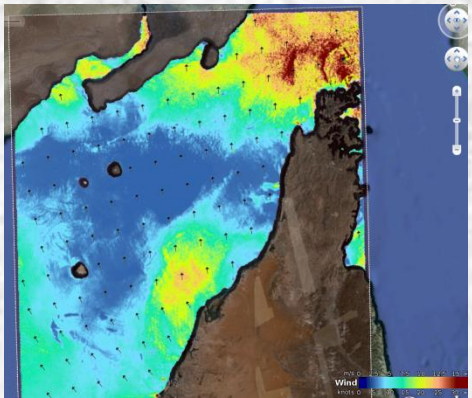


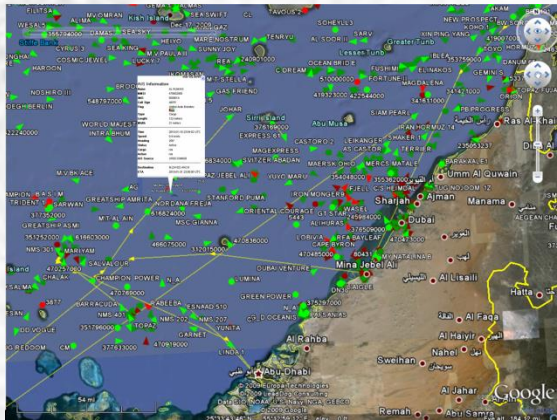
AVAILABLE SAR SATELLITES

Solution Architecture



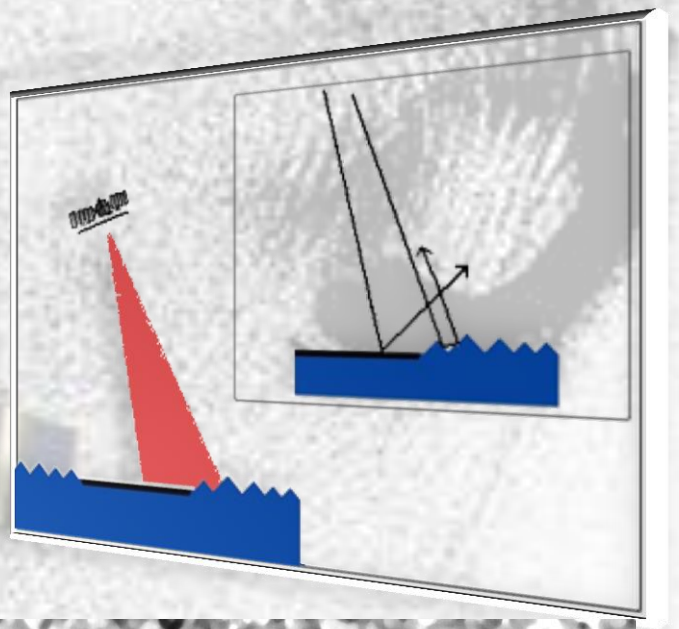


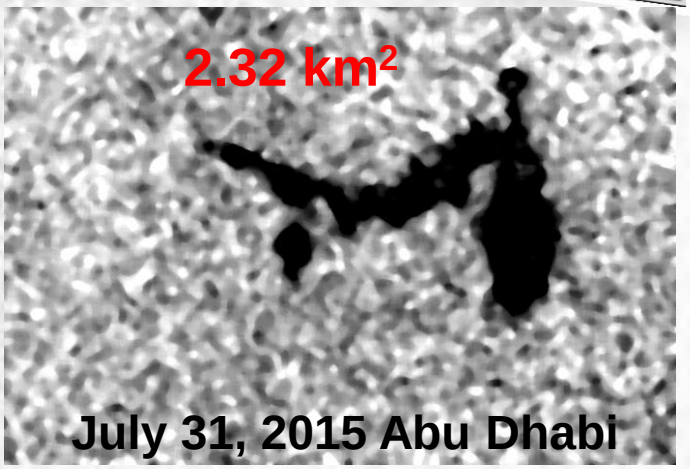




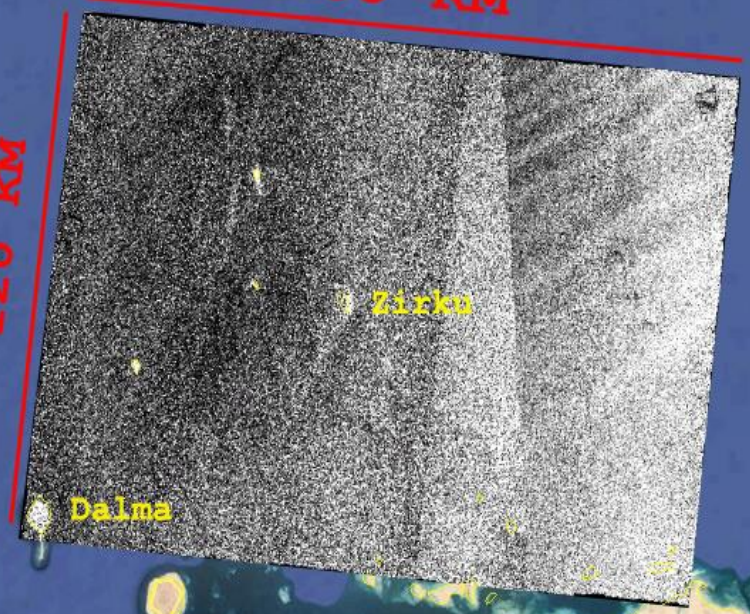
SAR Competence for Oil Spill Detection

- All-weather observation & independent from illumination conditions
- The effect of the oil is to reduce backscatter by suppressing surface capillary waves
- Capable of detecting oil on the ocean surface in light to moderate sea conditions (3-9 m/s)
- Define the position, type and volume of oil spill and work in real time
- Uniquely suited to detect both oil pollution and the ship responsible
- Attention to the looks-like spills





Study Area

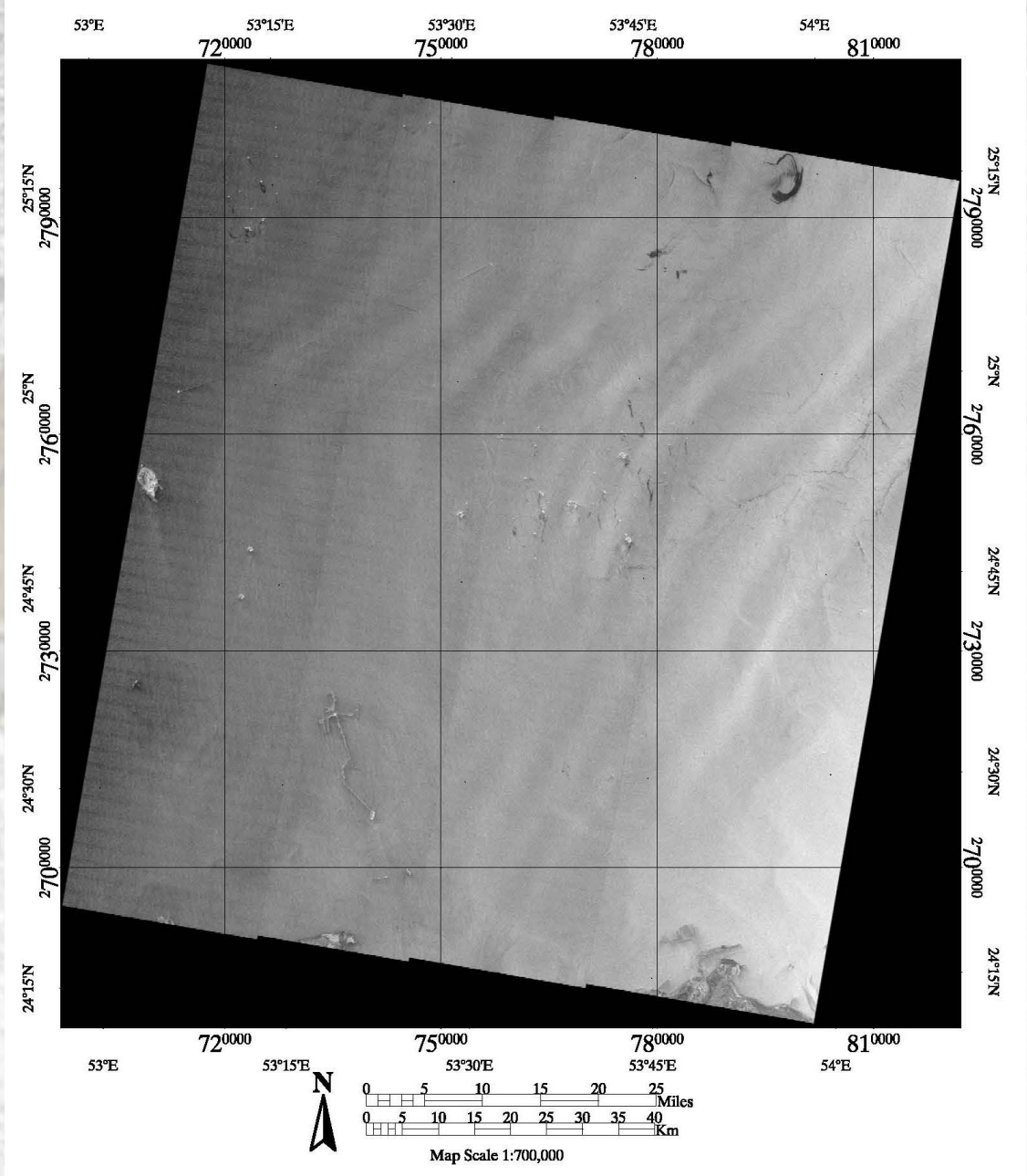


Data set

- KOMPSAT-5 SAR X-Band images
- Enhanced Wide Swath mode (EW)
- Vertical polarization (VV
- Resolution = 7.5 m

Images Preprocessing and product level

- 1C
- Geocoded on the reference Earth Ellipsoid and represented in cartographic projection (UTM)
- The data is aligned with the north direction



Oil Spill Areas Identification

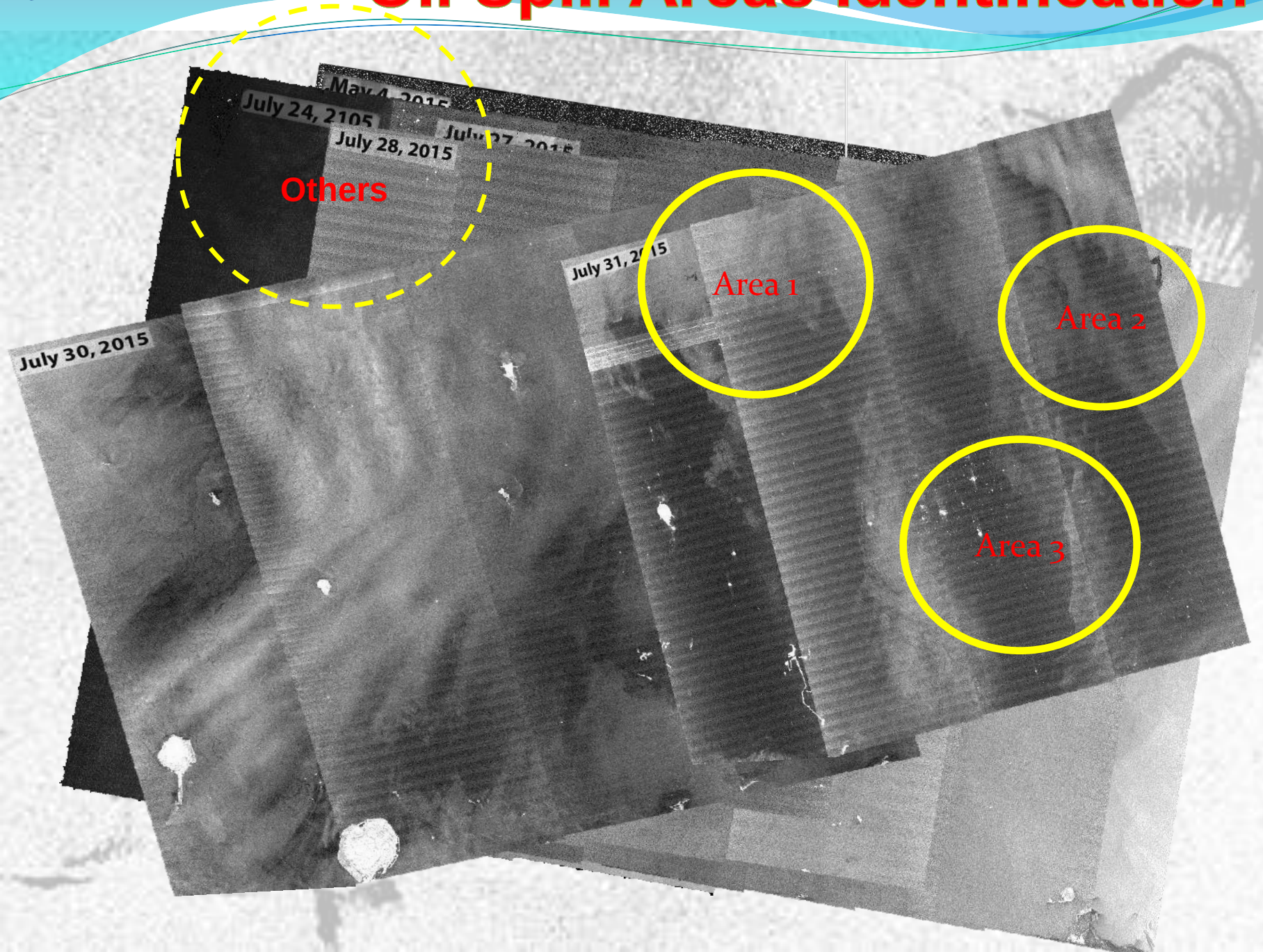
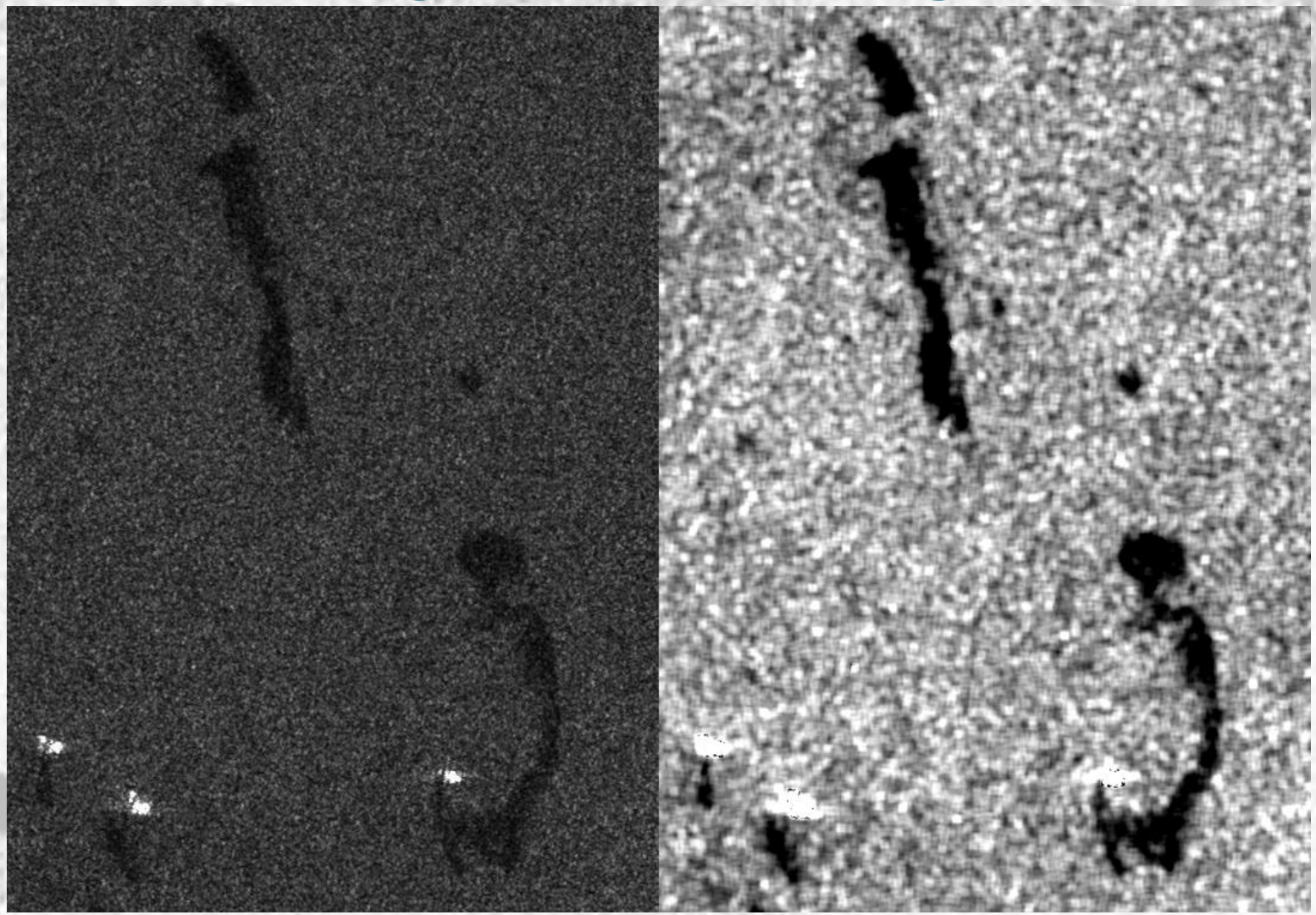


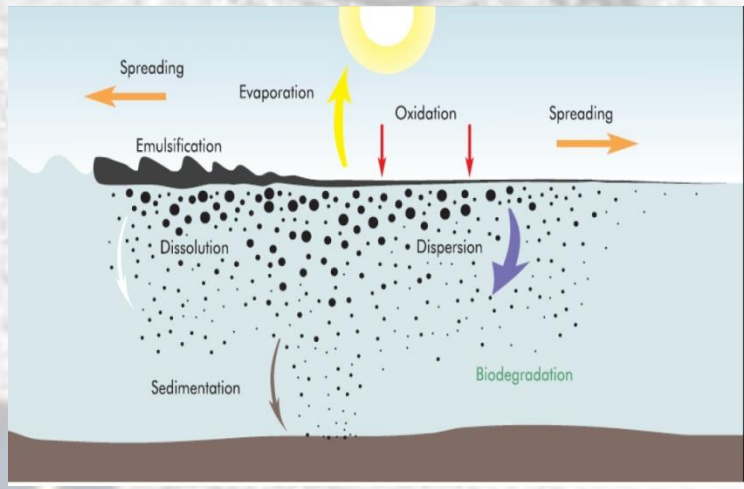
Image Processing



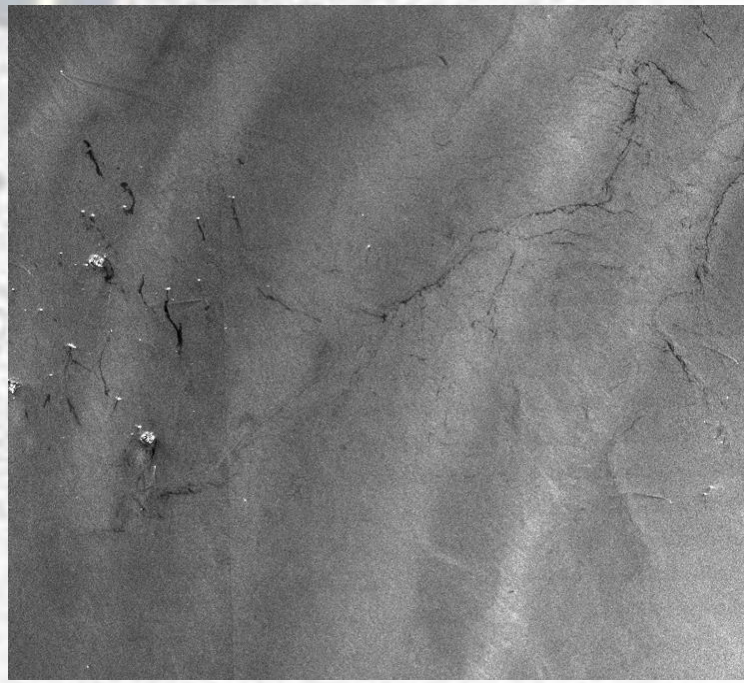
- Images Enhancement & Image Filtering (Gamma (7x7))

Visual analysis and oil spill digitization

- Oil Spill Weathering
  - Few hours to few days!



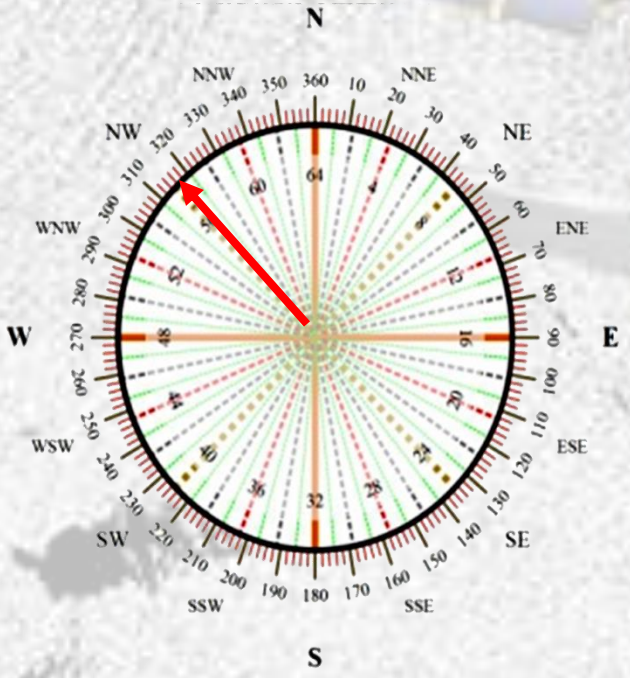
- Looks – like oil spill
  - natural slicks,
  - Wind effects: threshold winds, wind shadows behind islands, winds slicks (calm zones),
  - surface currents,
  - internal waves,



Total = 18.89

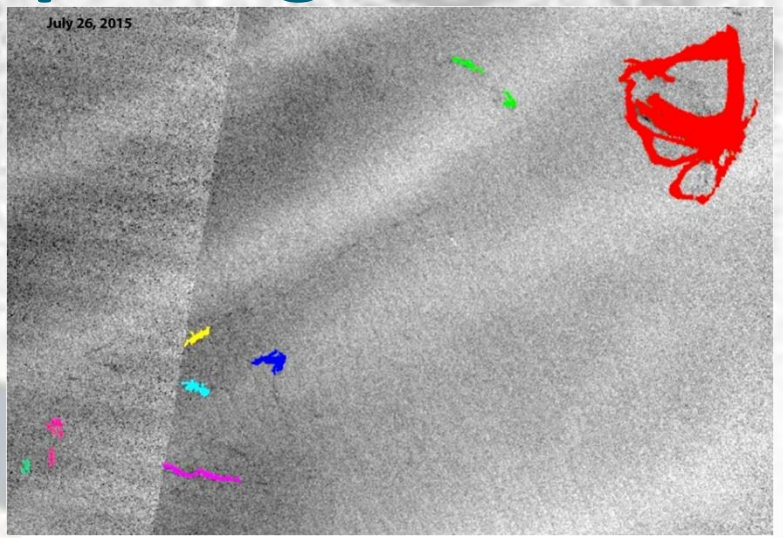
Visual analysis and oil spill digitization

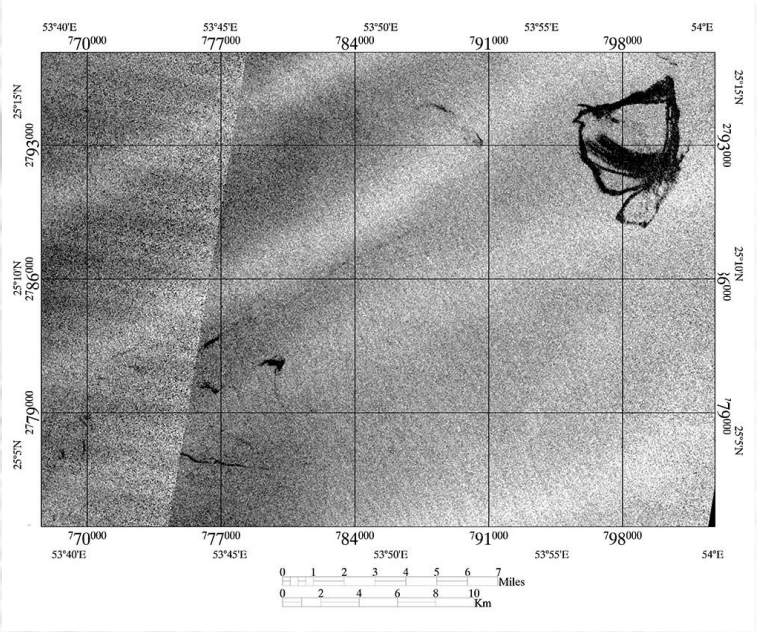
Weather conditions:
Wind (6m/s)Small waves, becoming larger



Area calculation
16.4
0.4
0.6
0.3
0.3
0.5
0.4
0.1

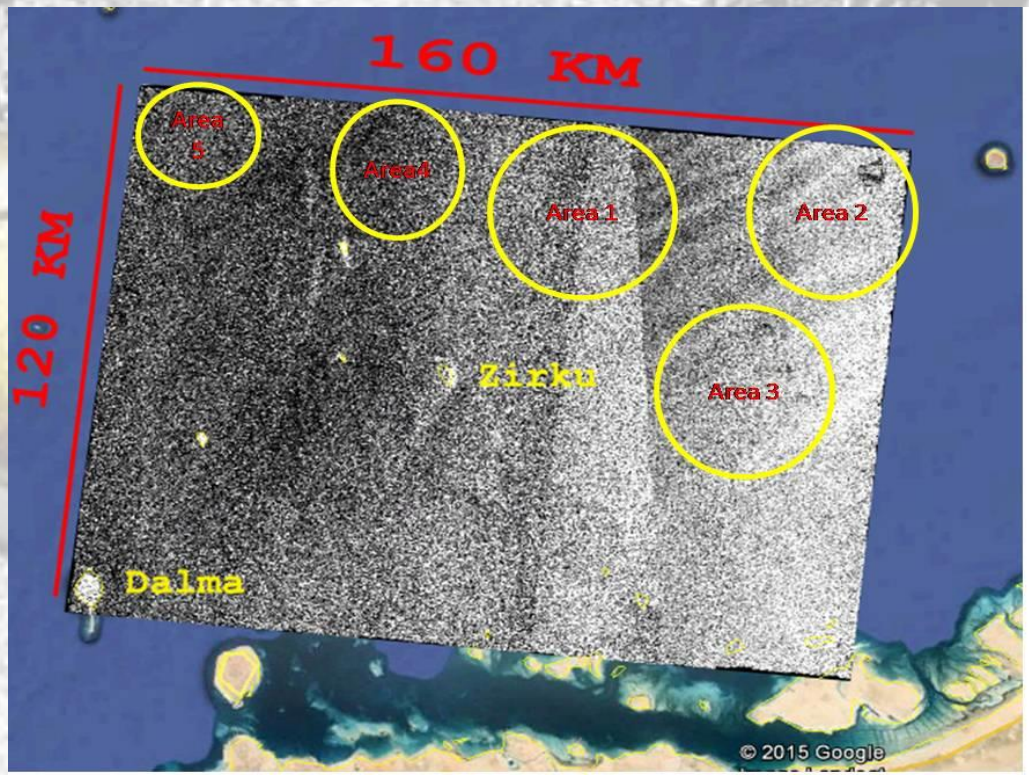
Total = 18.9 Km2



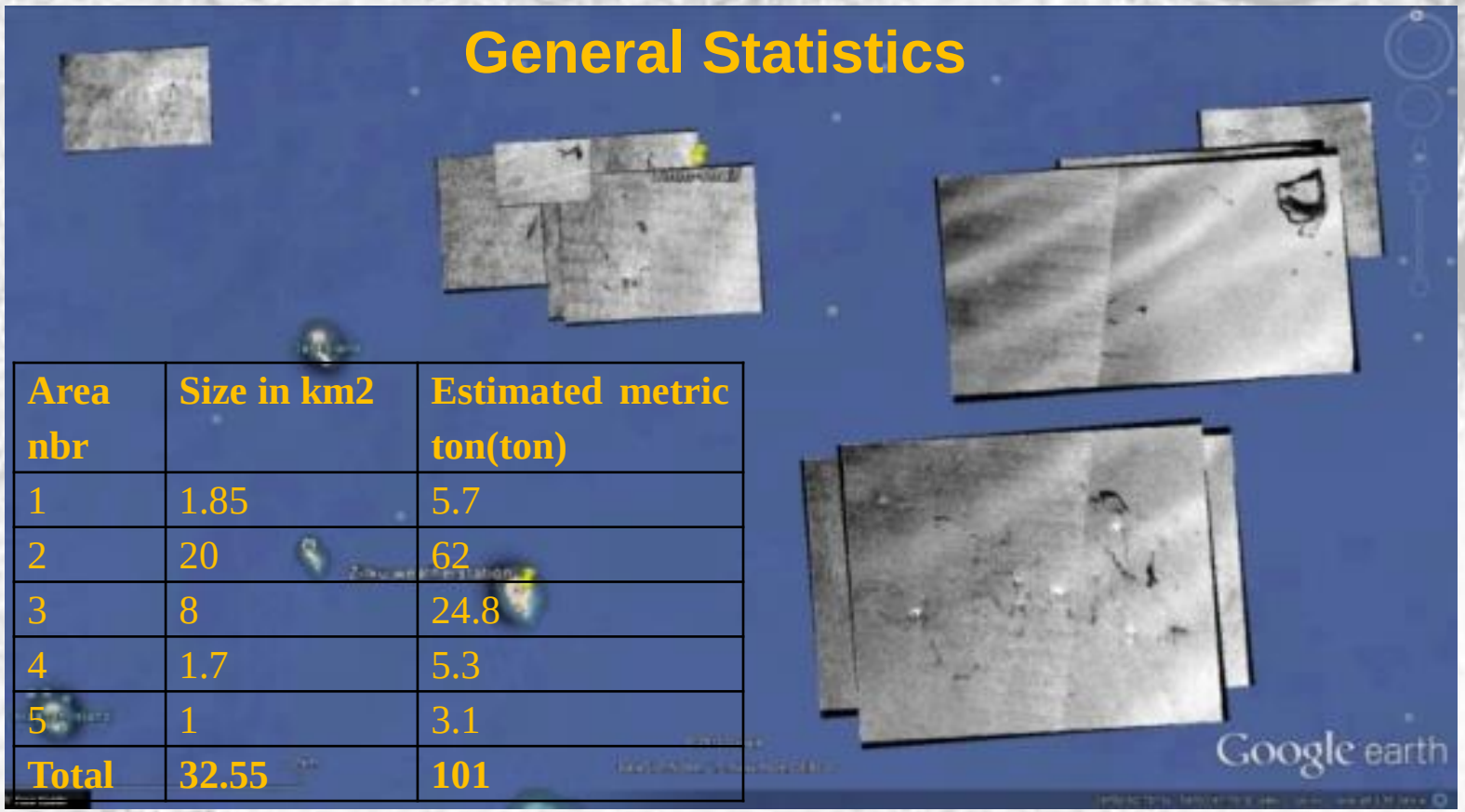


Analysis and Results

- Certain coastal areas of the UAE face frequent oil spills
- 73 oil spills identified and distributed through 14 areas of oil spill
- Mainly in three regions 1, 2 & 3



Analysis and Results



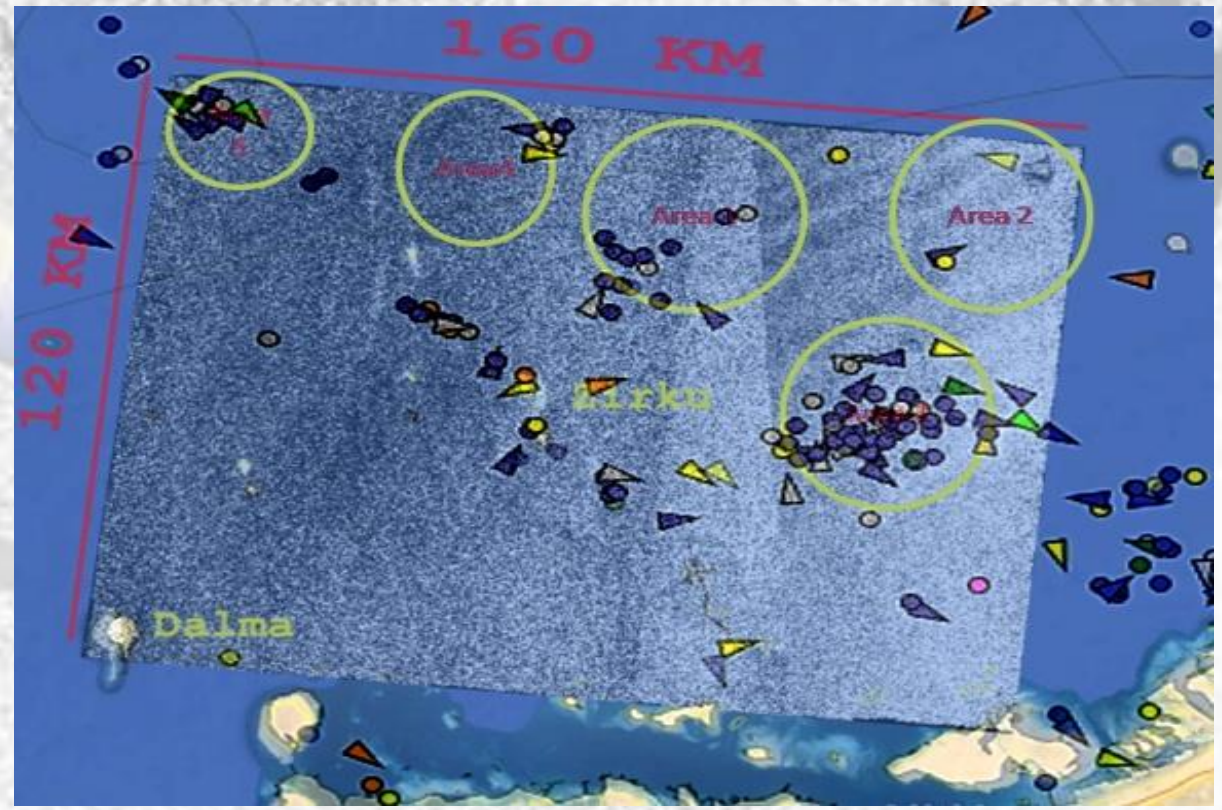
Area nbr	Size in km2	Estimated metric ton(ton)
1	1.85	5.7
2	20	62
3	8	24.8
4	1.7	5.3
5	1	3.1
Total	**32.55**	**101**

- Assuming:
  - Oil density 870 kg/m^3
  - There are in average 3500 litre/km2 (3.1 metric ton/km^2) of oil spill,
- We conclude:
  - total oil spill 32.55 km2
  - will spread 101 tons

Analysis and Results

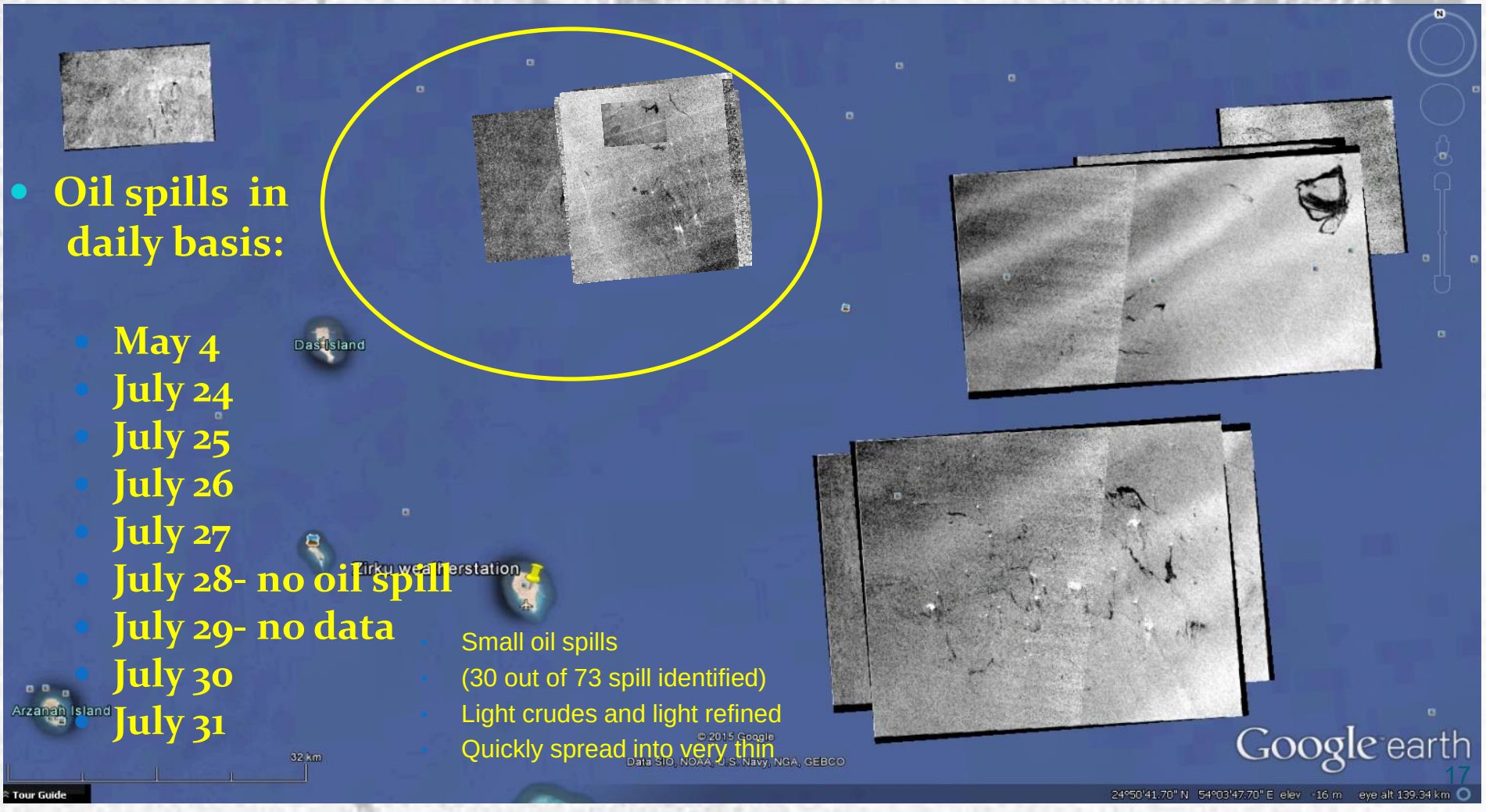
AIS observation

- Concentration of varies type of ship/vessel in the areas, and in particularly in these areas; 1, 2 and 3.
- **Type of ships** include crude oil tankers, Tug/supply vessel, or support vessel, and other type of ship
- Investigation about an accident
- analyses of vessel behavior patterns for potential prosecution



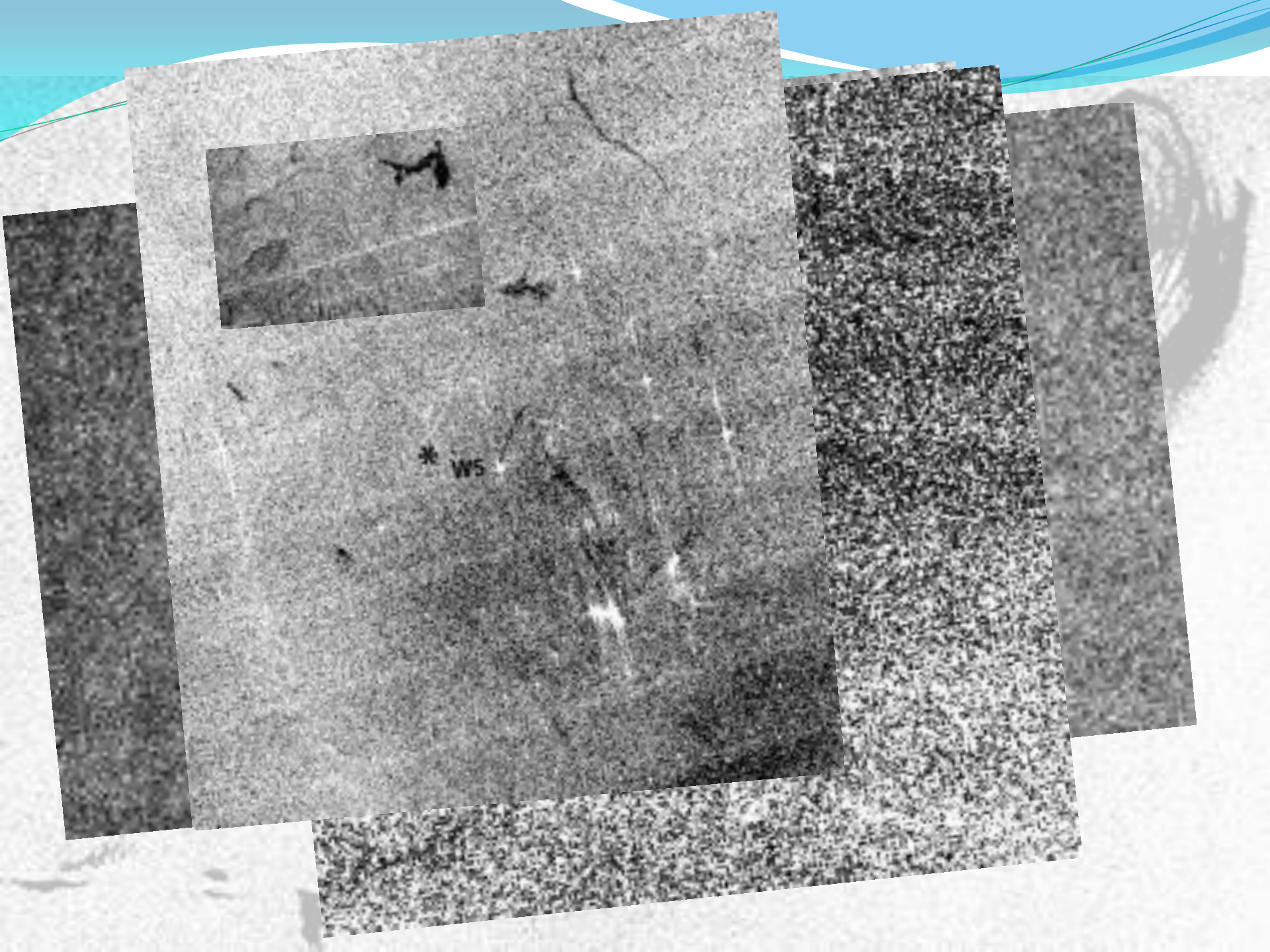
- **Tracing Responsibility (AIS)**
  - Turns on the AIS layer and Oil spill layers.
  - Look at the historical tracks associated with various vessels,
  - Adjusts the timeline as needed to analyze ship traffic patterns,
  - Trying to potentially trace responsibility to a specific vessel.

Oil Spills in Area 1

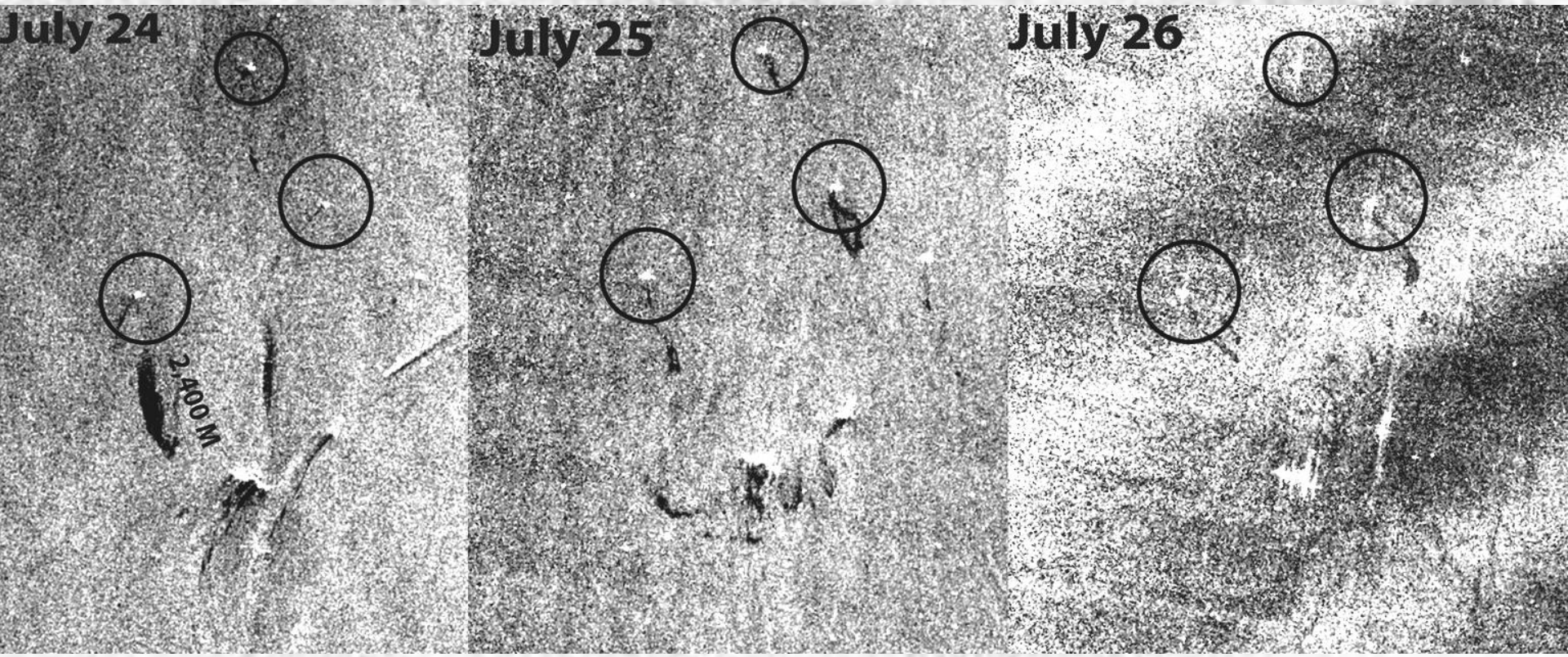


- **Oil spills in daily basis:**
  - May 4
  - July 24
  - July 25
  - July 26
  - July 27
  - July 28- no oil spill
  - July 29- no data
  - July 30
  - July 31

- Small oil spills
- (30 out of 73 spill identified)
- Light crudes and light refined
- Quickly spread into very thin


W5

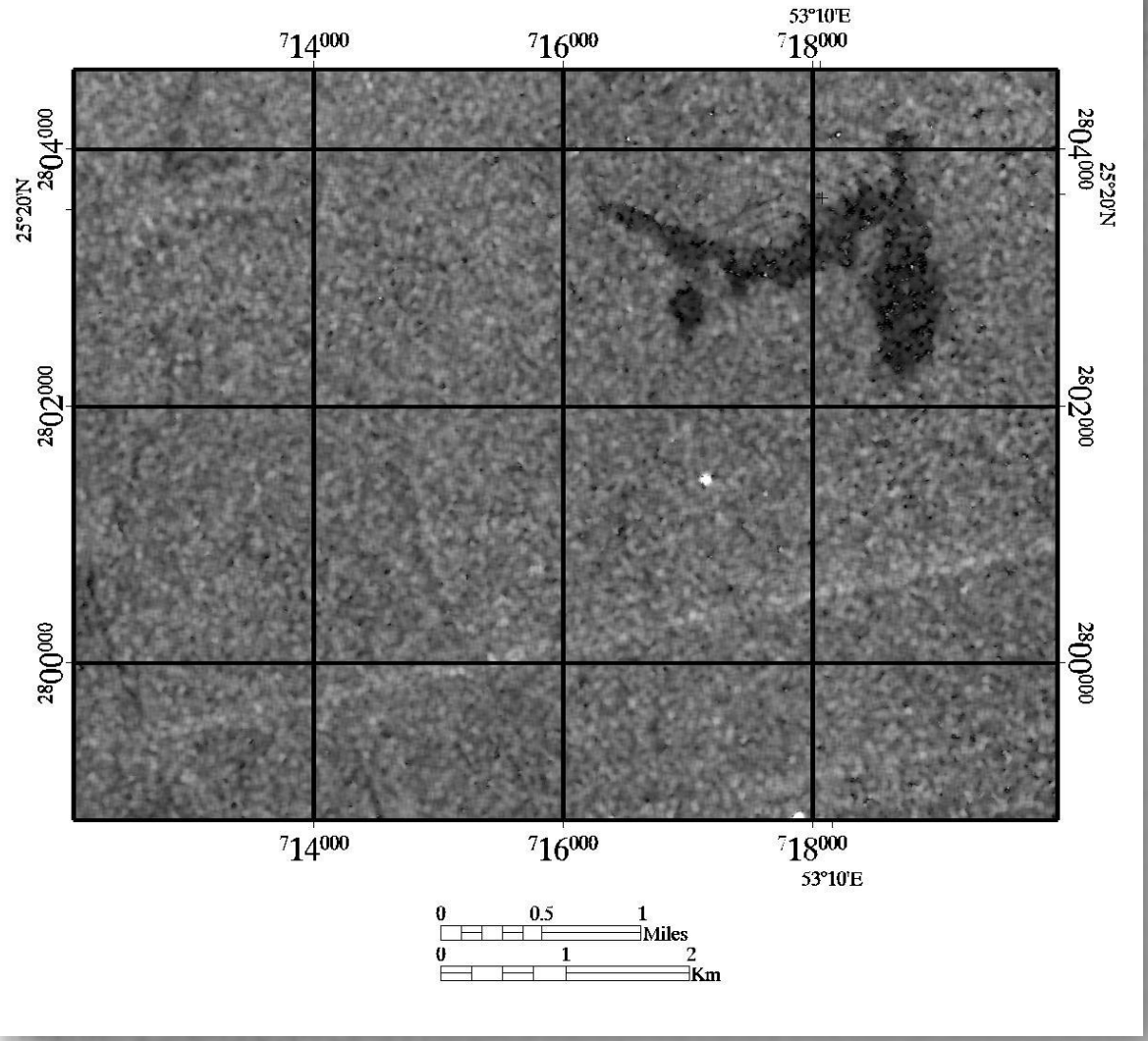
Analysis and comparison – Area1



- Life cycle of an oil spill vary from few hours to few days:
  - type of oil
  - size and quantity
  - weather conditions such as current and wind speed and their directions.
- Fast dispersion
- Daily several release of oil in the water and all disappear deep in the water affecting marine life.
- Length of oil spill may reaches thousands of meters and hundreds of width

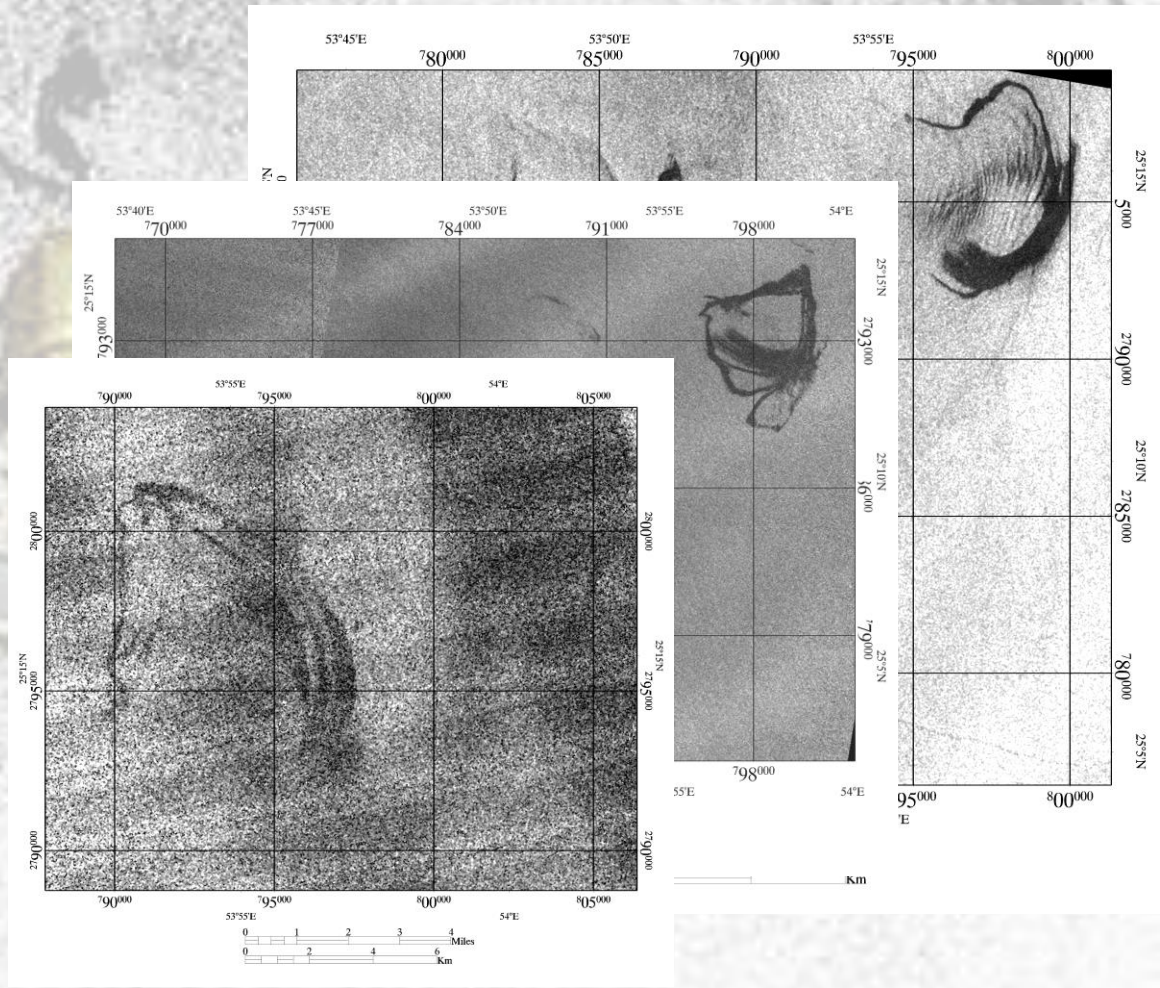
Oil Spill in area 1 with important size

- There are some with important size like the one identified in this region on July 31, 2015.
- It is about 2.32 km2, which could released more than 7 tons of oil!.



Oil Spills in Area 2

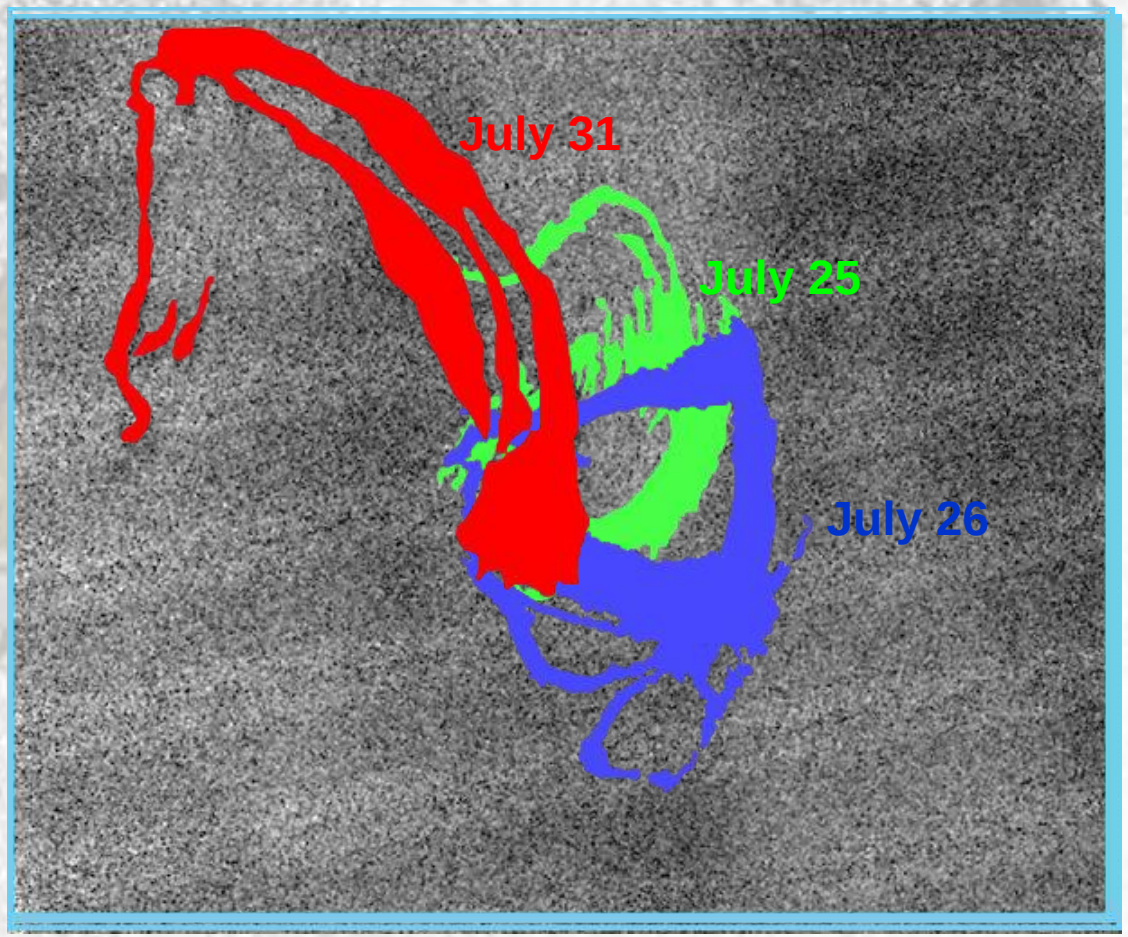
- A serious oil spill (over 14 km²)
- Probably it was released on July 24th or 25th,
- Development of the spill through the following days (about 10 days)
- No announcement about this incident
- About 85 km from thr coast of Abu Dhabi, and about 20 km from Sir Bu Nair Island



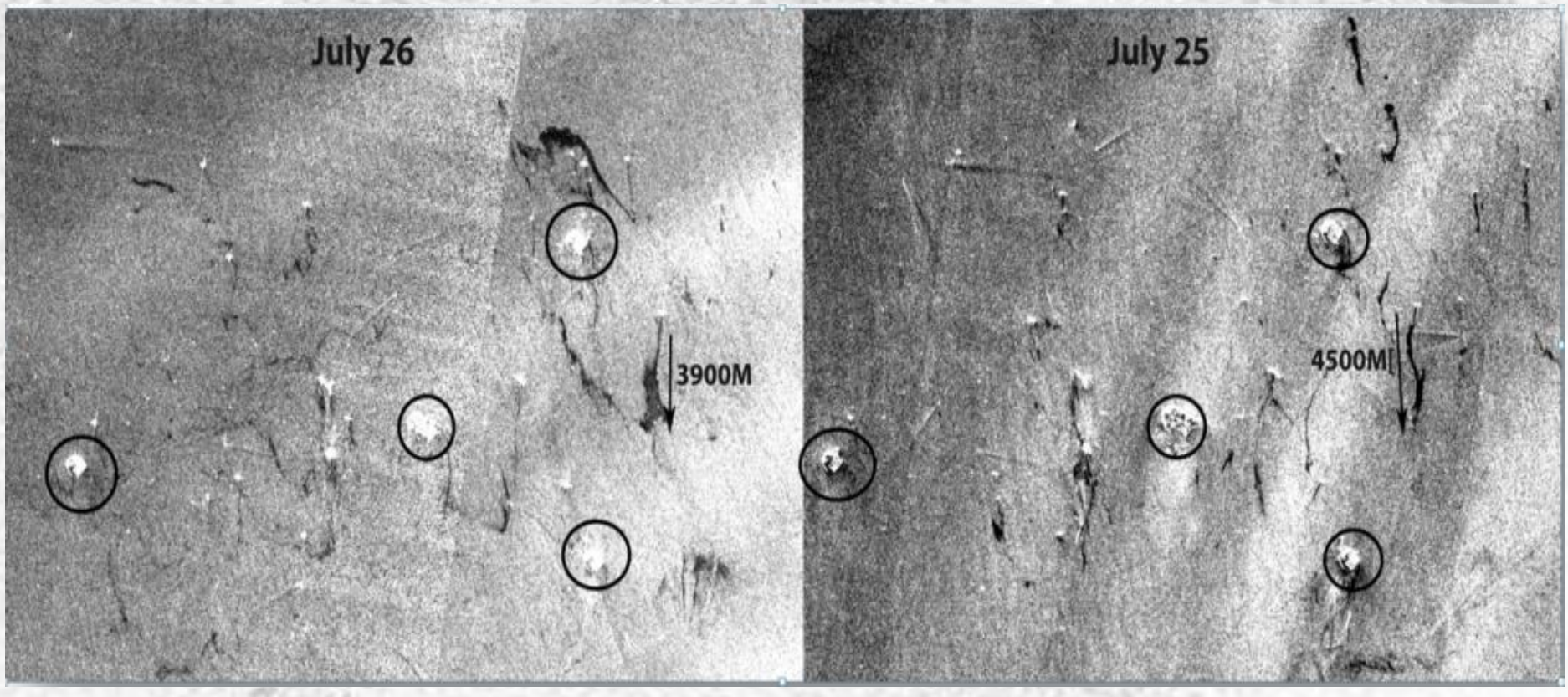
Oil Spills in Area 2

Oil Spill Movement

- Movement is controlled by local climate condition:
  - wind and
  - current,
- Developed almost in the same region.
- Necessitate a continuous oil spill monitoring

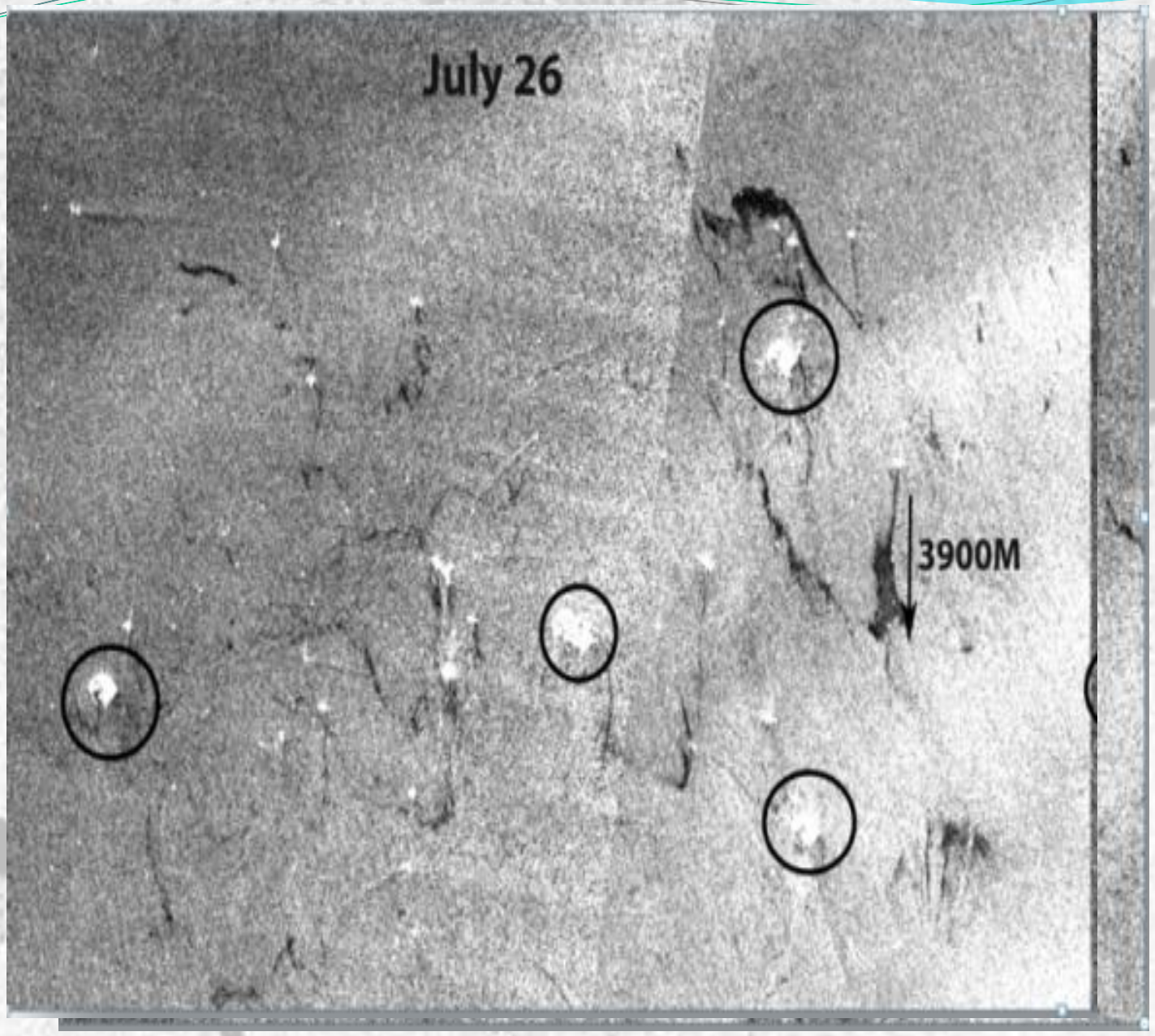


Oil Spills in Area 2



- An intensive movement of ships from different kinds,
- oil production platforms
- Oil spill with length about 5 Km

- Around 20 spills were observed
- Life cycle of these spills: from few hours to two days
- Size of oil spills in this area is about 8 km^2


July 26
3900M

Conclusion-Summary

- Remote sensing technology is very crucial for an effective detection and monitoring of oil spill.
  - Large coverage,
  - High frequency of acquisition
    - Daily coverage and it could be less than daily with the help of more than one satellite
- KOMPSAT 5 SAR proved its capabilities:
  - Detect clearly oil spill,
  - High resolution: identify very small oil spill (0.06 km^2)
  - High frequency of data acquisition(daily coverage)
- Easy to acquire the data and deliver the oil spill report in less an hour
- Adding AIS information could lead to the potential polluters,
- we can claim a near real time oil spill monitoring system.

Conclusion-Summary

- The big number of oil spills is a clear evidence of the problem:
  - Intensive movement of ships: in addition to oil tankers, there are supply and support vessels for the oil production platforms.
- Main causes of oil spill are the illegal actions, in particularly from the discharge of ballast water and the bunkering activities.
- Rapid disappear of the small oil spill(hours), few stay days:
  - All depend on the size and the type of materials, this could be crude oil or light diesel.
- Finally, we recommend to the national authorities to establish a national near-real time oil spill monitoring system based on SAR satellite imagery, with the support of other tools like AIS and navigation radars.

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