UAV applications for oil spill detection, suspended matter distribution and ice monitoring – first tests and trials in Estonia 2015/2016

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Outlook

- Introduction
- Oil spill detection
  - Drone operations
- Sensors
- Suspended matter distribution
- Waves
- Ice monitoring
- Drones
- Summary

Introduction - drone

- DJI Inspire 1
  - Flight time 10 – 20 min
  - RGB camera (RAW+jpg)
  - Wind resistance – 10 m/s
  - Temperature range -10°C to 40°C

  - Relativly cost effective
  - Different camera/gimbal systems and sensors available

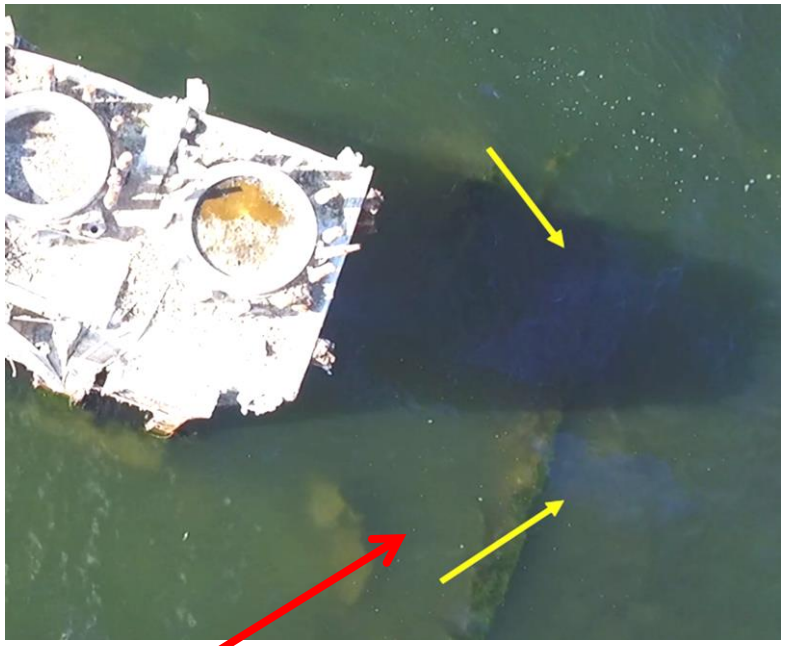
Introduction - drone

- Total flight time over 100h since August 2015
- Total flight distance over 400 km
- Great variability of weather conditions and locations
  - Minimum temp – approx. -24°C
  - Maximum wind speed – approx. 15 m/s
  - Maximum altitude – 500 m above sea level
  - Operations carried out mostly from shore, but also include small rowboat and research vessels
  - Operations both above open water and ice covered sea

Oil spill detection

- Visual camera sensor not perfect for oil spill detection
  - Difficult to distinguish oil from the background
  - Sun glint
  - Wind sheen
  - Sea weeds
  - Cannot operate at night
  - No methods to ensure the positive detection
  - The angle of the light
  - Seasonal differences
  - Reflections from waves and surface
  - Flight height
  - Wind, rain, snow etc
  - + Useful for documentation
  - + Cheap and widely available
  - + Easy to operate

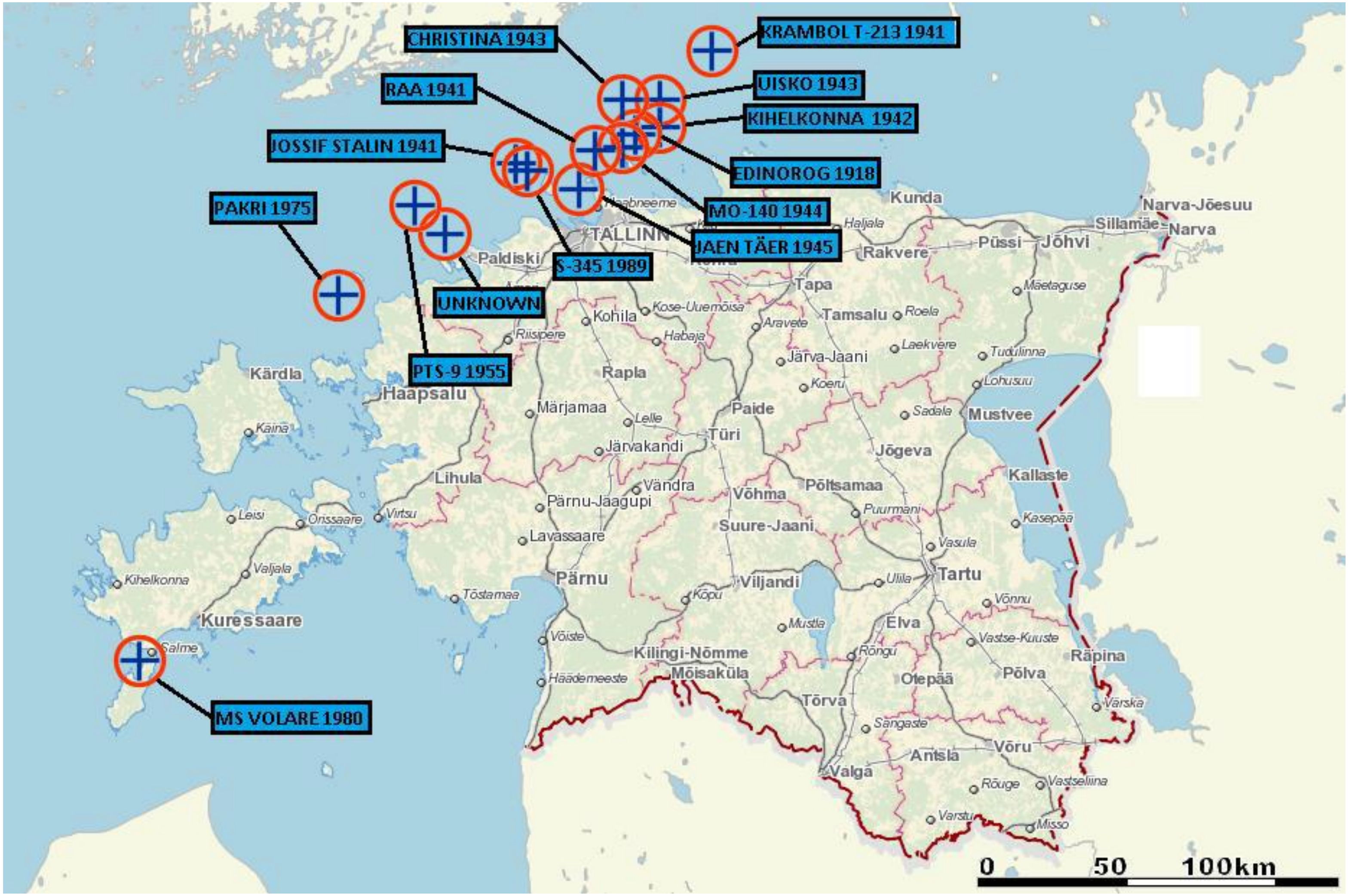
Oil spill detection



Drone photo from above, viewing remaining of the main engine of MS VOLARE wreck, arrows point on detectable oil slicks originating from the wreck

Near shore pollution as registered by UAV camera

MS Volare



CHRISTINA 1943
KRAMBOL T-213 1941
RAA 1941
UISKO 1943
KIHELKONNA 1942
JOSSIF STALIN 1941
EDINOROG 1918
PAKRI 1975
MO-140 1944
JAEN TÄER 1945
S-345 1989
UNKNOWN
PTS-9 1955
MS VOLARE 1980
TALLINN
Paldiski
Haapsalu
Kärdla
Kuressaare
Pärnu
Tartu
Narva
Rakvere
Viljandi
0
50
100km

MS Volare wreck after the salvage

Sensors

- Visual sensors – airborne and satellite
- Infrared and thermal infrared sensors
  - Probably the most applicable sensor to different types of UAVs
- Fluorosensors
  - Good pontential
- SAR
  - Many positive sides
- Lidar

Sensors

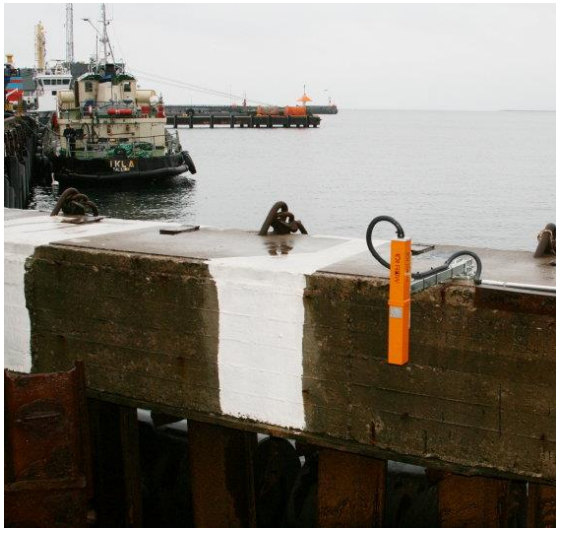
- Hyper-spectral
  - + Large spectral coverage = lot of information
  - - Not applicable to every type of UAVs

- Usage of filter to have different spectral bans
- Lightweight
- Saves image location

- Takes approx. 10 s to capture the image

Sensors – airborne fluorosensor (LDI Innovation)

- Heavy
- Maximum detection height approx. 10m
- Information from single point = underwater buoy stations



Sesnors – Lidar (LDI Innovation)

- Very heavy
- Single point measurements
- Gives specific parameters of oil

Other activities

Suspended matter distribution

Suspended matter distribution

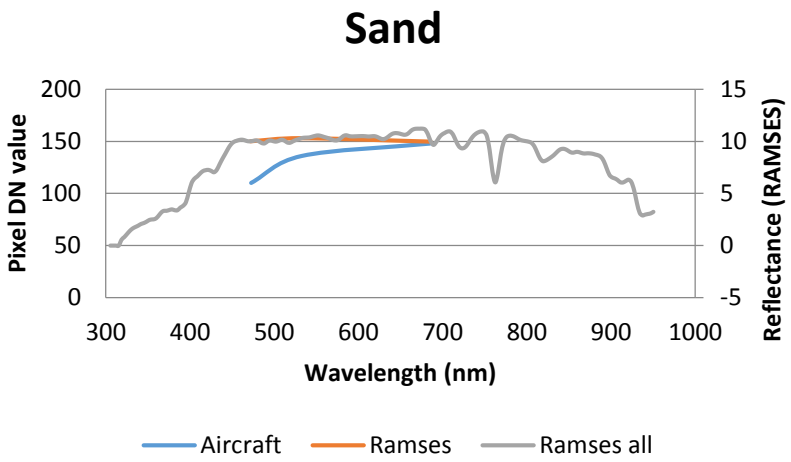
Suspended matter distribution

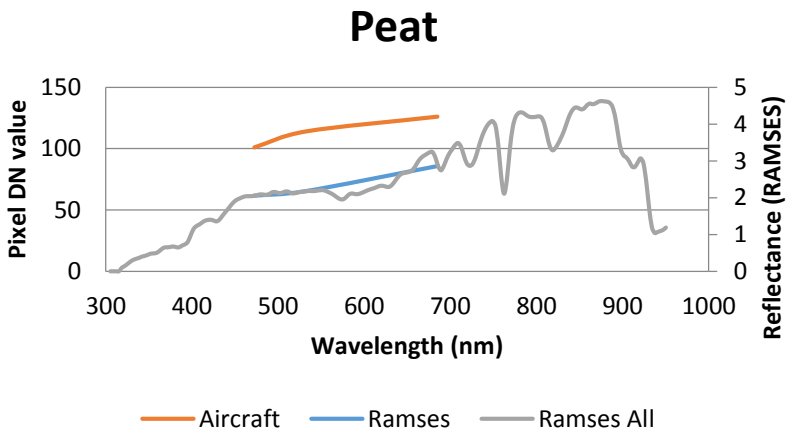
River runoff

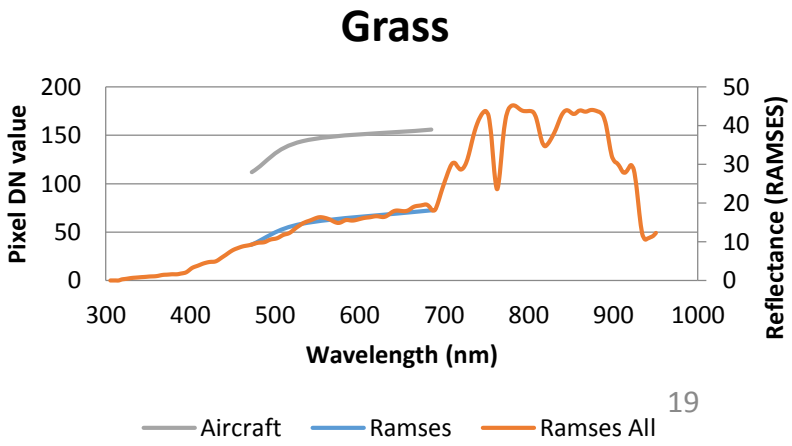
Ship maneuvering

Field tests – RGB spectrum

- Inspire 1 pixel values are compared with RAMSES (Radiation Measurements with Enhanced Spectral resolution) measurements
- Four diferent ground types were measured – sand, peat, grass and soil (not presented here)
- RGB values from aircraft are in good agreement with same values from RAMSES instrument in terms of shape

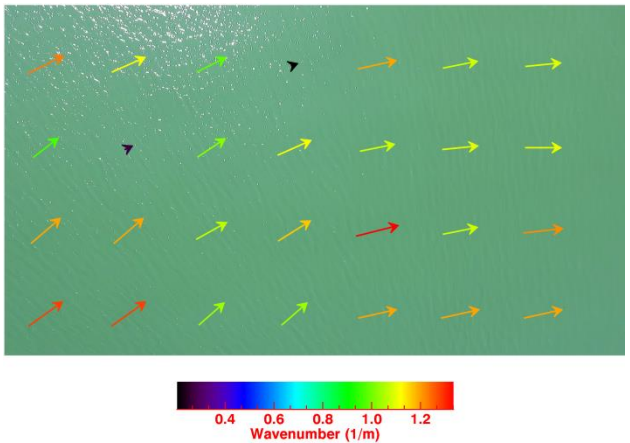


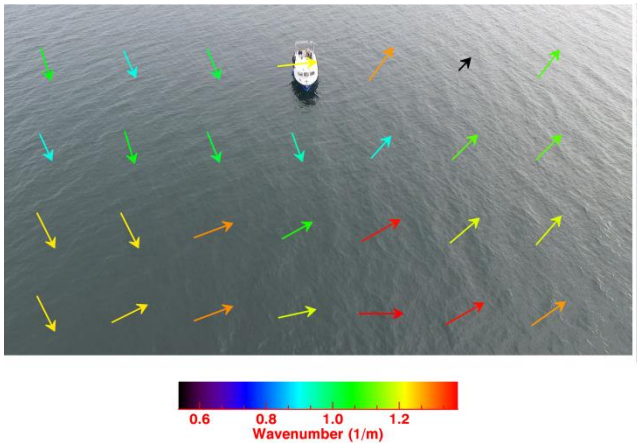


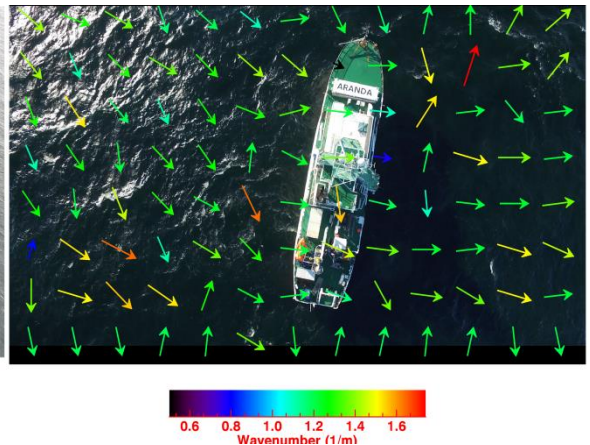


Waves

- As known, waves are important aspect of oil spill behavior
  - Wavelength estimations quite straightforward
  - Wave height estimation is extremly demanding, but possible







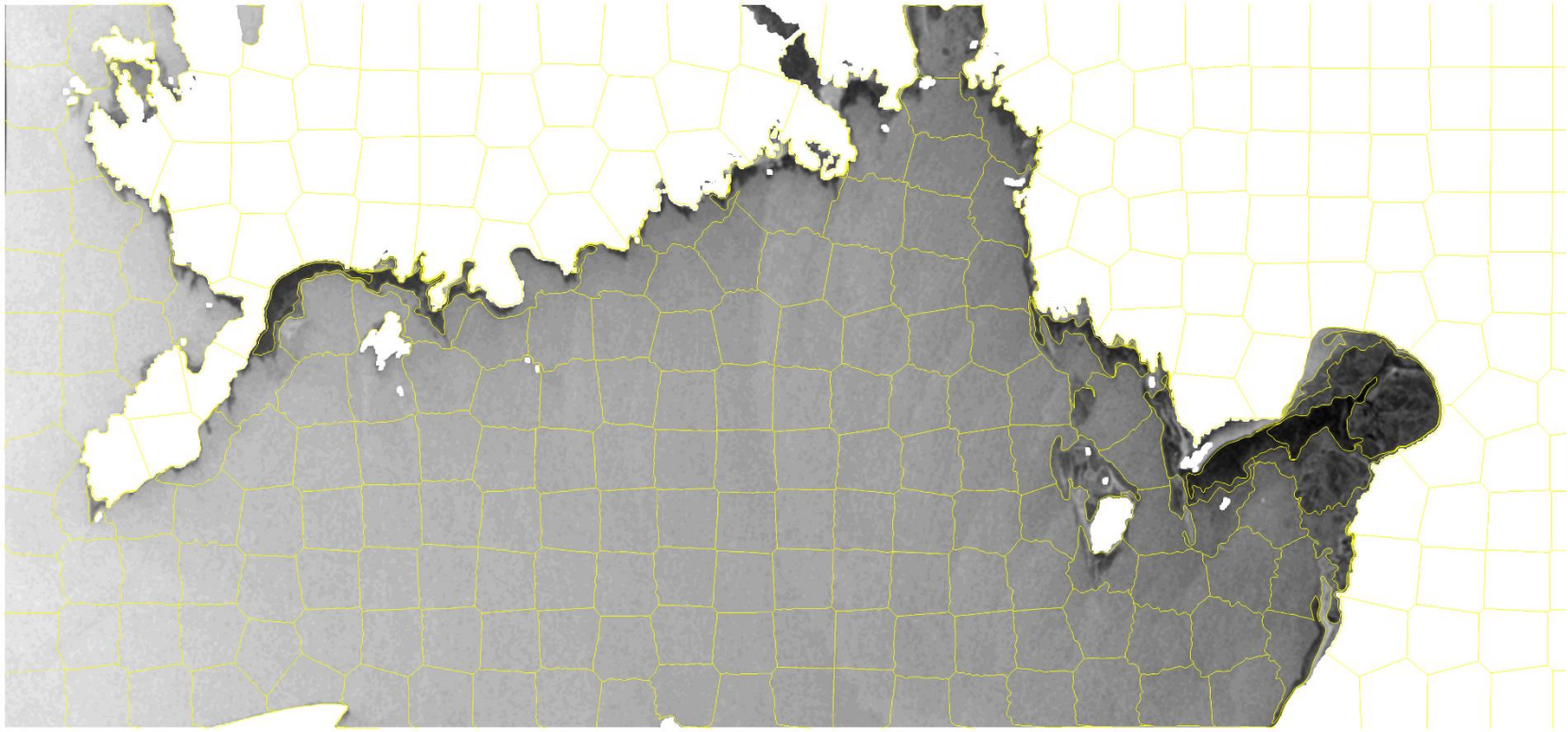
Wave height from camera image

- Extremly demanding task
  - UAV attitude (roll, pitch, yaw) and altitude, camera orientation must be known
  - UAV should able to fly around 1h over the wave buoy
  - Gamma corrections made by camera not known
  - Illumination of the scene
    - A sky panorama is needed
    - Complete cloud cover or completely clear sky needed
  - Atmospheric conditions must be known
  - Measured 2D spectra from a wave buoy

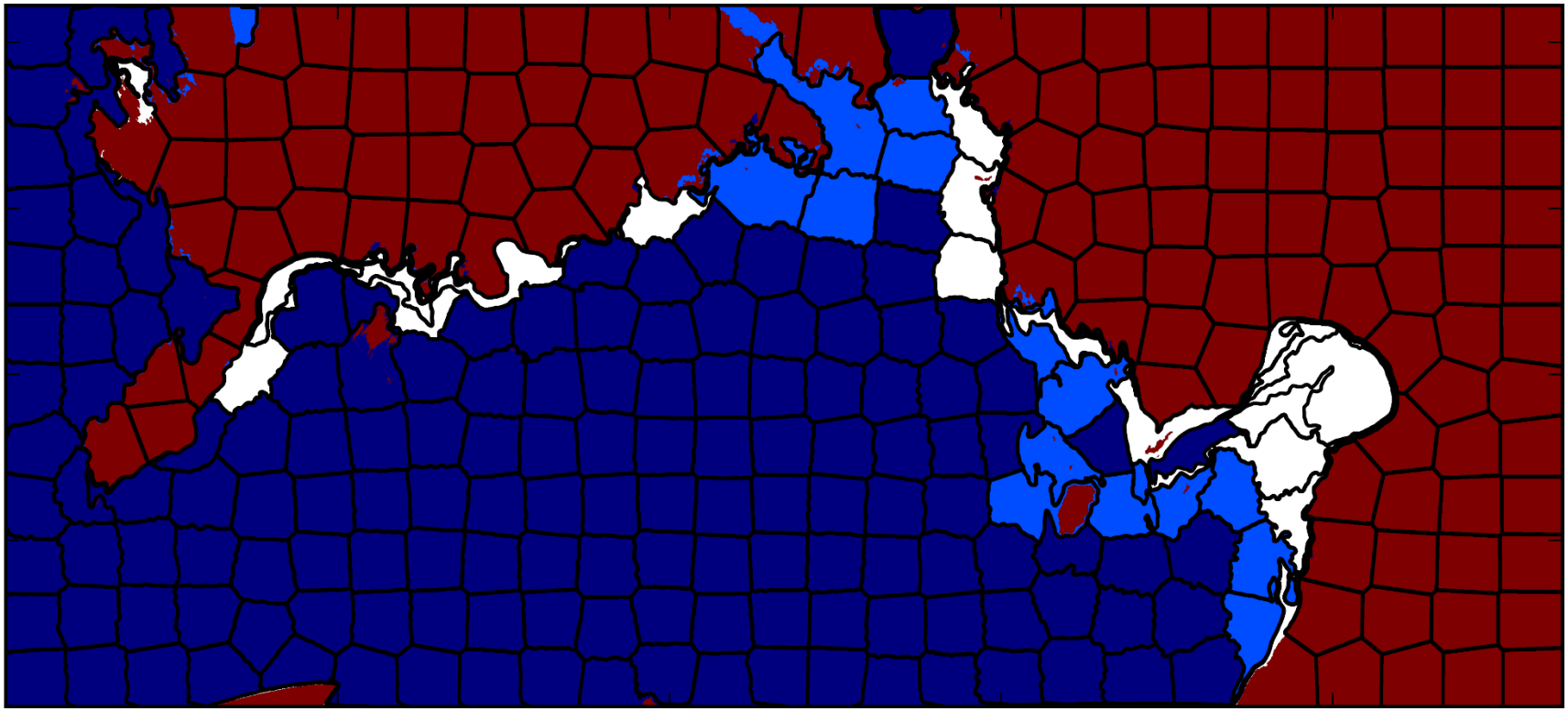
Ice monitoring

- Mostly used for determing whether there is ice or not
- „validation“ against SAR imagery
- Lots and lots of images of ice and its formations in different locations and conditions
- Monitoring of ice breaking activities

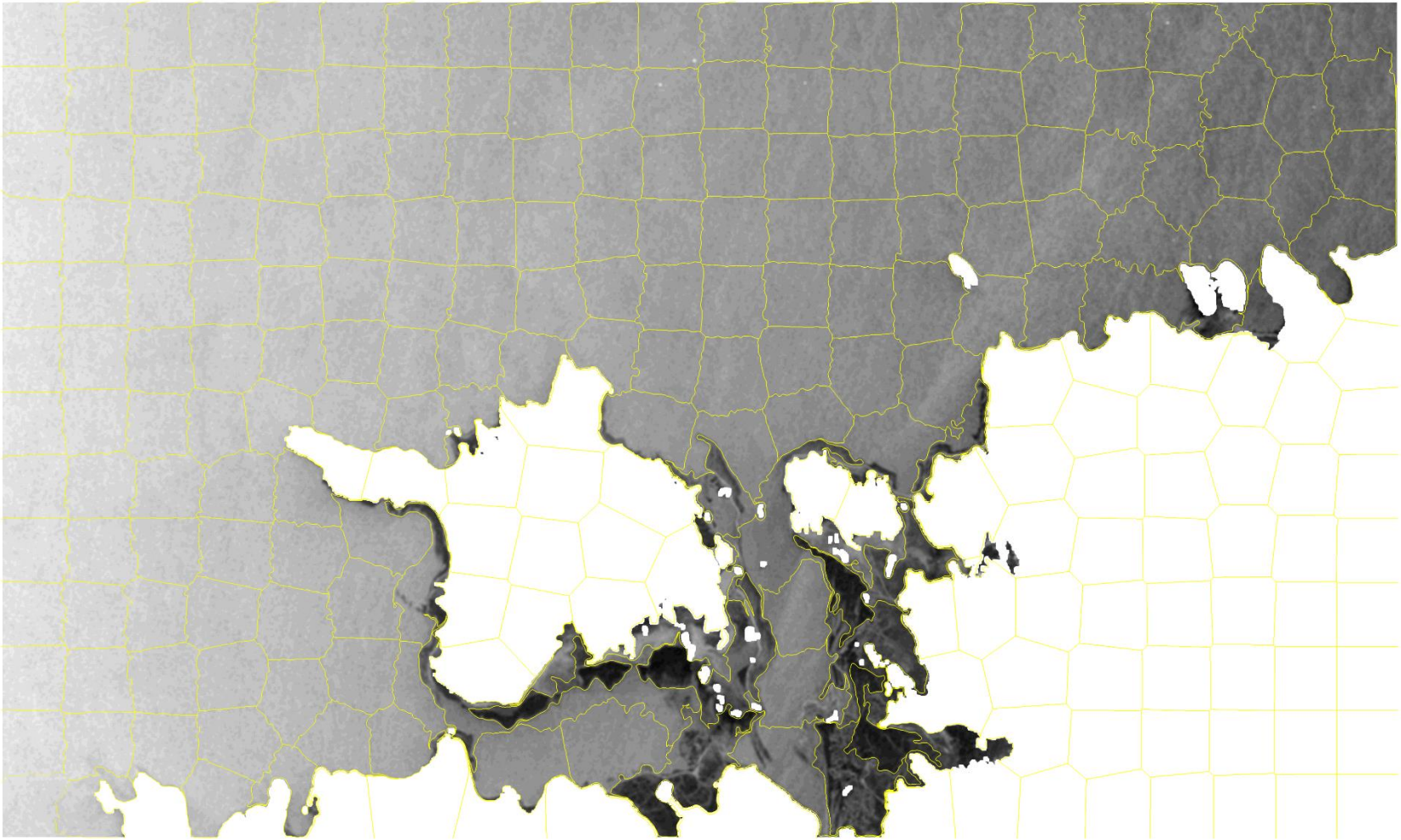
SAR image over the GoR



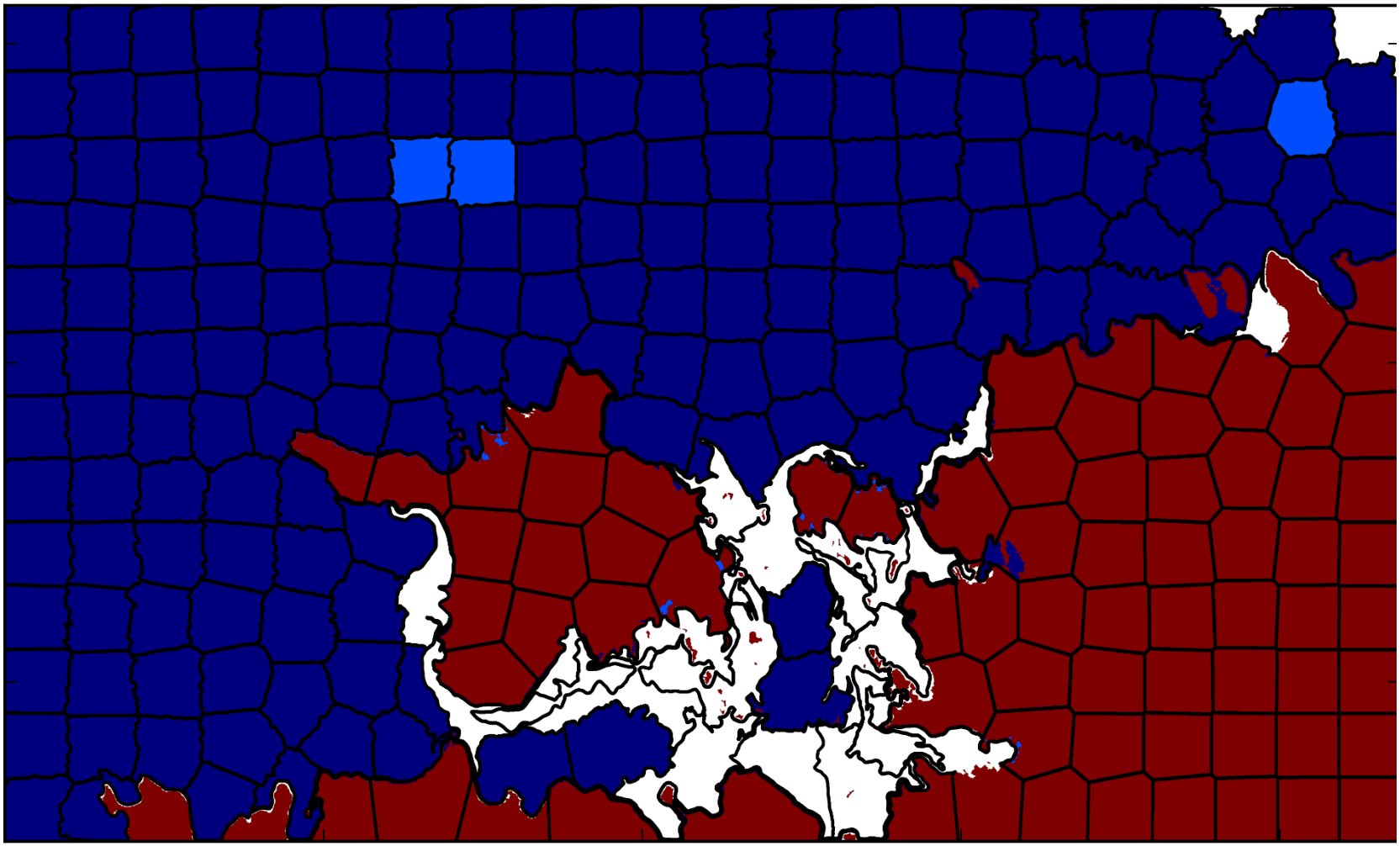
Ice classification map



SAR image over Väinameri



Ice classification map



Drones

Fixed wings

- Great flight distances
- Great coverage
- Can carry many sensors

- Real time information might not be available
- Wave height analysis not available
- Takeoff and landing might be problematic

Multirotor

- Able to measure at certain location
- Can carry many sensors

- Battery life
  - Bad flight time
  - Not that good area coverage

Summary

- Current technology has been very successful
  - Lot of experiences in many situations
  - Proves its usability
  - Not at its full potential yet

- Ideal solution would include different types of drones
  - Different sensors at the same time (fixed wings UAV)
  - Specific sensor (multirotor) to measure specific parameters of oilspill and waves
  - Great software-wise control over drones

Thanks for your attention

And of coarse, drones are good for photo- and videography