Advanced Inteligence Decision Support System

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INTRODUCTION

- **Advanced Inteligence Decision Support System (AI DSS) consist of:**
  - *Multisensor (multi and hyperspectral) system for airborne data aquisition.*
  - *Decision Support System (DSS) for support and help to decision making in conditions of uncertainty, on the basis of existing and collected data.*

MULTISENSOR (MULTI AND HYPERSPECTRAL) SYSTEM FOR AIRBORNE DATA AQUISITION

- **Multispectral frame camera DuncanTech MS4100**
  - *MS4100 digital frame camera (1920x1020 pixels) fitted with a single lens and three separate CCD areal arrays.*
  - *Record images of the same scene in four separate spectral bands simultaneously to generate either a true-colour or false-colour image.*
  - *Spectral range from 0,4 to 1,1 μm.*
- **Hyperspectral line-scanner – Imspector V9**
  - *Collecting data in 95 channels in spectral range from 0,43 to 0,93 μm.*

MULTISENSOR (MULTI AND HYPERSPECTRAL) SYSTEM FOR AIRBORNE DATA AQUISITION - 2

- **Digital frame camera Nikon D90**
  - *12.3 MP (4288 x 2848 pixels),*
  - *CMOS DX (15.8 x 23.6 mm).*
- **Digital thermal frame camera Photon 320**
  - *Spectral range from 8 to 14 μm.*
- **Inertial navigation system (INS)**
  - *Required for imagin mode for V9.*
- **GPS devices for navigation**

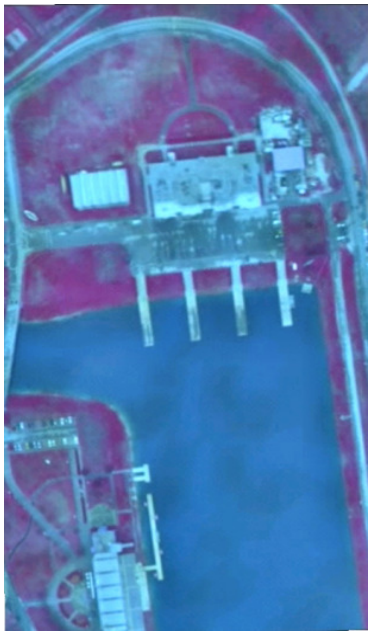
MULTISENSOR (MULTI AND HYPERSPECTRAL) SYSTEM FOR AIRBORNE DATA AQUISITION - 3

- **Sensors's pod on Mi-8 platform.**

- **Sensors's pod with multi and hyperspectral sensors, and INS.**

MULTISENSOR (MULTI AND HYPERSPECTRAL) SYSTEM FOR AIRBORNE DATA AQUISITION - 4

Color – Infra Red	Thermal Infra Red	Hyperspectral	Color photo
4 channels	**1** channel	**95** channels	**3** channels
MS 4100	**Photon 320**	**Imspector V9**	**Nikon D90**



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DECISION SUPPORT SYSTEM

- The DSS based on the SMART methodology (2001-2004), but independent on sensor types is from 2008 and in the operational use.
- The concept and the functions of the DSS are the symbiosis of a specific "archeology (due to temporal scale of 21 years)" and military reconnaissance and surveillance (postponed many years after the battle activities).

DECISION SUPPORT SYSTEM - 2

- The DSS was designed for analyzing and processing all accessible compatible data, information and expert knowledge about some particular scene and specific phenomenon on it.
- DSS provide end-users methodological tools for processing multi and hyperspectral, contextual data and expert knowledge.

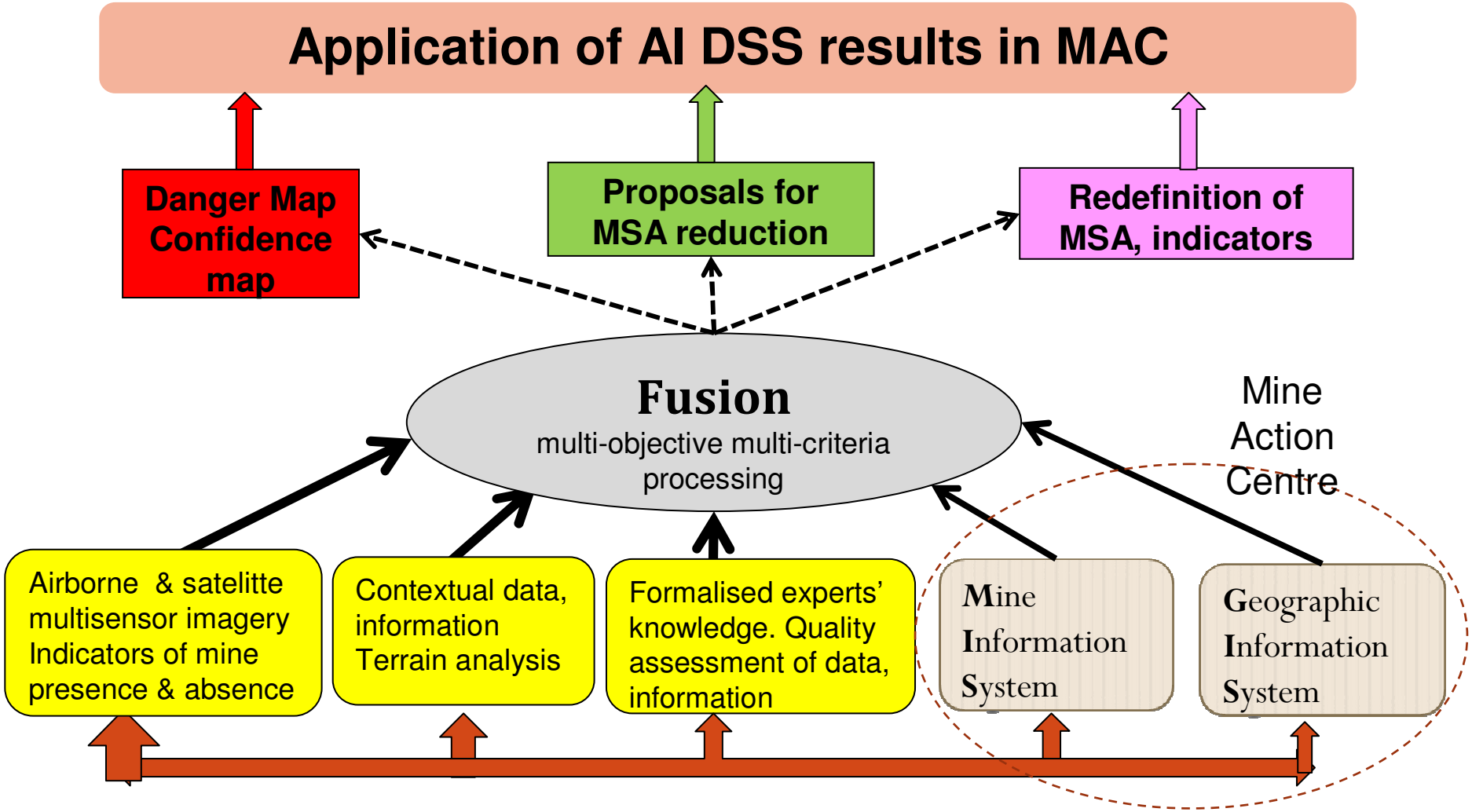
DECISION SUPPORT SYSTEM - 3

- **Metodologies used in MAC:**
  - *MIS (Mine field records, incidents, accidents, survey)* & *GIS (*Croatian Base Map, 1:5000 (*HOK),* Topographic Map, 1:25000 (T*K25), Digithal Orthophoto (DOP5, 1:5000; DOP2, 1:2000).*
  - *Scanned military maps.*
  - *War history data, data about explosive and landmine obstacles, 3D visualisation of the terrain.*

DECISION SUPPORT SYSTEM - 4

- **Metodologies used in AI DSS:**
  - *MIS, GIS, scanned military maps, war history data, data about explosive and landmine obstacles, satellite multispectral images, satellite digital elevation model (DEM).*
  - *Analytic estimation of the mine suspected area (MSA). Control and statistical evaluation and quality assessment of all data sources.*
  - *Detection of the indicators of mine presence (IMP) and mine absence (IMA) in the satellite images, airborne multisensor images, DOP (if available).*
  - *Collecting and processing of the contextual data and information.*
  - *Formalisation of experts' knowledge (membership function, relative importance of IMP, need to link the spatial and attribute data).*
  - *Spatial analysis of the terrain.*
  - *Classification, fusion, multi-objective, multi-criteria processing.*
  - *Derivation of the maps: danger map, proposal for reduction, confidence map, map of conflicts between MIS and AI DSS data.*

DECISION SUPPORT SYSTEM - 5



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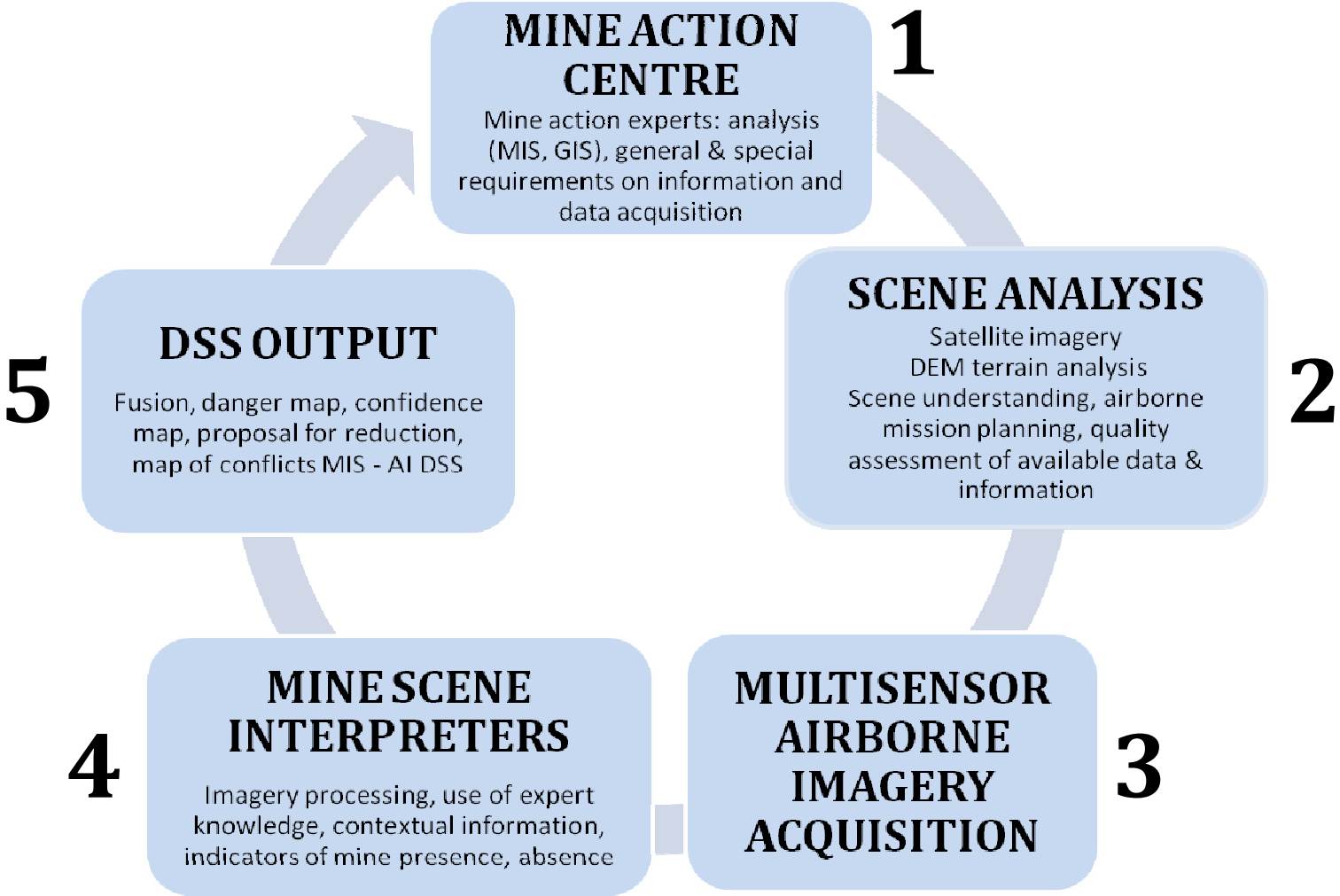
THE AI DSS USABILITY

- **Usability of the AI DSS based on airborne and space borne assets.**
  - AI DSS based on space borne and airborne assets is aimed and suitable for: areas where access is not possible on the ground, or where ground based technology is to costly. Terrain without snow, forests, crop fields without leaves.
  - Mine Action Centre shall provide available MIS and GIS data, scanned military maps, war history documents (if exist).
  - Experts for deployment of the explosive and land mine obstructions, military experts which know war history on the considered terrain, experts for mine action, shall derive general and special requirements regarding the difference between available and needed information and data, that should be provided by application of a AI DSS.

APPLICATION OF RESULTS OF AIDSS

- The proposals of AI DSS are based on the derived evidences, provided by measure of the confidence and they are delivered to the the decision makers in Mine Action Centers (MAC) authorised for MSA reduction and the general survey in MAC.
- The proposals given by AI DSS technology are conservative, they claim only the evidences of highest reliability.
- The decision makers in MAC examine, check and verify evidences of the proposals given by AI DSS, resolve the data conflicts and make decision about MSA reduction or including into MSA.
- The AI DSS Technology matches the variety of mine action status in the considered country and is based on the tight cooperation between the AI DSS team and the experts for general survey in MAC.

PILLARS OF AI DSS TECHNOLOGY



STRONG INDICATORS OF MINE PRESENCE

- Indicators of mine presence (IMP) and indicators of mine absence (IMA) are derived by project's methodology using all kinds of available imagery, especially of imagery collected in multisensory aerial reconnaissance and surveillance missions.

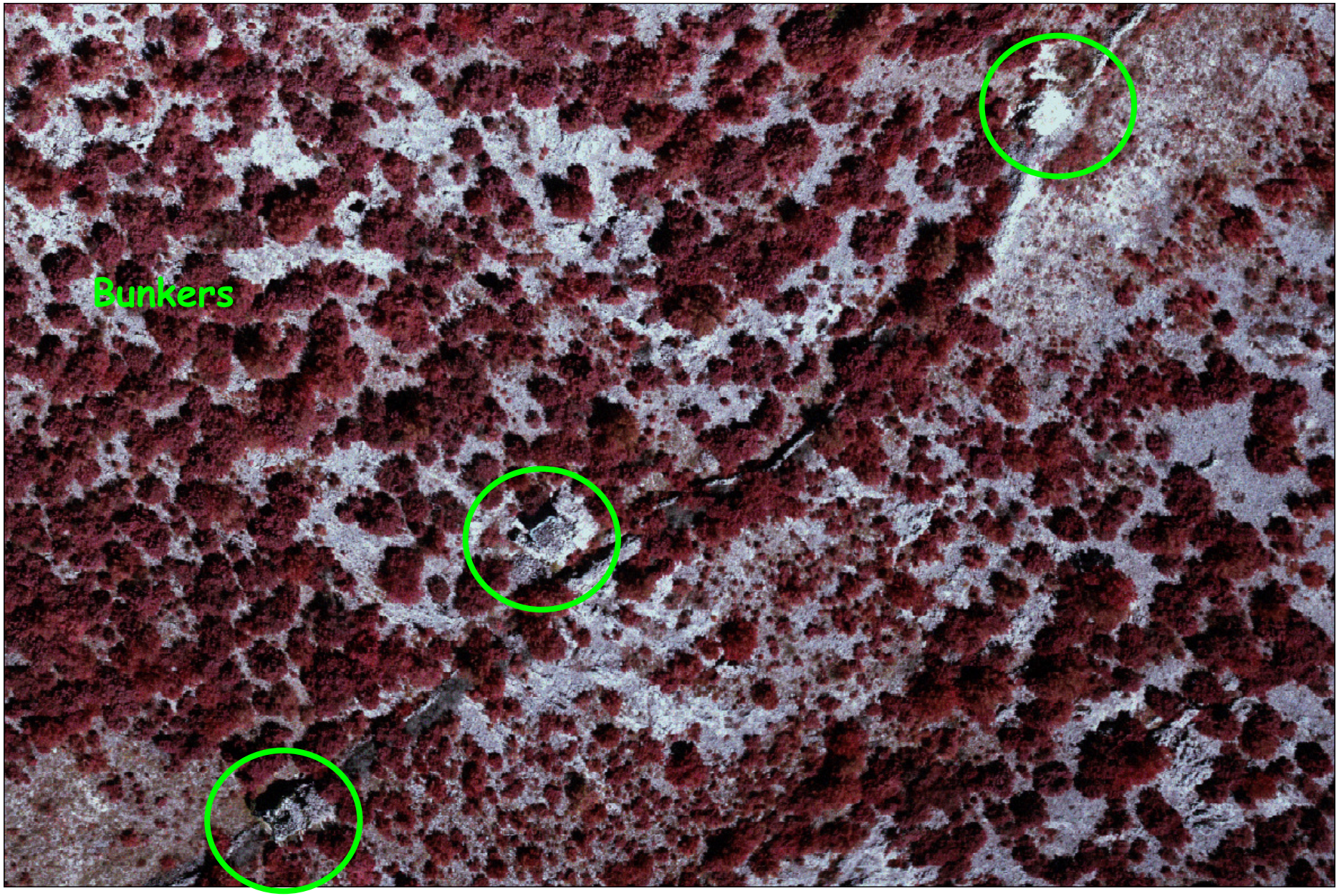
- At this stage of processing, the important person are interpreters of mine scene.

A

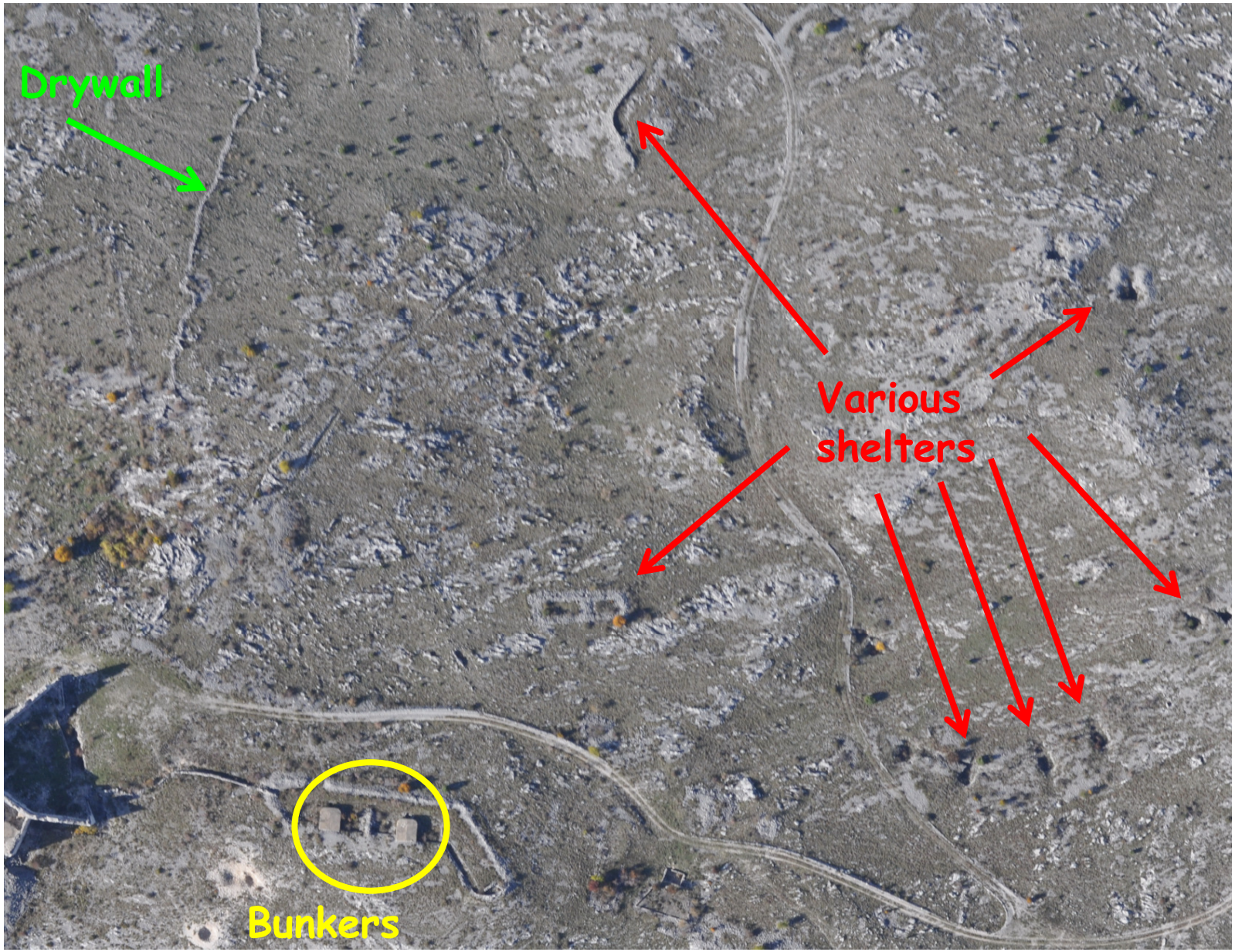
B

Military positions within MSA in Gospic municipalities.
A)Fuji FinePix,
B)Canon 5D.

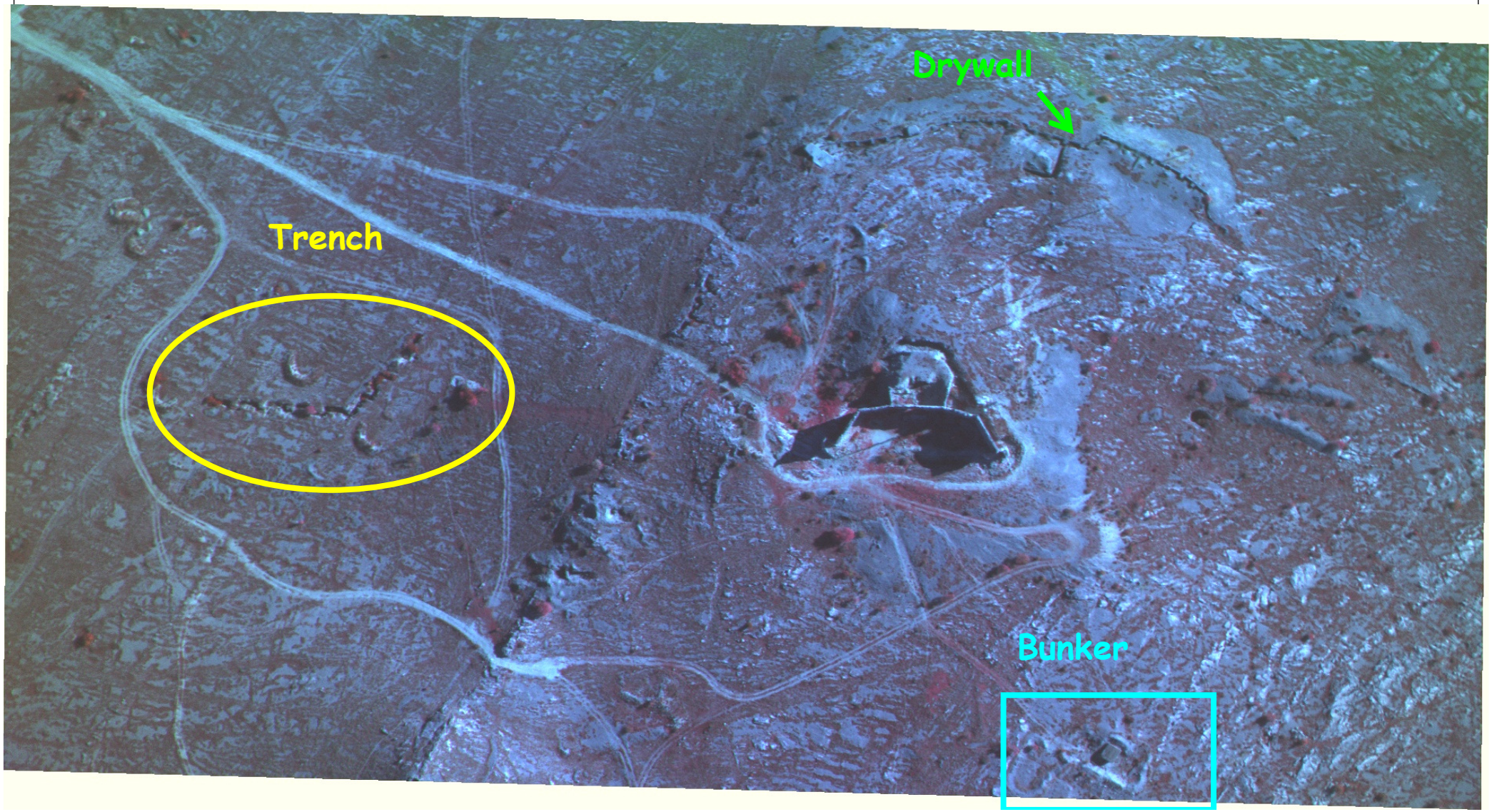
Military positions within MSA. Photogram metric digital image (RMK camera).



Military positions within MSA. Nikon D90 camera.

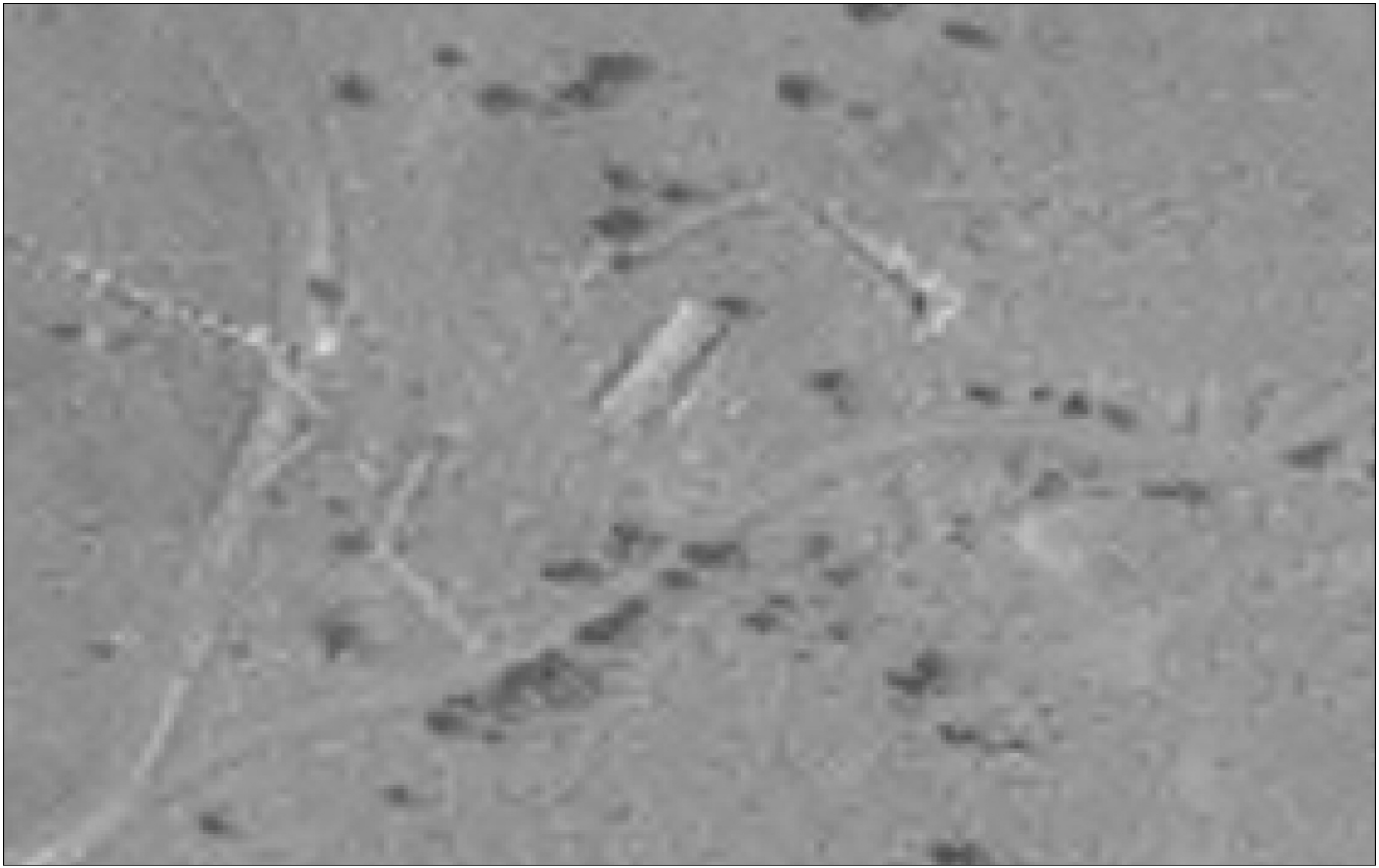


Military positions within MSA. MS-4100 camera.



Military positions within MSA. Fuji FinePix camera.

Shelters for infantry and artillery – DOP5 (1999).



Shelters for infantry and artillery – DOP2 (2006).

The edges of forests and destroyed house – DOP5 (1999).

The edges of forests and destroyed house – DOP2 (2006).

Overgrown agricultural land – DOP5 (1999)

Overgrown agricultural land – DOP2 (2006).

Extracting of indicators

- The interpreter of mine scene viewing and processesing all images and the contextual information about an observed scene, in order to find and spatial positioning of indicators.

- Indicators are extracted interactively.

- MIS data that can be positioned in the space is also used in the system (minefield record, mine accident, information from military maps,…).

Data fusion

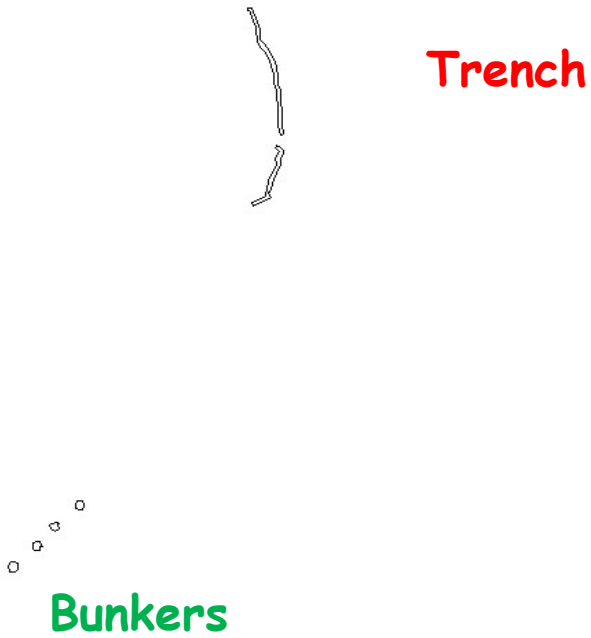
- The concept of fusion
  - Collection and processing of all available and relevant data through the mediation of knowledge.
    - These data can be:
      - Visual (imiges, vectors)
      - Contextual (attributes, measurement results, written reports and general and expert knowledge)
  - Formalization of expert knowledge, linking the impacts on the environment, and each other, with physical objects in space (indicators).

Zone of IMP influence of the environment

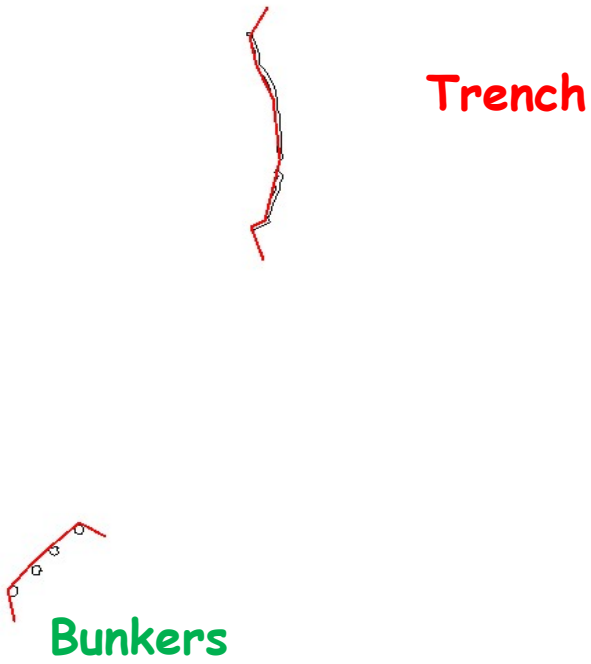
- Determine the impact of the strong IMP on the environment.
- These impacts are showing with danger zones around the indicator.

Indicators	The danger begins from	The greatest danger from	The greatest danger to	No danger
Indikatori minske prisutnosti (IMP)				
minski zapisnici	0	0	100	200
minske incidenti	0	0	100	200
obilježenost minskog polja (“MINE”)	0	20	220	250
fortifikacijske zapreke	0	0	100	150
trenches	**0**	**50**	**400**	**500**
bunkeri	0	50	400	500
prirodni objekti uređeni za vatreno djelovanje	0	50	400	500
suhozidi (u borbenom rasporedu postrojbe)	0	50	400	500
zakloni za topništvo	0	40	200	300
mostovi i mostni prelazi	0	0	100	150
dominirajuće uzvisine	0	40	400	500
rubovi šume	0	40	200	300
plitki gazovi	0	0	150	250
rijeke i drugi vodotoci u rajonu odrene postrojbi	0	0	50	250
heliodrom	100	100	150	250
putevi u rajonu obrane koji se ne koriste	0	0	100	500
zapuštene, zaraštene površine	0	0	220	350
srušene kuće na prvoj liniji obrane	0	50	200	300
osmatračnica na prednjem kraju obrane	50	50	100	250

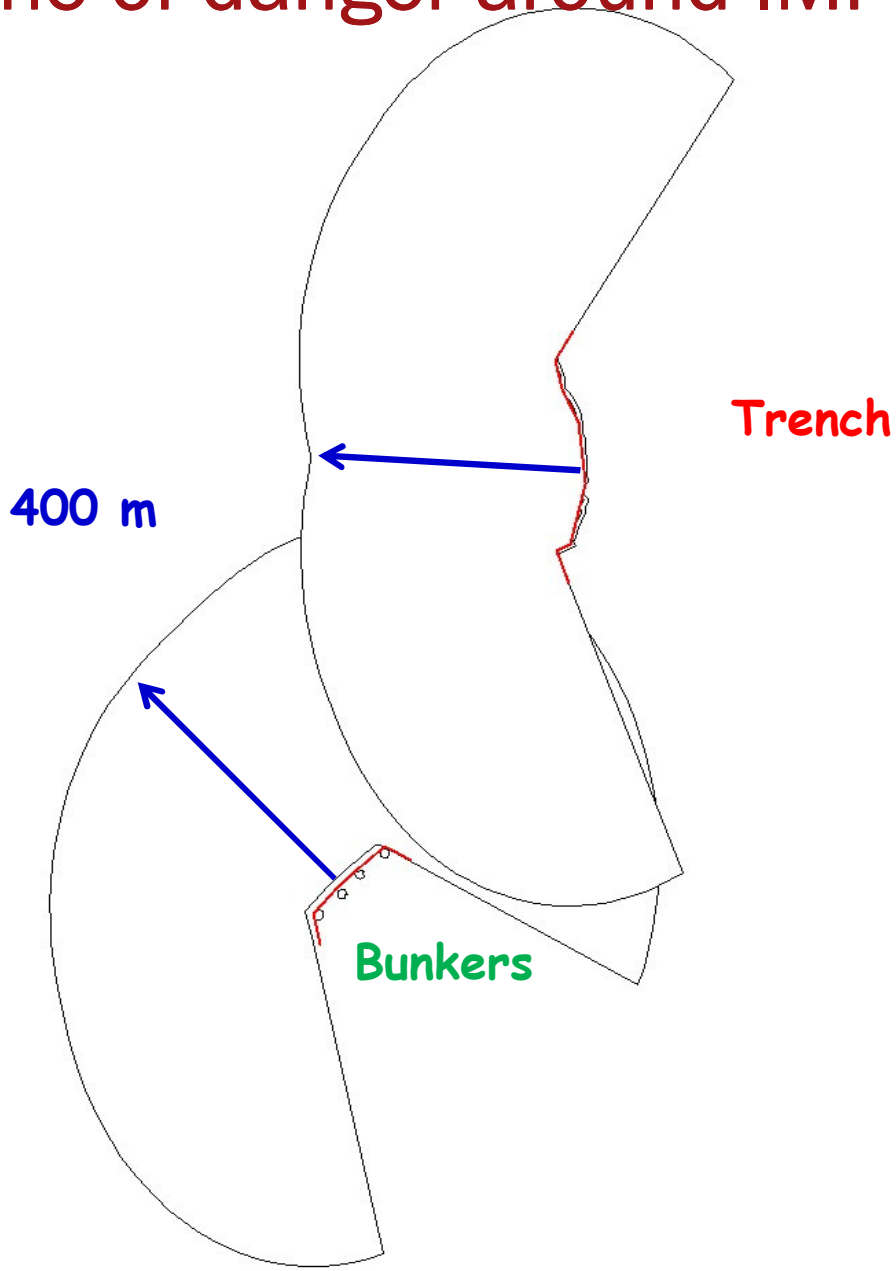
Vectorized IMP-i



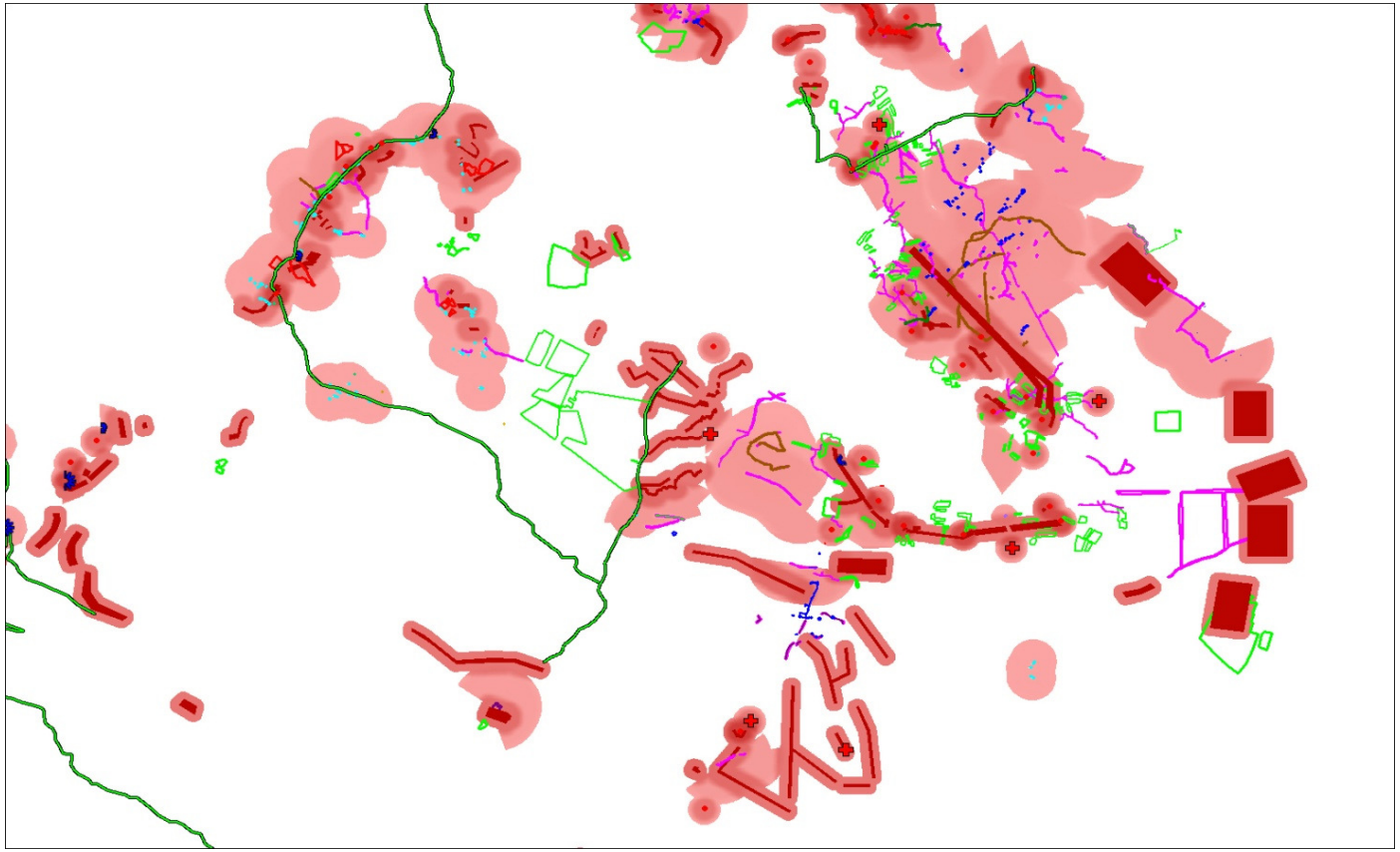
Generalized location of IMP



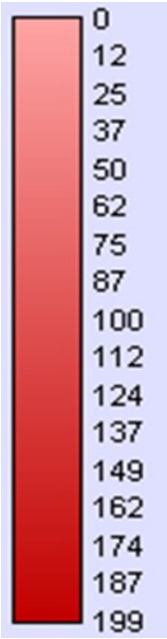
Zone of danger around IMP



Danger map



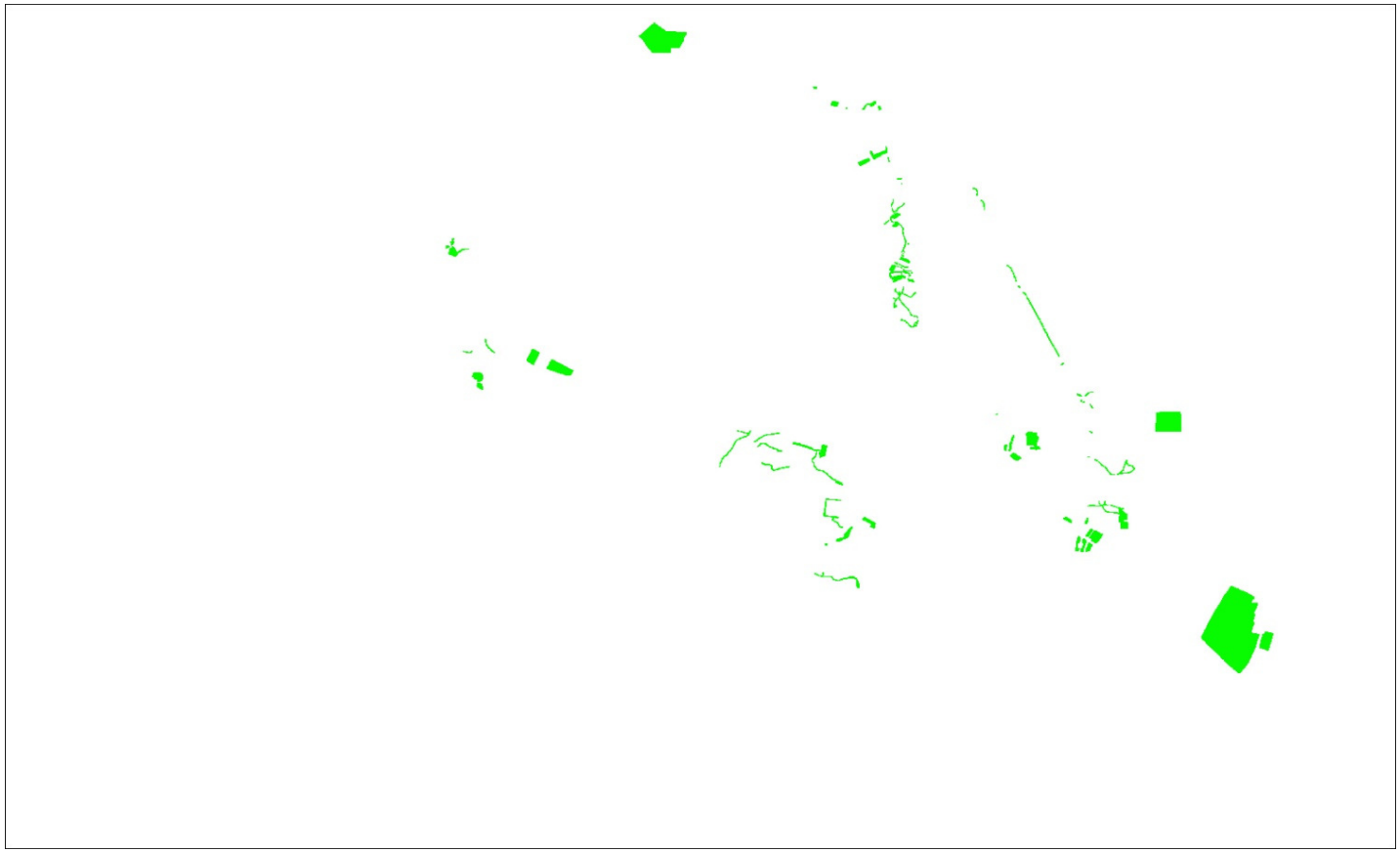
low



high

The level of danger

Proposal for reduction

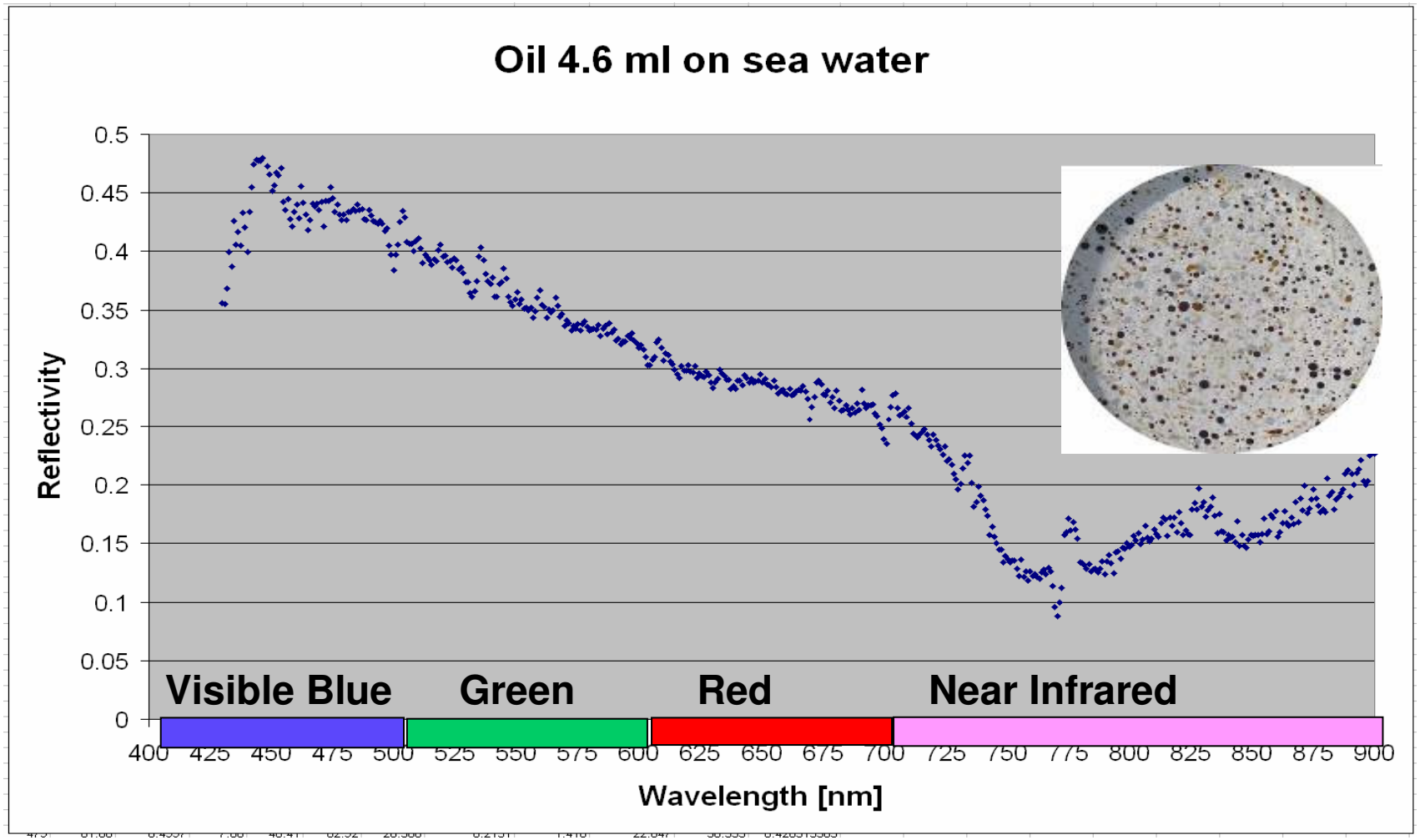


- Proposal for reduction (by AI DSS)

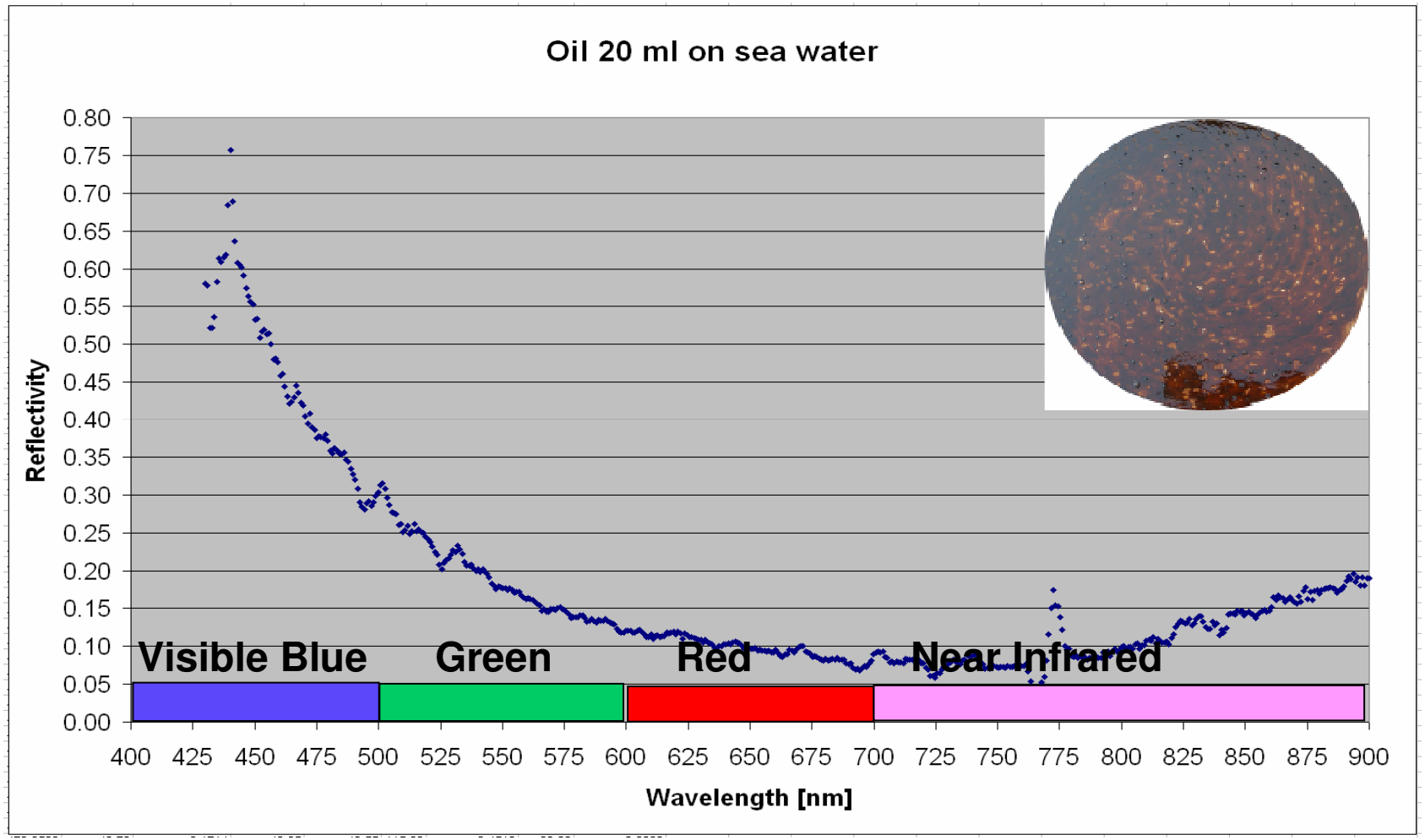
AI DSS in environmental protection

- **Monitoring of oil pollution**
- **Monitoring of forests**

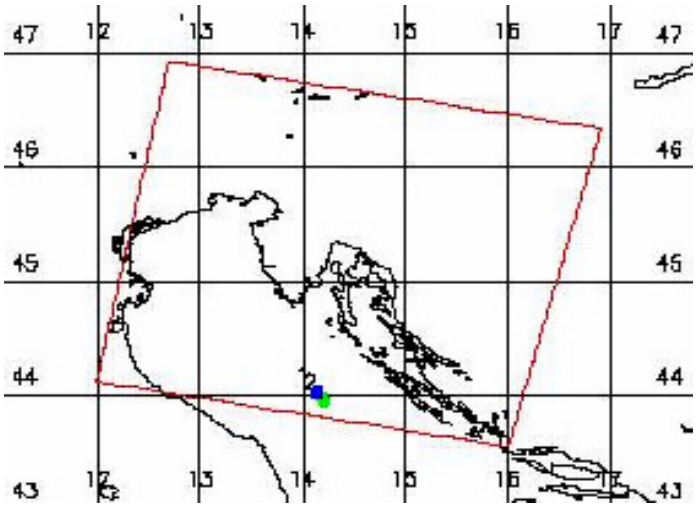
4.6 ml sample of oil in 30 liters of seawater



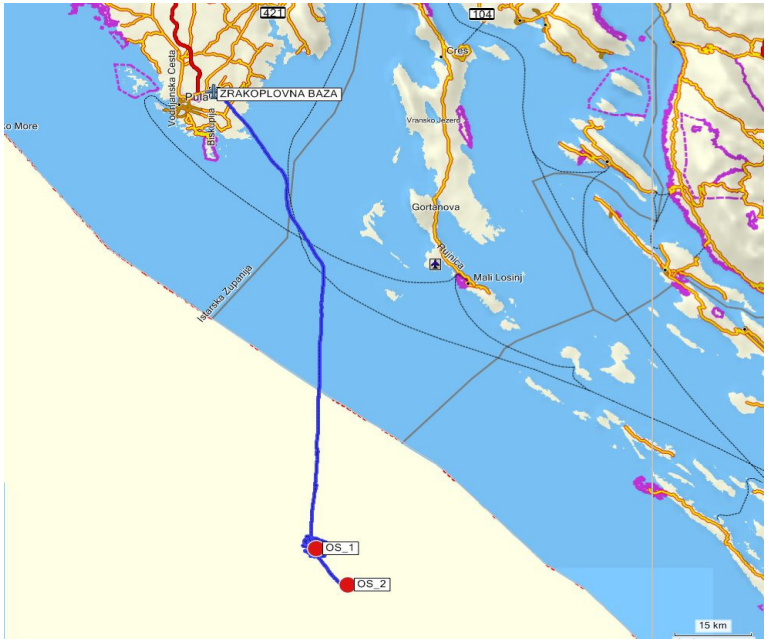
20 ml sample of oil in 30 liters of seawater



Monitoring of oil pollution of the Adriatic



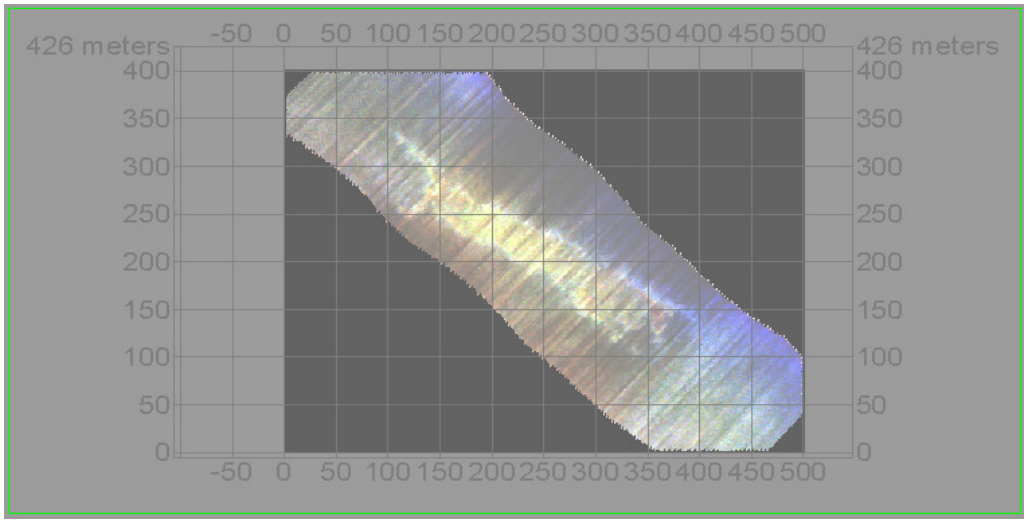
Position of the satellite images (red) and potential pollution (blue and green dot), (CleanSeaNet).



Routes to pollution.

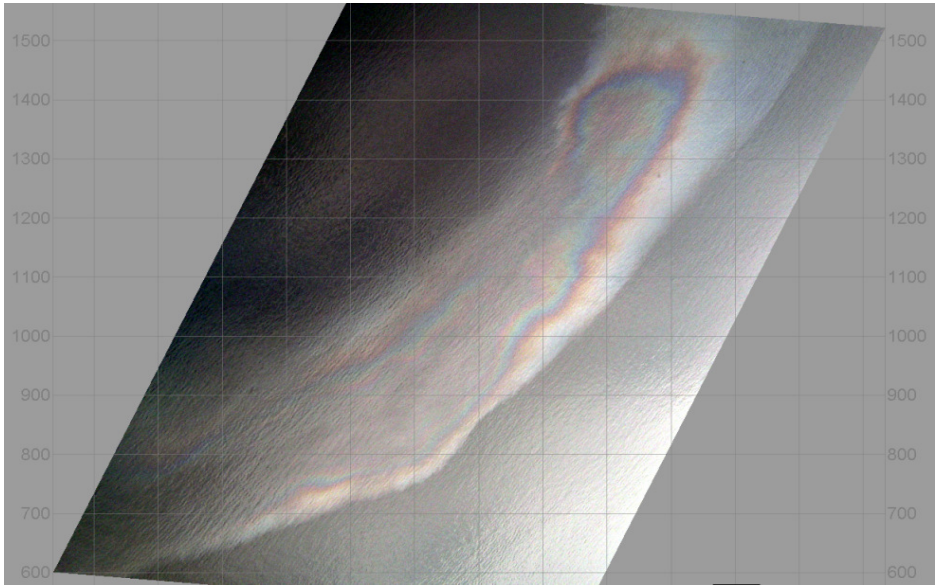
Monitoring of oil pollution of the Adriatic - 2

Pollution on the RGB image (FujuFine Pix).



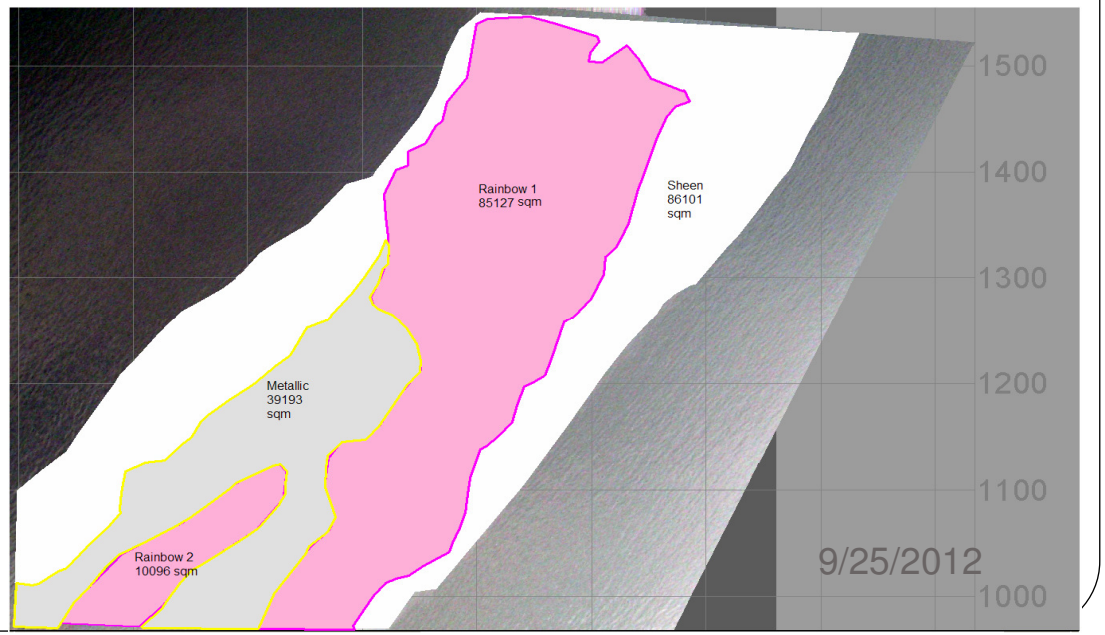
Pollution on the hyperspectral, parametricali geokoded image (imaging mode).

Classification of Oil Pollution

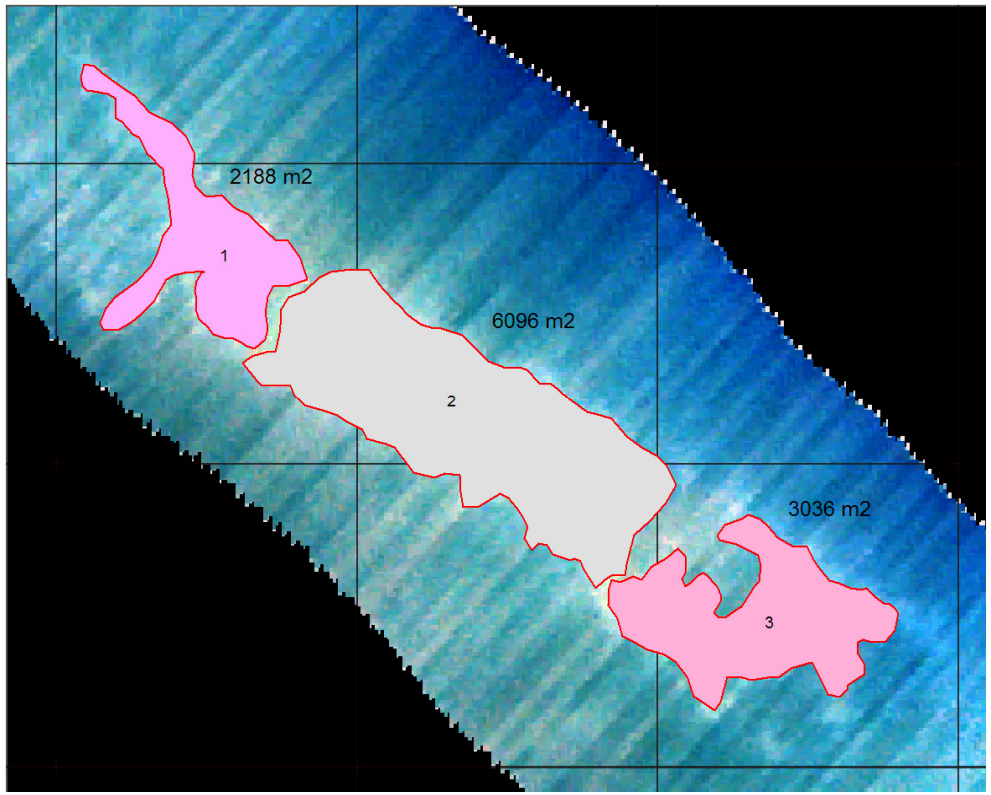


Pollution on the RGB image (FujuFine Pix).

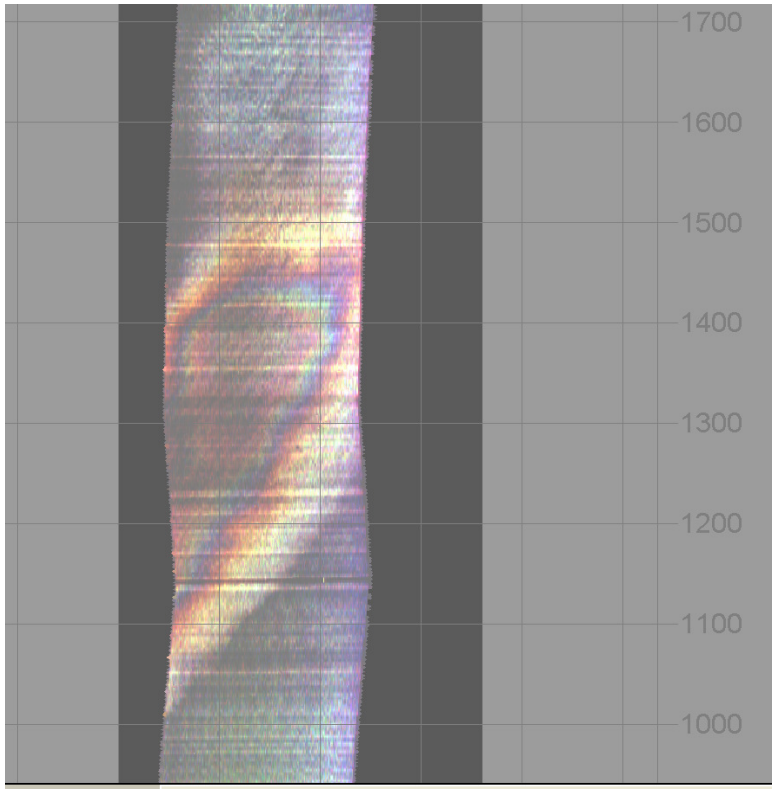
Classification of pollution with the area they occupy.



Classification of Oil Pollution - 2



Classification of pollution with the area they occupy (hyperspectral image).



Pollution on the hyperspectral, parametricali geokoded image (imaging mode).

Silver fir (*Abies alba* Mill.)

- Most widely distributed conifer species in Croatia
- One of the most important commercial and ecological species
- Most endangered tree species in region (narrow ecological valence, excessive exposure to polluted air, etc.)
- Apart of the insects and fungi increasingly infested by white mistletoe

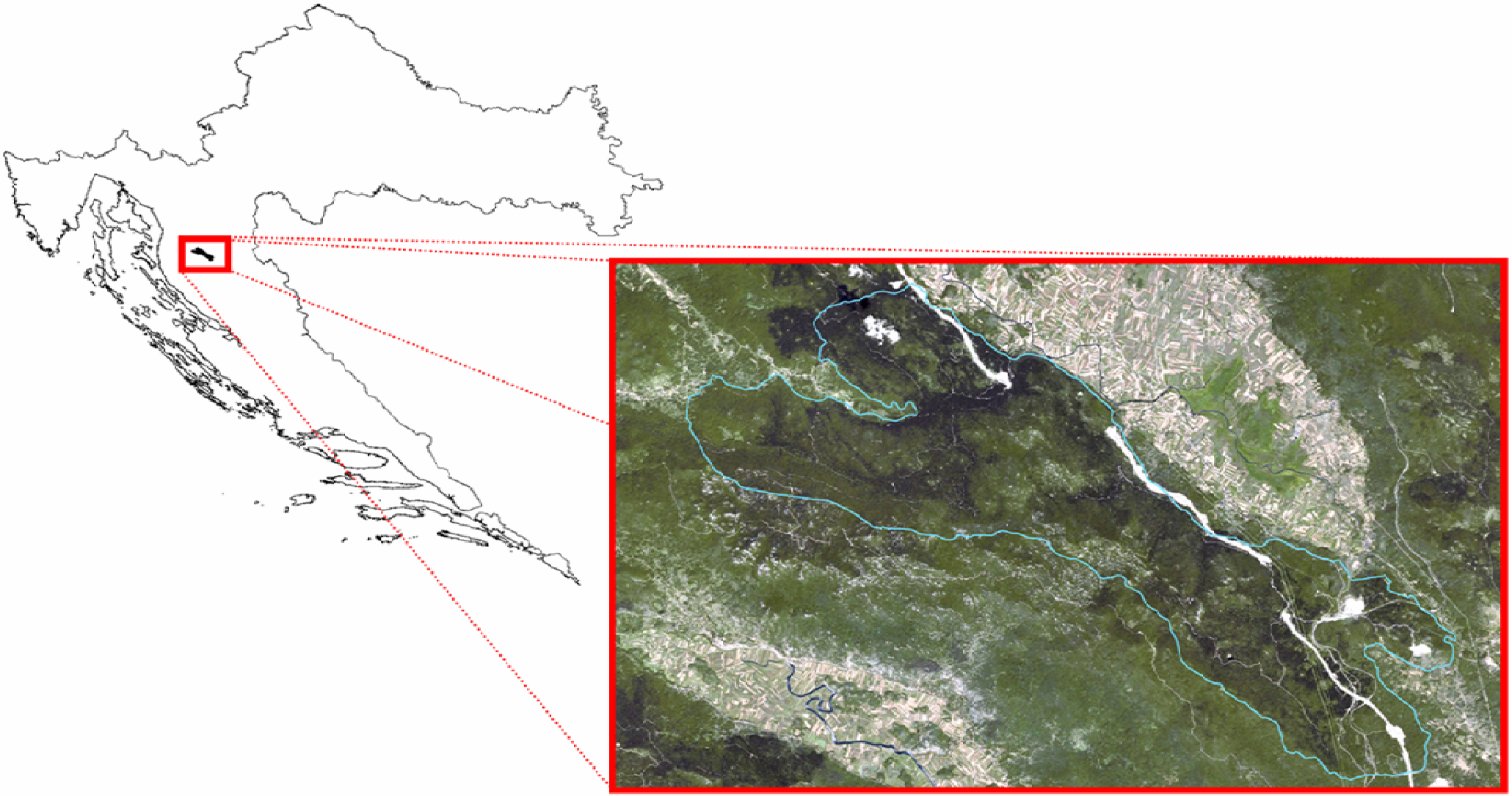
Mistletoe (*Viscum album L.* ssp. *abietis* /Weisb./Abrom.)

- semi parasite (water and nutrients consumption)
- physiological weakening of the tree
- may indicate the presence of stress factors in the site
- large number of bushes even cause premature death

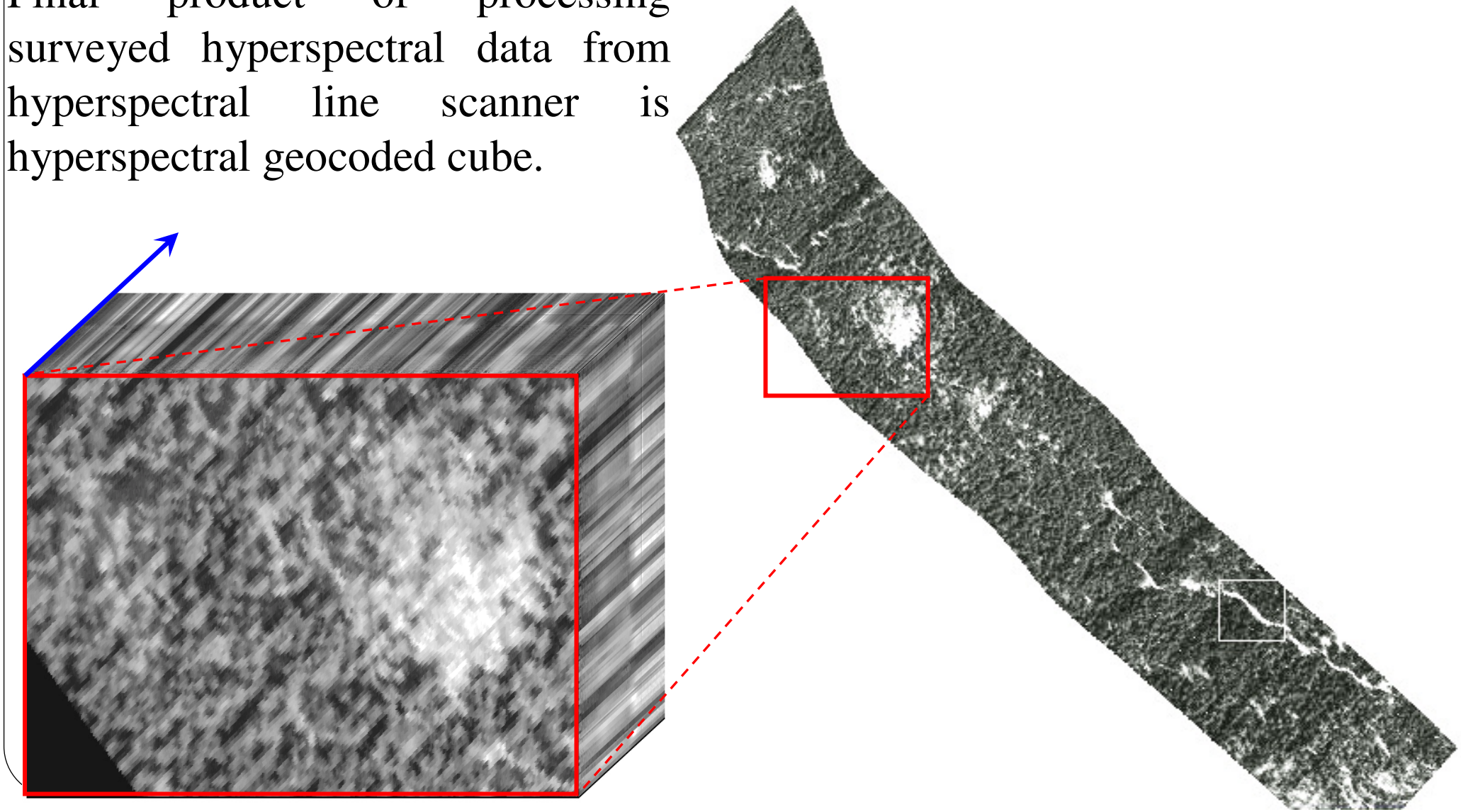
The purpose of research:

- to develop of efficient and reliable method of mistletoe detection
- to establish the correlation between mistletoe occurrence and tree damage (health status)
- to provide the possibility of monitoring the fir health status on large areas

Research area

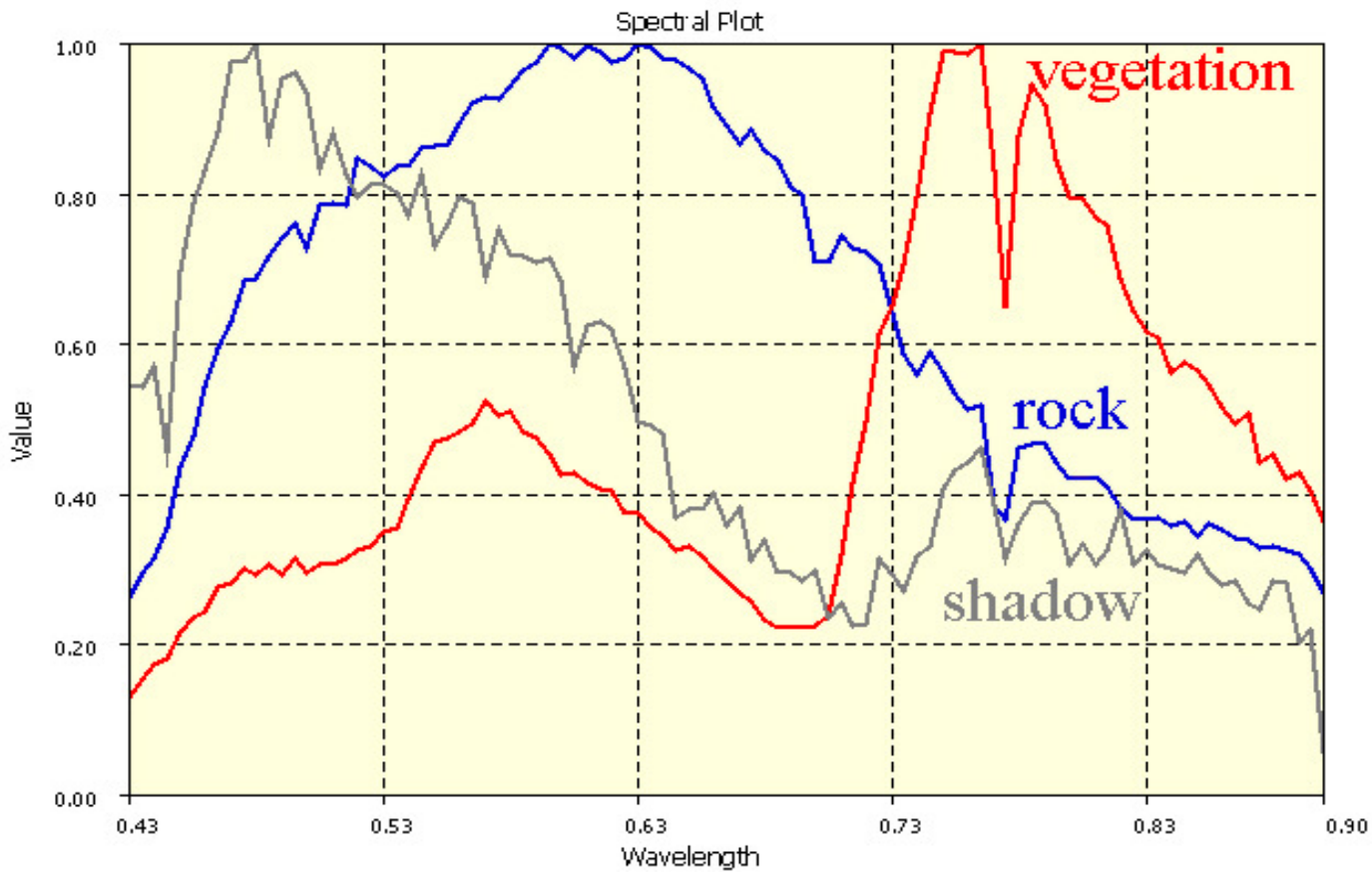


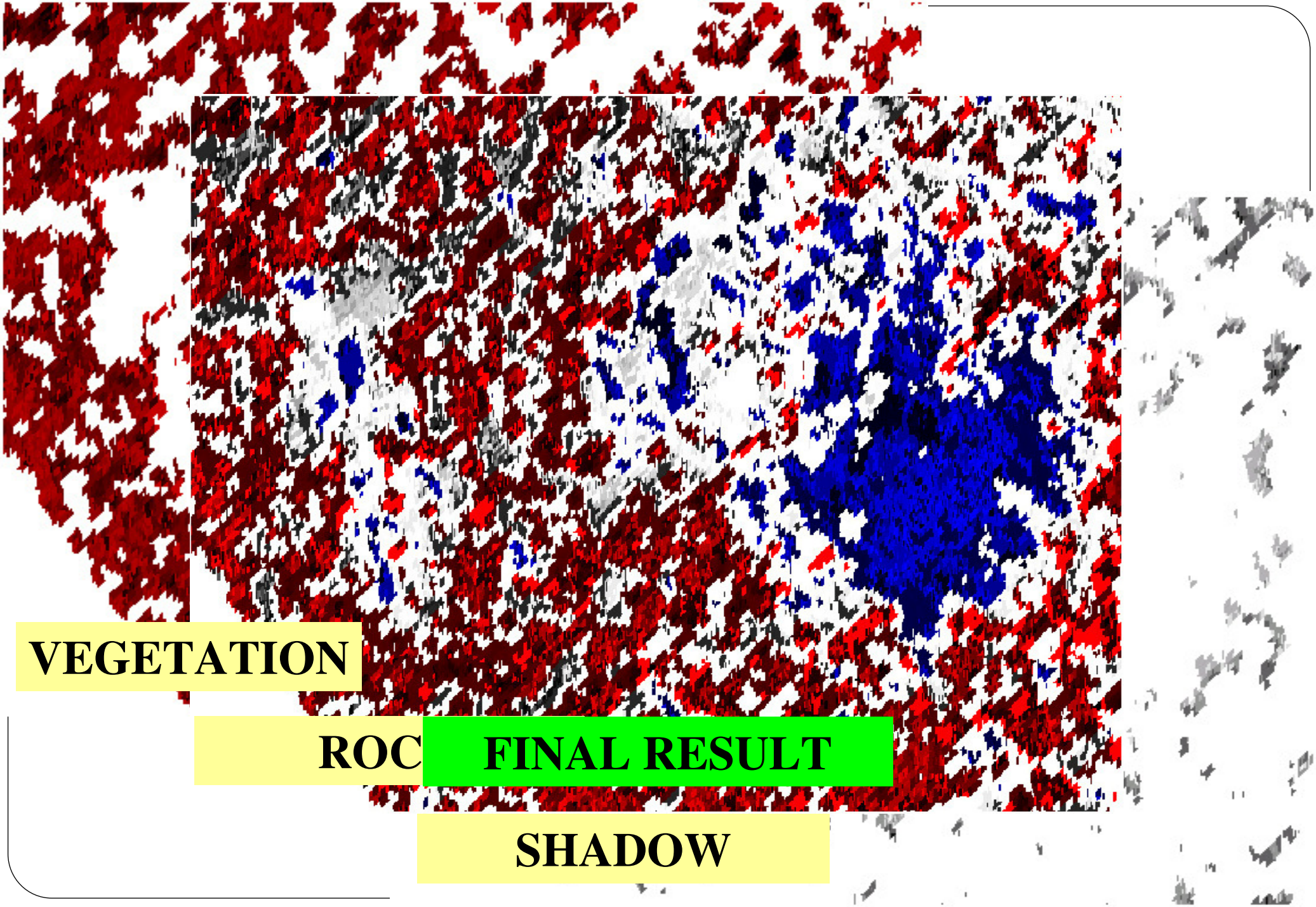
Final product of processing surveyed hyperspectral data from hyperspectral line scanner is hyperspectral geocoded cube.



Samples was taken from the hyperspectral cube for particular classes:

- vegetation
- stone
- shadow

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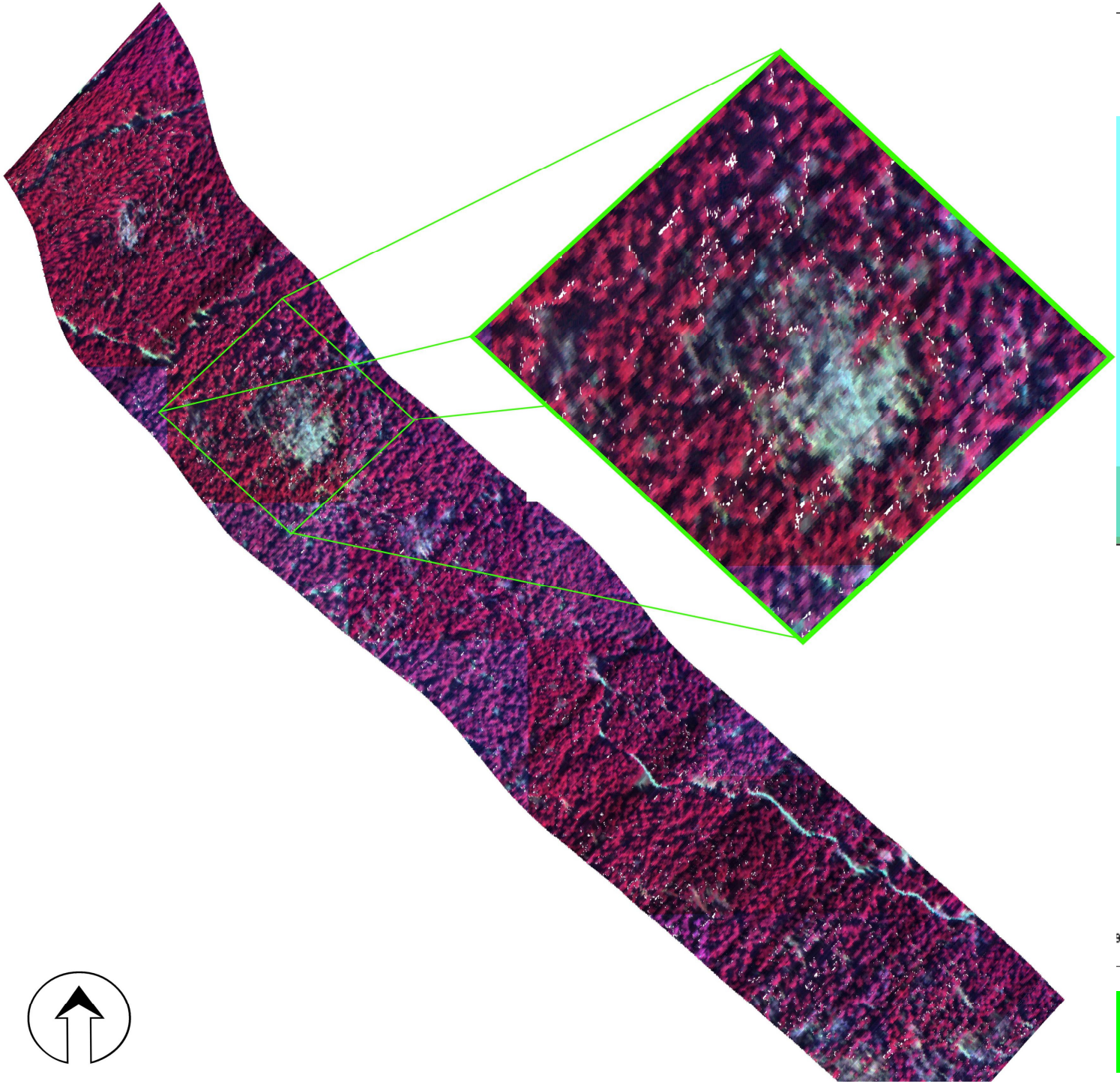

nisteltoe

to be

CONCLUSION:

The conducted research defined the procedures for interpretation of hyperspectral images and confirmed the advantages of multispectral and hyperspectral images in damage assessment of individual trees and stands, as well as mistletoe detection on fir; therefore, these methods can be recommended for operative application in the forestry of the Republic of Croatia.

THAN YOU, ANY QUESTIONS?

ADVANCED INTELIGENCE DECISION SUPPORT SYSTEM

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