

# Situational awareness system for civil IED Disposal and Mine Action in a risky post-conflict environment

Domagoj Tuličić\*, Milan Bajić\*\*

\*University of Applied Sciences Zagreb, [domagoj.tulicic@tvz.hr](mailto:domagoj.tulicic@tvz.hr)

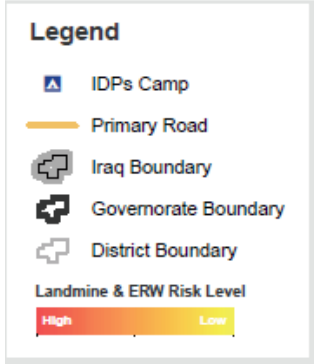
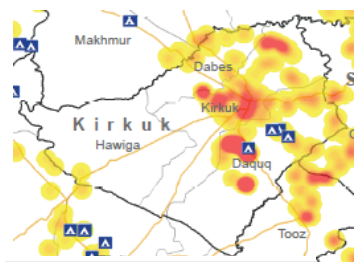
\*\*PhD, Ret. LTC, Scientific Council of HCR – CTRO, Zagreb,  
[milan.bajic1@gmail.com](mailto:milan.bajic1@gmail.com)

# Mine Action & IED Disposal

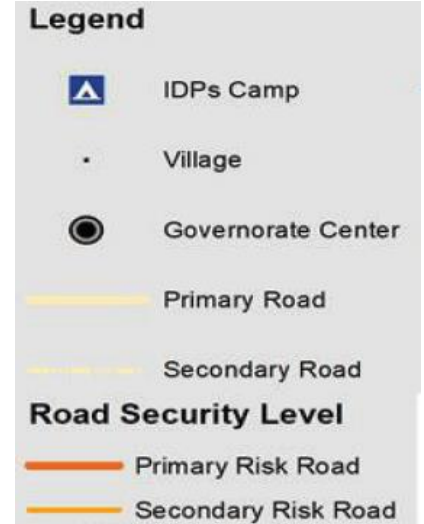
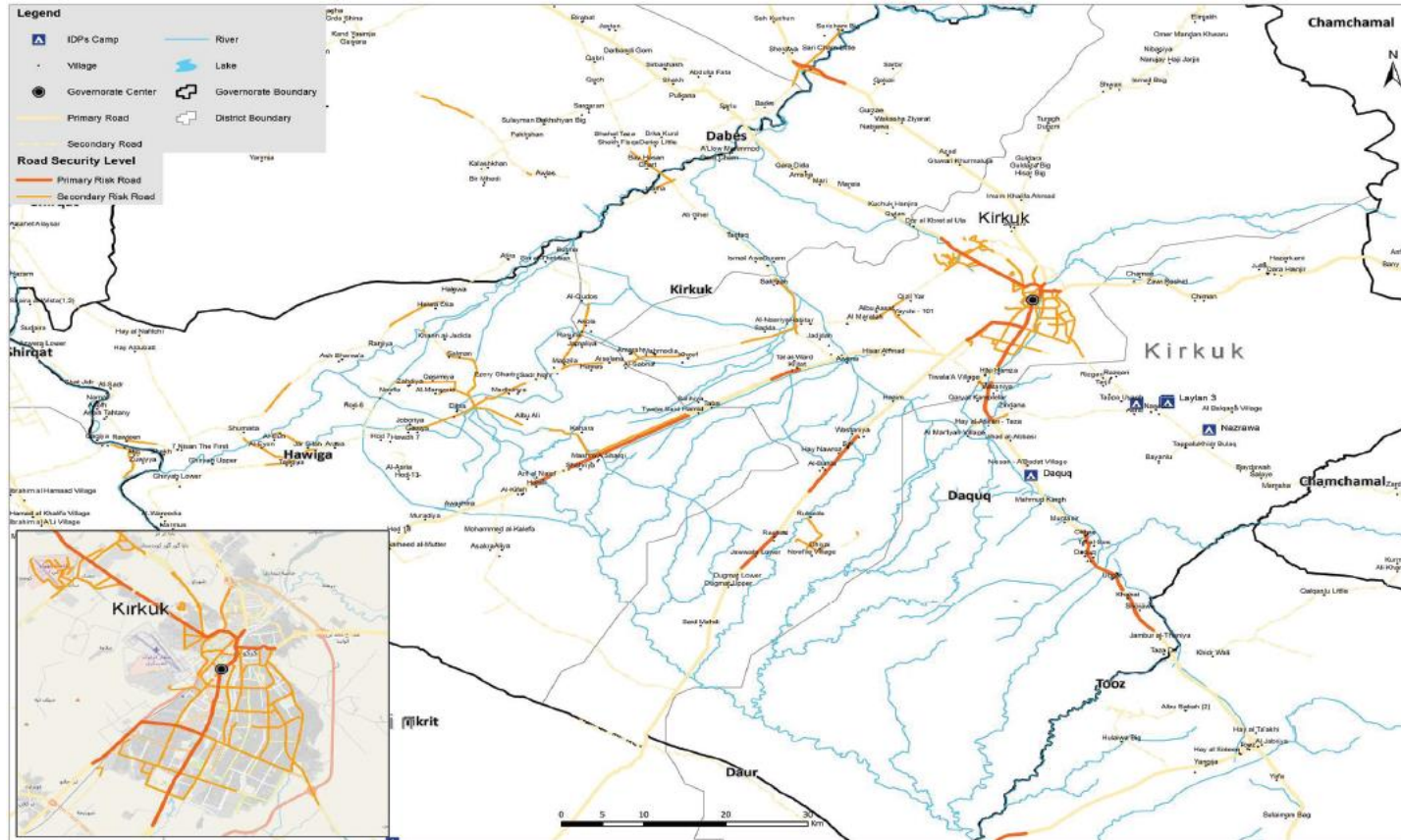
- The influence of improvised explosive devices (IED) changed humanitarian mine action (MA) scene and this process continues in different directions, an overview derived by GCIHD [1] presents status estimated by end of 2016. The comprehensive insight into the current situation in Iraq from August 2017, [2], enables a more realistic understanding of this process. Similar situations can be expected in Yemen, Lybia, Afganistan and possibly once in Syria.
- We will consider civilian aspects of MA IED Disposal (IEDD) relations while military response can be perceived via the example of NATO technology detection programme [3], via a description of current needs expressed by the military and/or security forces, e.g. [4].

# Road Security Problem, example from Iraq

## August 2017, [2]



Landmine and Explosive Remnants of War Risk Level



Risk Levels on Primary and Secondary Roads

Copyright © iMMAP, IHF Humanitarian Access Response - IHF project – 2018, Samir Mohammed (PM) smohammed@immap.org, Report July 2018

# Intelligent situational awareness system

- Ground vehicles convoy (logistic, humanitarian, search and rescue, reconstruction, Mine Action, etc.)
- Several logistic companies in Iraq send daily 20 convoys.
- Group of MA, IEDD vehicles moving from base to working areas and back.
- Emergency vehicles MA, IEDD moving from working location to hospital.
- Surveillance perimeter of MA, IEDD working area etc.

The INTELAW system is aimed to provide continuous situational awareness in mentioned cases, environment, and to support decision making in actual risky situations.

# Intelligent situational awareness system

Background for considered system solutions is developed and implemented from our MA R&D [13], [14] as well as from other sources [15], [16], [17]. The main promising and verified groups of technologies for advancement in MA and IEDD are:

- **Modern RPAS platforms**, for programmable automated reconnaissance, surveillance, photogrammetry mapping and production of excellent digital surface models and digital elevation models, e.g. [12].
- **Sensors**. Hyperspectral, longwave infrared (LWIR), [18], non-linear junction detectors (harmonic radar), very high resolution color images, [11], [10].
- **Machine learning and methods for cognitive decision support for situational awareness**, [15], [16], [17], [19].

# Versions of INTELSAW



- **Station for IEDD Non-Technical Survey, Targeted survey, Situational Awareness Assessment.** Located in the premises of user of the INTELSAW, MA IEDD, MA or in civil convoys company. Two persons and hardware/software station.



- **The mobile module of SAW for ground vehicles civil convoy leader.** One operator hardware/software station for control of RPAS, for real-time risk changes assessment (fusion of static and dynamic risk data), a subsystem for Dual sensor RPAS control.



- **Dual sensor real-time warning RPAS flying in front of the first vehicle.** Flight at a distance which provides time for reaction after detection of the IED or the ambush. One operator of RPAS in the ground vehicle.

# Threat analysis

- Threat analysis is an essential part of the situational awareness system.
- **Threat** is an expression of intention to inflict evil, injury, or damage.
- Threat analysis definition: The analysis of the past, present, and expected actions of external entities, and their consequences to identify menacing situations and quantitatively establish the degree of their impact on the mission, the intents, the plans, the action, and the human and material assets of some valuable units to be protected, taking into account the defensive action that could be performed to reduce, avoid, or eliminate the identified menace[19, p.55].

# Coordinated Machine Learning and Decision Support for Situation Awareness

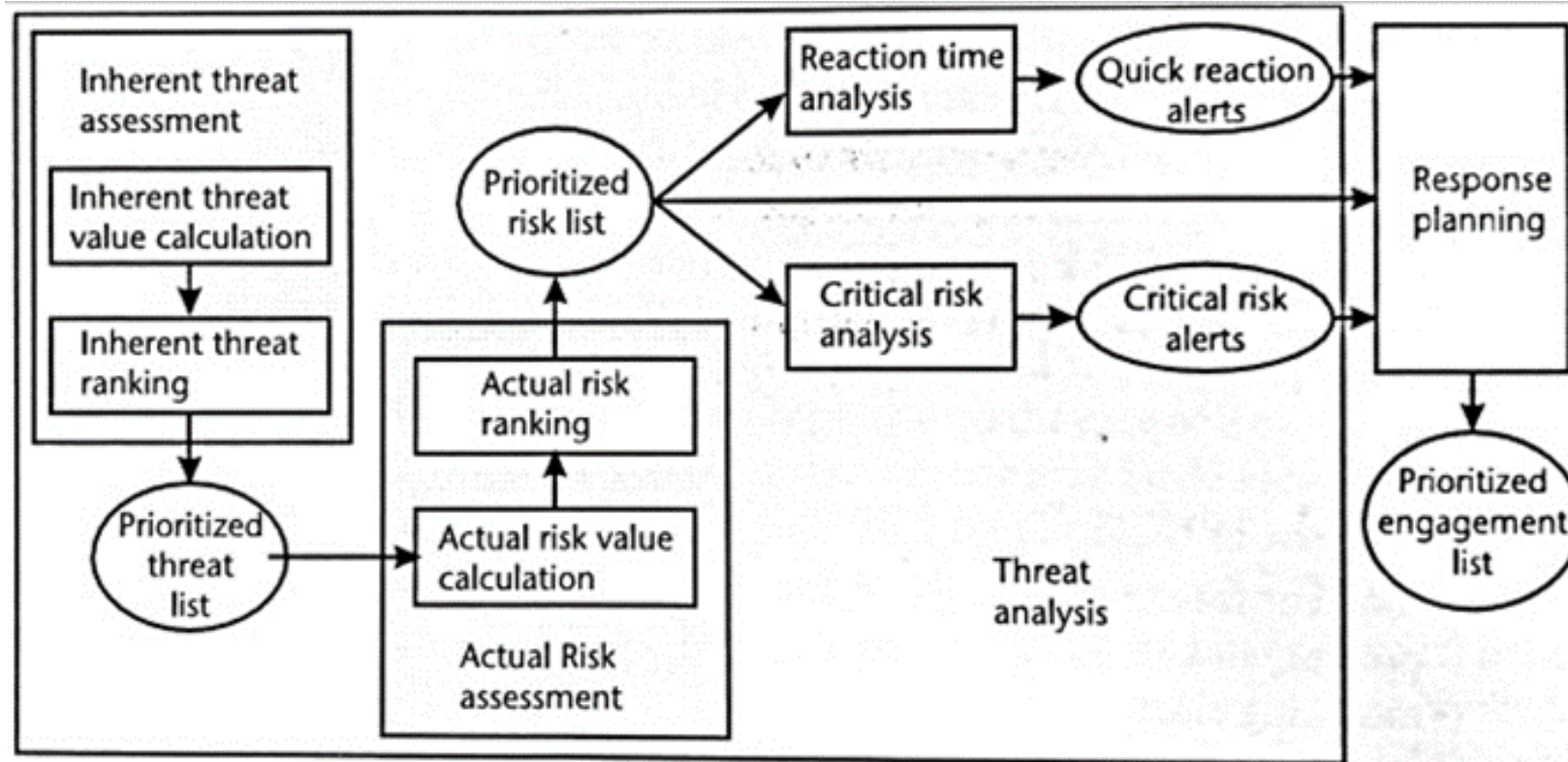
- data fusion
- static situation in mine action – GIS – based multi – criteria analysis
- dynamic IEDD, MA situation – we found promising solution in research conducted by SANDIA laboratory
- Research: „Coordinated Machine Learning and Decision Support for Situation Awareness”
  - Improving situational awareness during operational work
  - Effectiveness of INTELAW system in changing environment



# INTELSAW and machine learning

- INTELSAW – adopting concept of threat analysis and coordination of machine learning
- supervised learning, unsupervised learning, reinforcement learning
- reinforcement learning is a training method based on rewarding desired behaviors and/or punishing undesired ones. A reinforcement learning agent learns from the environment where it performs its task.
- self-organizing Neural networks – based on Adaptive Resonance Theory (ART) technology
- Adaptive Resonance Theory – widely implemented approach to modeling the learning capabilities of the human brain.

# Threat analysis diagram [19, p. 55]



# Coordinated Machine Learning and Decision Support for Situation Awareness

- With partially observable Markov decision process POMDP we achieved to get prioritized risk list
- From this risk list reaction-time and critical-risk analyses are performed
- INTELSAW – „human in the loop” system – the human operator gives the final decision about prioritized risk list. Such system provides changes during operation which is accomplished with reinforcement learning signal which essentially could be positive or negative
- Reason why signal should be back – propagated through the system
  - E.g. the operator disagrees with prioritized risk list of the current state

# How system reacts in the environment?

- In case when operator disagrees with prioritized risk list of the current state reinforcement signal is sent to a part of the system for information fusion and new mapping of data is activated during operation
- final action decisions are fully in the domain of the human operator and are not automated.
- This system is an aid to the human, it is not the replacement.