Levels of data within AI DSS

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Abstract

Mine clearance and reduction of Suspected Hazardous Area (SHA) are complementary actions in the process of removing the mines and of finding the final solution of mine problem in Croatia. Reduction of SHA in Croatia is carried out with the help of Advanced Intelligence Decision Suport System (AI DSS). The system analyzes and processes all available and comparable information, data and expert knowledge of the mine scene. For that purpose information and data from Minefield Information Systems (MIS) in Croatia and Bosnia and Herzegovina are need to be complemented with new and different data. In this article are listed and described types of images, information, data and expert knowledge used in decision support system for humanitarian demining for SHA reduction in Croatian and Bosnia and Herzegovina. These images, information and data were collected with aim to enable reliable detection of the indicators of mine presence and the indicators of mine absence. The quality of acquired images by AI DSS depends on the indicators that are looking at the scene. The public and comercial satellite images were very useful source for wider view of the considered areas, especially if they are collected with a time base. Contextual information and expert knowledge are associated with the type and configuration of the terrain and the indicators that are contained on it. All of mentioned type of data were used for the fusion of data and production of danger maps. Experts use those danger maps and the results of AI DSS for decision support in humanitarian demining.

1. Introduction

During 2003 and 2004, based on Croatian Mine Action Centre's (CROMAC) Standard Operational Procedures (SOPs) from passed stipulating the methods for the definition of SHA and reconstruction of estimated suspected hazardous area (SHA) until 2003, there were surveying and marking of the entire territory of the Republic of Croatia performed. 1.174 km² of the territory of the Republic of Croatia was defined as SHA. However, due to the reduction of risk and lack of information from the depths of the MSA, its boundaries are defined in the larger areas than it takes in reality. At the end of 2005 started the revision of SHA aiming at sustaining constant up-to-dateness of data relating to SHA i.e. up-to-dateness of SHA. On 07th of February 2012, it occupied 743.4 km ² territory of the Republic of Croatia [URL1]. This process continues nowdays. Reduction of SHA in Croatia and Bosnia and Herzegovina is carried out with the help of The Advanced Intelligence Decision Suport System (AI DSS). For that purpose information and data from Minefield information systems (MIS) are need to be complemented with new and different data. In this article are listed and described types of images, information, data and expert knowledge used in decision support system for humanitarian demining for SHA reduction in Croatian and Bosnia and Herzegovina. All of mentioned type of data were used for the fusion of data and production of danger maps. Demining experts use those danger maps and the results of AI DSS for decision support in humanitarian demining.

2. Minefield Information Systems Data

CROMAC MIS is the unique information system adjusted to CROMAC activities within the sphere mine of action in Republic of Croatia. MIS is dynamic system which reflects the actual CROMAC's needs and goals and therefore it should be continuously updated. This MIS consist of folowing data: minefield records data; mine incidents; digital orhophotos (DOF) with scale of 1:5000 (DOF5) and 1:2000 (DOF2); maps (with scale of 1:5000 (Croatian Base Map (CBM)), 1:25000, 1:50000, 1:100000); data from military working maps; vectorized SHA; vectorized areas for general and technical survey, vectorized results of general and technical survey (Figure 1). This data are useing for preparing and makeing of demining project documentation.

DOF5 are panchromatic, contain data from the time period 1999-2001. They were useful in the initial phase in 2008 for the search of the indicators (before the availability of the airborne high resolution multisensory images). The

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color DOF2 show the situation in the time period (2006) but only inside the strictly defined MSA. Due to time delay of DOF2 from (2006) to DOF5 (1999-2001), additional information was derived for certain class of the indicators. Example at Figure 2 shows change of the demolished and not used houses (at DOF5) into a reconstructed houses (at DOF2). Due to the radiometric compression (for internet portal) they lost certain amount of information about small indicators of the mined scene. [Bajic, Krtalic 2009].

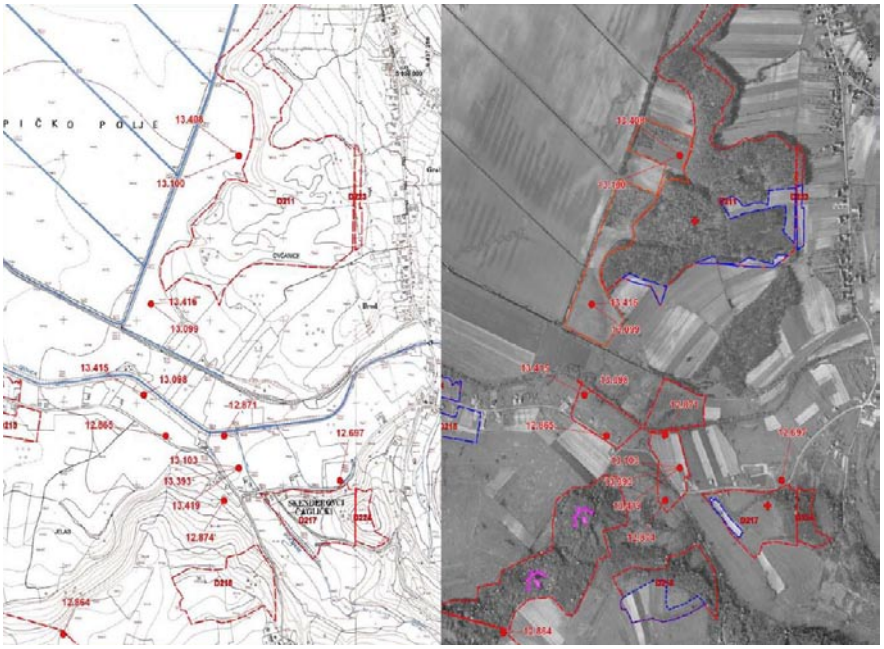


Figure 1. Display of the same area with vectorized SHA on CBM with scale of 1:5000 (left), and on DOF with the same scale [URL1].

a b

Figure 2. The demolished houses from 1999 – 2001(a) were reconstructed in 2006 (b) [Bajic, Krtalic 2009].

3. Advanced Intelligence Decision Suport System

The AI DSS for the reduction of the SHA was developed in the frame of the project [Fiedler 2007] supported by the Ministry of Science of the Republic of Croatia, following the basic methodology of SMART [Yvinec 2005], and used in Croatia (2008) and Bosnia and Herzegovina (2009). In comparison to SMART, the AI DSS was developed as a complete system, that contains airborne multisensor acquisition subsystem (visible, infrared, thermal, hyperspectral), the interpretation subsystem, the trained team of operators and interpreters, and the general standard operation procedures.

3.1 Airborne multisensor acquisition system and images

The airborne multisensory acquisition system was used on board of the helicopter Mi-8. The system was used for acquisition images and data over the SHA. During the airborne missions was acquired a very large amount of images (visible, infrared, thermal) and data, with multisensors system within AI DSS. These images and data were collected with aim to enable reliable detection of the indicators of mine presence and the indicators of mine absence. The image resolution is determined by the size of indicators. Using raw images (Figure 3) the mine field indicators were detected and their locations were accurately defined on the maps or on the digital ortho photo maps. Owing to these images and data, the abundance of different minefield indicators was collected and used in the further processing and interpretation [Bajic, Krtalic 2009].

Figure 3. Strong indicators of mine presence (threnches and shelter for heavy weapons) and indicator of mine apsence (area in use) within SHA on image of MS3100 camera [Bajic, Krtalic 2009].

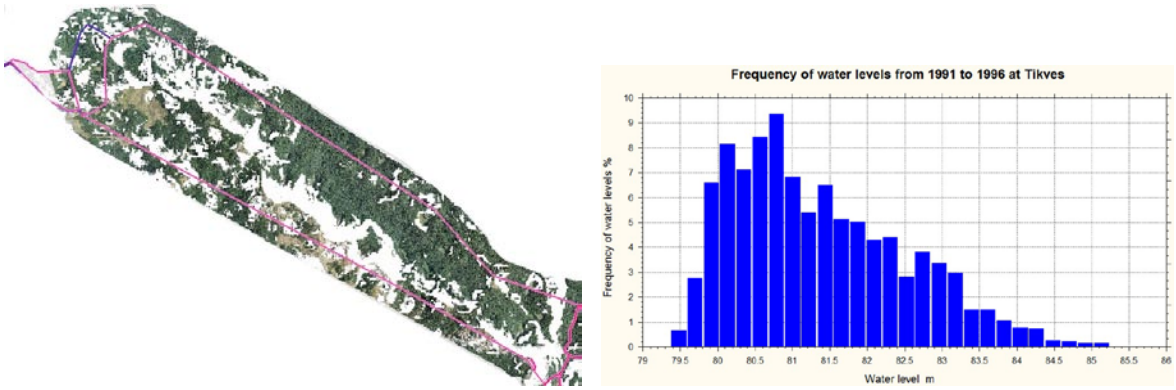
3.2. Other sources of images and data

The public (Google Earth - Figure 4) and comercial satellite images were very useful source for wider view of the considered areas. Data contained in these images have date of the acquisition and provide additional information (time domain) about the considered scene. The satellite images are not radiometrically compressed and in many cases enable initial insight into the scene.

Figure 4. The long linear trench is visible very clearly in the satellite image (Google Earth) from 2006 [Bajic, Krtalic 2009].

The very significant levels of data are also contextual information, expert knowledge and results of the fusion of all available data (). Contextual data are linked with type of the terrain. For example, in the swampy areas, it is important to know the water level during the years of conflict (Figure 5b). Or, in the mountainous areas it is important to know the slope (Figure 5a). Based on these data someone can produce the prediction models of areas which are not contaminated with mines. On the other hand, the expert knowledge connect the indicators and their

impact on the environment and each other. Membership functions is creat for the formalization of the expert knowledge.



a b

Figure 5. a) White areas, inside pink polygons ((for search) at the ridge of a mountain Velebit, shown for 35 degrees of terrain slopes. b) The frequency of the water levels from 1991 to 1995 at Tikveš in Kopački rit (Bilje, Croatia) [Bajic, Krtalic 2009].

4. Conclusion

CROMAC MIS is a dynamic information system which reflects the actual CROMAC's need and goals and therefore it should be continuously reviewed and updated. AI DSS is designed for this purpose. It is a flexible system that adapts to the type of terrain and the size and type of indicators. AI DSS displays the current state of the SHA as opposed to DOF representing the state at the time of their formation. The main contribution of AI-DSS is a formalization of expert knowledge and production of various thematic maps (danger, confidence, conflict map) that are used as decision support in mine action in terms of reduction of the SHA.

5. References

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