Visualization of Land Mine Danger, Svilaja Region (Croatia)

Andrija Krtalić, Ana Kuveždić Divjak and Robert Župan

Faculty of Geodesy, University of Zagreb, Zagreb, Croatia

ABSTRACT
Mines remaining from the Homeland War are a huge problem in Croatia. The joint work of experts in humanitarian demining and military doctrines in certain geographical areas, and scientists of various profiles, has resulted in a concept for producing mine danger maps, which show areas and levels of potential hazards from mines, i.e. suspected hazardous areas. This paper presents the concept for producing mine danger maps for a suspected hazardous area (Svilaja, Croatia). The input data comprise information stored in mine information systems and additional data collected on the suspected hazardous area (e.g. bunkers and shelters for tanks, artillery and people). The resulting maps (Main Map) seek to improve the identification of areas where there is no threat so that parts of suspected hazardous areas can be proposed for mine reduction, or suspected hazardous areas can be better defined.

1. Introduction: the mine problem in Croatia
Mines are one of the gravest consequences of the Homeland War in Croatia (1991–1995). Defining suspected hazardous areas has been the basic task ever since a systematic approach to demining in Croatia was adopted. A ‘Suspected Hazardous Area (SHA) is one where there is reasonable suspicion of the presence of mines/Explosive Remnants of War (ERW), or contamination on the basis of indirect evidence of the presence of mines/ERW’ (IMAS 04.10, 2003, January 1). In 1998, the Croatian Mine Action Centre was established and began work on a General Survey (Official Gazette, 2017) and Technical Survey (IMAS 04.10, 2003, January 1) of all SHAs in Croatia.

By 2008, Croatian Mine Action Centre personnel had completed the General Survey and defined and marked all SHAs in Croatia. They were defined as larger than in reality, in order to reduce risks for local populations. Mine clearance (IMAS 04.10, 2003, January 1) is a long-term, expensive process, and Croatia has committed itself to resolving the problem of landmines on its territory by 2019 (National Mine Action Strategy, 2017). The General Survey is a ‘set of measures and procedures by which data on actual or potential areas and/or buildings under contamination by mines or explosive remnants have been collected, analysed, confirmed and updated’ (Official Gazette, 2017). The Technical Survey refers to the collection and analysis of data, using appropriate technical interventions, about the presence, type, distribution and surrounding environment of mine/ERW contamination, in order to define better where mine/ERW contamination is present, and where it is not, and to support land release prioritisation and decision-making processes through the provision of evidence. (IMAS 04.10, 2003, January 1)

On 1 July 2017, the total SHA in Croatia was 440.6 square kilometres (sq km) (CROMAC, 2017a), a figure which is reducing annually (due to demining and reduction) by about 60 sq km (in 2015, by 67.7 sq km; in 2016, by 41.7 sq km (CROMAC, 2017b). The plan for 2017 was 58.3 sq km (Government of the Republic of Croatia, 2017)). It is clear that at this rate, Croatia will not be able to fulfill its obligations to resolve the problem of mines by 2019. In order to speed up the process, methods must be found to analyse and visualise existing and newly collected data for reducing and redefining SHAs (CROMAC, 2010) without actually entering them physically. A Non-Technical Survey (IMAS 04.10, 2003, January 1) has been carried out for this purpose. The Non-Technical Survey refers to the collection and analysis of data, without the use of technical interventions, about the presence, type, distribution and surrounding environment of mine/ERW contamination, in order to define better where mine/ERW contamination is present, and where it is not, and to support land release prioritisation and decision-making processes through the provision of evidence. (IMAS 04.10, 2003, January 1)

In 2008, the Advanced Intelligence Decision Support System (AIDSS) was developed in Croatia for conducting the Non-Technical Survey (Bajić, Gold, Fiedler, & Gajski, 2008), and was implemented from 2008 to 2011 in Croatia and Bosnia and Herzegovina...
(Bajić & Turšić, 2010). It was further developed and used in the TIRAMISU project (TIRAMISU, 2012–2015) and renamed T-AIDSS (Krtalić, 2016). The AIDSS methodology is described in Bajić (2010), Bajić, Matić, Krtalić, Čandjar, & Vuletić (2011), and Bajić, Laura, & Turšić, (2012), and T-AIDSS in Krtalić (2016). The technique described in this work is actually an improvement on the Non-Technical Survey providing a potential development in non-technical survey tools rather than in actual mine clearance.

The main objective of this work was to create a large-scale mine danger map for Svilaja SHA in Croatia. The input data consisted of information stored in mine information systems (MIS) and additional data collected on SHAs (e.g. positions of bunkers and shelters for tanks, artillery and people). These data and their influence on the environment were visualised on maps respecting scientific cartographic principles. The resulting maps (see Main Map) aim to improve the identification of areas where there is no information about threats, so parts of SHAs can be proposed for mine reduction.

2. Methods

AIDSS was developed through the implementation of generic methodology for support in decision-making out of the SMART project (SMART, 2001–2004; Yvinec et al., 2003; Yvinec et al., 2017) funded by the European Commission. Improvements were made in the TIRAMISU project (TIRAMISU, 2012–2015), and it was renamed T-AIDSS, also funded by the European Commission. The concept of T-AIDSS and the tasks in each phase are shown in Figure 1.

The main entry data in AIDSS are indicators of mine presence and absence and their confidence levels (Maathuis, 2001; Vanhuyssen et al., 2004; Yvinec et al., 2017). An indicator of mine presence (IMP) is a military fortification object such as a trench or bunker, or a natural object such as abandoned agricultural land on terrain which experts in military doctrine in the specific geopolitical area assume to be defended by mines. An indicator of mine absence (IMA) is a surface assumed to be free of mines. The main entry data in T-AIDSS are strong IMPs (Bajić et al., 2009a) and their confidence levels (Krtalić & Racetin, 2015). Strong IMPs in Croatia and Bosnia and Herzegovina include artificial objects such as trenches, shelters, bunkers, drywalls, and other fortification obstacles set up for military purposes. The SMART project research defined a wide range of IMPs for all types of land (lowland, hilly or mountainous) and corresponding socio-economic aspects (Bajić, 2010; Bajić et al., 2011), (Bajić, Krtalić, Matić, & Vuletić, 2009b). This article concerns only IMPs found in Svilaja SHA.

2.1. Analytical assessment of existing data and requirements for collecting additional data

The most crucial step (Step 1 in Figure 1) for the success of T-AIDSS application is the analytical assessment of data available in the Mine Information Systems (MIS) of national Mine Action Centres (Matić, Laura, Turšić, & Krtalić, 2014). Analysis indicates the general and
specific requirements for airborne and space-borne collection (Step 2 in Figure 1) and the production of new information, data and evidence about the current situation in an SHA (Step 2 in Figure 1 (Bajić et al., 2011)). A well-structured spatial database is essential for successful demining management (Gentile et al., 1997; Lacroix, Shimoni, Acheroy, & Wolff, 2000). Although the most widely used system in this context is the Information Management System for Mine Actions (IMSMA, 2017), the Croatian Mine Action Centre has developed its own MIS (Biljecki et al., 2006), adapted to deal with complex humanitarian demining procedures and the implementation of public procurement and quality control processes for technical surveys and demining in Croatia (Jelenić & Šaban, 2000).

2.2. Collection, pre-processing and processing of new data within T-AIDSS

Based on the general and specific requirements for airborne and space-borne collection of new data, the list of indicators for Svilaja SHA was established. Additional information in the Non-Technical Survey was collected using aerial or satellite images (Step 2, Figure 1) (Acheroy & Yvinec, 2008; Maathuis, 2001).

Strong IMPs are detected and extracted by mine scene interpreters who examine aerial and satellite images, and a confidence level is assigned to each one (Step 2 in Figure 1). A confidence level is the level of the expert’s confidence in his decision about the existence of IMPs on images. Experts in humanitarian demining determine the general importance of each IMP (Table 1) based on their knowledge of military doctrines in specific geographic areas, and on their prior experience in demining projects. The general importance of an IMP can be changed depending on the confidence level. An IMP with a higher confidence level and lower general importance may be assigned higher relative importance, and vice versa. So an expert decides on the importance and usefulness of the information. There is an important distinction between information gleaned from MIS and that acquired by extraction from aerial and satellite images. Not all MIS information includes confirmed data. In contrast, all IMPs detected in images can be spatially positioned, confirmed, and supported by the appropriate level of confidence.

2.2.1. Zone of influence and membership function

Minefields are areas of ground containing mines laid with or without a pattern (IMAS 04.10, 2003, January 1). Minefields are laid to protect human life in or behind fortification objects. At the same time, soldiers are expected to defend their fortification. For this reason, the distance of the minefield from the fortification object depends on the type of terrain where conflict took place. On level ground, minefields tend to be further away from fortification objects, but in mountainous terrain, they are closer. All data were derived strictly for the considered region and cannot be generalised to other regions. Experts in Croatia and Bosnia and Herzegovina can produce information about how far a minefield is likely to be located from the fortification object (Step 2 in Figure 1). This information is based on military documents specifying precise instructions on making fortifications and laying certain types of mines (Rules of Service of the Yugoslav People’s Army), familiarity with war doctrine applied in certain geographic area, type of the terrain, on contextual data, on the data obtained from military maps and years of experience spent on demining projects (over 20 years). The zone extending from the fortification object to the furthest point assessed by the expert is known as the zone of influence (Vanhuysen et al., 2004) (Figure 3(c)). Zone of influence on the environment indicators are linked with IMP membership functions (Ross, 2010). Membership functions (Figure 2) describe the influence of each IMP on its surroundings and neighbouring indicators. Control points determined by an expert (Table 1) define the form of membership function. In this way, expert knowledge is introduced in a membership function.

Table 1. List of indicators of mine presence with importance, zone of influence on the environment and control points of membership functions for the production of danger maps for the mountainous terrain of Svilaja, Croatia.

| Indicator of mine presence (IMP) | Risk starts at (m) | Max. risk from (m) | Max. risk to (m) | No risk beyond (m) | Importance of IMP |
|---------------------------------|-------------------|--------------------|-----------------|-------------------|------------------|
| Mine accident                   | 0                 | 0                  | 100             | 200               | 1                |
| Reconstructed position of minefield | Surface of indicator |                    |                 |                   | 2                |
| Trench                          | 0                 | 50                 | 250             | 300               | 3                |
| Bunker                          | 0                 | 50                 | 250             | 300               | 3                |
| Shelter                         | 0                 | 50                 | 250             | 300               | 4                |

Figure 2. Membership function for linking the zone of influence of trenches with control points. The maximum risk starts at 50 m and ends 250 m from the trench. Further than 250 m from the trench, the risk is reduced and is eliminated at 300 m. However, the zone of influence for the same IMP varies depending on the type of terrain and previous demining experiences.
2.2.2. Position lines

The positions of neighbouring IMPs are generalised and shown with lines (Step 2 in Figure 1) and the position lines of military units (Figure 3(a,b)). The confidence of the strongest IMP in the system is attached to these position lines. Lines of the same confidence are stored together in vector files, and the zones of influence are attached to them in the form of buffers (Figure 3(c)). This is an innovation in relation to the methodology developed in the SMART project, and was done by drawing buffers around or on one side of position lines according to the control points (Table 1).

2.3. T-AIDSS decision support system

The weights of all IMPs were calculated using the Analytic Hierarchy Process (AHP), a technique for converting subjective assessments of relative importance into a set of weights (Saaty, 1987) (Step 3 in Figure 1). To make comparisons, a scale of numbers is required that indicates how many times more important or dominant one IMP is over another in relation to the criterion or property to which they are compared (Saaty, 2008).

AHP is a multi-criteria decision-making approach which helps structure the problem of making decisions based on mutual comparisons of the alternatives and expert decisions (Peng, Kou, Wang, Wu, & Shi, 2011). The decision-maker makes an independent assessment about the relative importance of some criteria over others, and the procedure is repeated for the other alternatives in accordance with each criterion. In comparison with other decision-making methods and techniques, AHP allows a comparison of the individual importance of any one IMP in relation to another based on confidence. A pairwise comparison of the all IMPs was performed in order to allocate them a relative weight related to their importance. Based on previous humanitarian demining experience, an expert determines the importance of IMPs, introducing empirical knowledge into the calculation of weights.

The T-AIDSS Decision Support System was designed to analyse all available data on a battlefield stored in MIS and additional SHA data collected and processed by the T-AIDSS, and implement data fusion (Step 3 in Figure 1). Multi-criteria analysis is used to calculate the weight of all IMPs based on their importance and confidence, while data fusion is used to visualise the overall impact of all IMPs on the environment and each other. Data fusion provides experts with additional information about the SHA to help them make decisions on redefining its size. The end results of data fusion are mine danger maps (Yvinec et al., 2017).

2.4. Mine danger maps and proposals for Suspected Hazardous Area reconstruction

In T-AIDSS, mine danger maps serve to visualise the positions and zone of influence of all detected IMPs on the environment. In other words, they visualise areas for which T-AIDSS has provided data indicating the possible presence of minefields. Two types of mine danger maps have been defined: discrete and continuous (Bloch, Milosavljević, & Acheroy, 2007; Wolff, Vanhuysse, & Willekens, 2004). Discrete location maps (Step 4, Figure 1) indicate the zone of influence of IMPs on the environment, based on expert knowledge of mine-laying methods (Matić, Krtalić, Vuletić, Bajić, & Gold, 2004) around detected IMPs, and the joint impact of all indicators on the location observed (Bloch et al., 2007; Wolff et al., 2004). The result is binary, in the zones of influence of the IMPs there is mine danger, whereas outside, T-AIDSS has no information about danger. All the indicators are on the same level, there is no weighting of the indicators according to their importance. Continuous location maps show zones of influence around all detected IMPs, and differ from discrete maps by showing the interaction between types of indicator based on importance within a set of IMPs and confidence level, rather than only the common impact of all indicators (Bloch et al., 2007). The continuous location map pictures a weighted sum of factors derived from the IMP. They form the basis for the final T-AIDSS output (Step 4, Figure 1):

Figure 3. (a) All detected and extracted indicators of mine presence (IMPs) in one part of Svilaja SHA. (b) Position line (blue) based on IMPs and terrain configuration. (c) Zone of influence attached to position line (pink buffers) depicted on a topographic map at a scale of 1:25,000.
– proposal for SHA reduction,
– proposal for including area in SHA.

2.4.1. Danger maps in the SMART project
Two types of continuous location maps have been defined (Wolff et al., 2004): location maps (Figure 4 (a)) and confidence maps (Figure 4(b)). A confidence map is a thematic map which shows the degree of confidence of claims presented on a continuous location map (Wolff et al., 2004). Within T-AIDSS, only one such map type has been defined with all data from both maps (location maps and confidence maps).

2.5. Validation and application of T-AIDSS results
T-AIDSS results do not show actual, but potential danger from mine threats. So T-AIDSS methodology implies a confidence level for each claim. Validation of T-AIDSS results and decisions regarding risk levels is carried out by experts from the Croatian Mine Action Centre according to state legislation and standard operating procedures (CROMAC, 2010; Laura, 2012). They decide on exclusion or inclusion in an SHA or require further action (Step 5 in Figure 1). Following a decision, changes are stored in the MIS (Step 6 in Figure 1).

2.5.1. Internal cost benefit analysis
The blind tests performed on 3 SHAs in Croatia (≈ 33 sq km) in the SMART project showed that this method had a reduction rate of 26% and an error rate of 0.1% (Yvinec, 2005). For three areas processed (the municipalities of Gospić, Bilje and Drniš ≈ 115 sq km) as part of the Deployment of the Advanced Intelligence Decision Support System for Mine Suspected Area Reduction project, cost benefit analyses were carried out (Bajić and Krtalić, 2009; Bajić, 2010). The outcome of applying AIDSS to SHA reduction was a proposal in 2010 for a reduction of 10.99 sq km (Gospić: 5.23 sq km, Bilje: 5.68 sq km, Drniš: 0.08 sq km – 10.5% of the total area of interest). The data were used in General Surveys conducted by the Croatian Mine Action Centre in 2011, when the SHA was reduced by 70,355.31 square meters (sq m) (27,665.26 sq m by demining and 42,690.05 sq m by reduction) (CROMAC, 2012). A cost benefit analysis was performed mainly for the user of the results achieved by the project (Bajić and Krtalić, 2009). The cost of the project was USD 244,512.47 while the cost of demining borne by the Croatian Mine Action Centre was USD 16,434,098.56 (Bajić and Krtalić, 2009). The calculated cost did not include performing the proposed reduction on the part of the Croatian Mine Action Centre. The estimated time needed Centre to carry out the proposed reduction was between one and three months (Bajić and Krtalić, 2009). This information was presented in (Bajić et al., 2012) and Davor Laura (Head of Sector for Operations at the Croatian Mine Action Centre) at the Humanitarian Demining 2012 international symposium in Šibenik, Croatia.

3. Mine Danger Maps of Svilaja Suspected Hazardous Area
One region of interest in the TIRAMISU project was Mt. Svilaja in Dalmatian Zagora. Croatian Mine Action Centre personnel wanted to verify suspicions regarding

Figure 4. Examples of (a) a continuous location map and (b) a continuous confidence map for Pristeg SHA, Croatia, derived from the SMART project (Wolff et al., 2004).
IMPs outside the defined SHA. Significant areas of danger had been shown outside the SHA. The T-AIDSS results must be checked separately. If they are accurate, the areas in question should be proposed for inclusion in the SHA, which would enlarge it and emphasise the mine danger more. On the other hand, handling the discovery and marking the area appropriately would actually reduce the danger to human life, as the local population would have access to new information and conduct themselves appropriately.

3.1. Discrete mine danger map for Svilaja Suspected Hazardous Area (Croatia)

The importance of IMPs and confidence was not used to produce the Discrete mine danger map for Svilaja SHA (see Main Map). The area of all buffers around IMP position lines was considered dangerous by T-AIDSS. This of course does not imply that the rest of the SHA is free of mines. T-AIDSS has no data and cannot calculate the presence of mine danger in that area. The map shows the area that could potentially be excluded from the SHA according to T-AIDSS.

3.2. Continuous mine danger map for Svilaja Suspected Hazardous Area (Croatia)

Multiplying the weight factors obtained and the discrete mine danger map resulted in the thematic presentation of all IMP zones of influence, coloured according to weight factors on the Continuous mine danger map for Svilaja SHA (see Main Map). The surfaces of all zones of IMP influence with the weighted sum of factors derived from the IMP or IMA were shown on the map.

4. Cartographic visualisation

A section of sheet TK25 4416-4-2-4 of the Pribude topographic map (produced by the State Geodetic Administration in 2001) was used as the base map to create the main content of both mine danger maps (see Main Map). Objects depicted on the base map were graphically subordinate to thematic data on mining activities. The contrast was adjusted, and the entire contents of the topographic map shown in one colour (grey), so that the thematic data depicted were clearly the primary content.

On the Discrete mine danger map, the IMP zones of influence were shown in red, and the IMA zones in green. This complies with conventional visual language, as red is usually associated with prohibition and green with permission.

On the Continuous mine danger map, a scale of red shades was created to select the intensity of degrees of mine danger.

Svilaja SHA was marked by an orange-filled symbol outline. Triangles along the symbol outline related the symbol to point hazard features, while the transparent fill did not conceal the underlying topographic map. The symbol fill for the area to be demined was complemented by 45° cross-hatching, to distinguish it from the symbol for the area to be investigated.

This method of creating symbols was aligned with the recommendations for producing cartographic symbols for humanitarian demining maps in the Information Management System for Mine Action (IMSMA) (Kostelnick, 2005). By adhering to standardisation and easily recognisable symbols at the international level, we attempted to align the visual appearance of our symbols (Kostelnick, Dobson, Egbert, & Dunbar, 2008).

The point symbol for mine accident was adopted from the recommended IMSMA set of map symbols, but four additional symbols for indicators (bunker, armoured vehicle position, infantry combat shelter, earth berm) had to be freshly designed following the taxonomic structure and visual organisation of map symbols for IMSMA (Figure 5), in order to ensure

| Map symbols adopted from the IMSMA map symbol set | Newly designed map symbols for inclusion in the IMSMA map symbol set |
|-----------------------------------------------------|---------------------------------------------------------------|
| ![Hazards (Areas)](image) | ![Bunker](image) |
| ![Mined Area](image) | ![Infantry combat shelter](image) |
| ![Cleared/Safe Area](image) | ![Earth berm](image) |
| ![Mine accident](image) | ![Position of armoured vehicle](image) |

Figure 5. The graphic appearance of existing IMSMA map symbols (left) was completely maintained, adhering to the concepts of standardisation and better international recognition. New solutions for missing symbols were created (right) following the taxonomic structure and visual organisation of existing IMSMA symbols.
the consistency and homogeneity of their graphic appearance in relation to existing symbols. The new symbols will be submitted to the Geneva International Centre for Humanitarian Demining (GICHD) for inclusion in the current symbol set (Figure 5).

5. Conclusion

The results of this research were two mine danger maps for Svilaja SHA (Croatia) at the scale of 1:25,000. The Discrete Mine Danger Map for Svilaja SHA indicates the zone of influence of IMPs on the environment, while the Continuous Mine Danger Map for Svilaja SHA shows the zones of influence around all detected IMPs, and differs from the discrete map by showing the interaction between types of indicator based on importance within a set of IMPs, rather than only the common effects of all indicators. These are the first attempts to include the importance, weight and confidence of all strong IMPs on mine danger maps, visualised in the same display, specially adapted for cartographic communication in humanitarian demining, and abiding by scientific cartographic principles.

Mine danger maps are products of the Non-Technical Survey and are highly applicable in humanitarian demining, to better visualise IMP influence on the environment and assess mine danger before entering an SHA. Surveyors and Mine Action Centre resources can be used better to indicate areas with no data on mine contamination, or where the confidence of statements is very low. This is a useful move forward in visualising SHAs and should lead to improving efficiency by supporting clearance planning and implementation. Mine danger maps can also be useful when reducing an SHA. Visualised IMP zones of influence can help detect potential danger areas and those with no IMP influence. Surveyors from national Mine Action Centres can then be sent into these areas to confirm or refute information from mine danger maps. This has already been implemented in two SHAs in Croatia and has resulted in significant reductions (11 sq km). It saves money which would otherwise be spent on demining the reduced areas, and shortens the time needed to demine Croatia as a whole.

An additional benefit of mine danger maps is the potential for modelling various scenarios. The buffers around IMPs, control points of zones of influence and weight factors can be changed based on the configuration of the terrain, previous demining experiences, and additional information about a particular SHA. Mine danger maps are ‘live products’ and can be updated and modelled according to new insights and data on military doctrines or methods of laying minefields and obstacles in a specific geographic area.

The limitations of this concept are the ability to detect IMPs on aerial and satellite images, and the skills of mine scene interpreters.

Software

Indicators were vectorised using QGIS software, while ArcGIS software was used to draw buffers, as it provides the option of drawing one-sided buffers. Idri software was used to calculate the weight factors of all indicators and perform multi-criteria analyses and data fusion. The maps were produced using QGIS.

Data

The following data were used in the production of mine danger maps for Svilaja SHA:

- MIS data (graphic, attribute, contextual) specially prepared and provided with a license for use for the TIRAMISU project and dissemination of results by the Croatian Mine Action Centre for Svilaja SHA.
- Lists of IMPs and expert knowledge of military doctrines in the specific geographic area, formalised according to these parameters; importance of IMPs, control points for depicting zones of influence of individual IMPs, calculated weight factors according to the importance of IMPs, and levels of confidence for all IMPs.
- Aerial images acquired using a 3 K photogrammetric camera (DLR), and satellite images from the Worldview2 system (purchased by the Free University of Brussels, Belgium IGEAT) for the needs of the TIRAMISU project.
- Vectorised positions of IMPs (by researchers from the Faculty of Geodesy, University of Zagreb, Croatia, and its partners: Free University of Brussels, Belgium (IGEAT); Royal Military Academy, Brussels (RMA), Belgium (IGEAT); Paris-Lodron University of Salzburg Centre for Geoinformatics, Salzburg, Austria (PLUS); German Aerospace Centre, Germany (DLR), and NOVELTIS, Labège, France).

Acknowledgements

Tools developed by the following TIRAMISU project partners were used to produce thematic data depicted on these maps: Free University of Brussels, Belgium (IGEAT); Royal Military Academy, Brussels (RMA), Belgium (IGEAT); Paris-Lodron University of Salzburg Centre for Geoinformatics, Salzburg, Austria (PLUS); German Aerospace Centre, Germany (DLR), NOVELTIS, Labège, France).

Disclosure statement

No potential conflict of interest was reported by the authors.
Funding
This work was supported by European Community’s Fifth Framework Programme (FP5-IST), Project ID [2000–25044] (‘SMART project’), and European Community’s Seventh Framework Programme (FP7-SECURITY – Specific Programme ‘Cooperation: Security’), under grant agreement No. [284747] (‘TIRAMISU project’).

ORCID
Andrija Krtali @ http://orcid.org/0000-0002-9441-0179
Ana Kaveždić Divjak @ http://orcid.org/0000-0003-1059-8395
Robert Župan @ http://orcid.org/0000-0001-7882-1173

References
Acheroy, M., Yvinec, Y. (2008). Chapter 3, Mine-suspected Area reduction using aerial and satellite images. eBook Humanitarian Demining, Edited by Maki K. Habib, ISBN 978-3-902613-11-0, 392 pages, Publisher: i-Tech Education and Publishing, Chapters published 1 February, 2008 under CC BY-NC-SA 3.0 license, DOI: 10.5772/5409.
Bajić, M. (2010). The advanced intelligence decision support system for the assessment of mine-suspected areas. The Journal of ERW and Mine Action, 14(3), 69–75.
Bajić, M., Buhin, L., Krtalić, A., Cveto, T., Čandjar, Z., Gold, H., Laura, D., Matić, C., Pavković, N., & Vuletić, D. (2009a, April 27–30). Fusion of data, a priori information, contextual information and experts’ knowledge for decision making support in mine suspected area reduction. International Symposium ‘HUMANITARIAN DEMINING 2009’, Šibenik, Croatia, Book of Papers, Oto Jungwirth (editor), Zagreb: HCR-CTRO d.o.o., 11–14.
Bajić, M., Gold, H., Fiedler, T., Gajski, D. (2008). Development of a concept from 1998 and realization of the system for the airborne multisensor reconnaissance and surveillance in crisis situations and the protection of the environment in 2007–2008. Proceedings of the First International Conference on Remote Sensing Techniques in Disaster Management and Emergency Response in the Mediterranean Region, Zadar, Croatia 22–24 September 2008, ed. M. Oulić, EARSEL, pp. 401–410.
Bajić, M., Krtalić, A. (2009). Deployment of the Advanced Intelligence Decision Support System for Mine Suspected Area Reduction in Bosnia and Herzegovina, Final report 2009, V2.0.0, International Trust Fund for Demining and Mine Victims Assistance, Ig, Slovenia, HCR Centre for Testing, Development and Training, Ltd., Zagreb, Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina, April 2009, Internal for ITF, CTRO. Information retrieved 27 January 2018 from https://www.hcr.hr/en/aktualnostCijela.asp?ID=1039
Bajić, M., Krtalić, A., Matić, C., & Vuletić, D. (2009b). Minefield Indicators and Analytical Mine Contamination Assessment in Scientific Projects and in Practice. International Symposium ‘HUMANITARIAN DEMINING 2009’, 27–30 April, Šibenik, Croatia, Book of Papers, Oto Jungwirth (editor), Zagreb: HCR-CTRO d.o.o., 7–10.
Bajić, M., Laura, D., Turšić, R. (2012). Three points of view on the deployment of the Advanced Intelligence Decision Support technology for assessment and reduction of a large suspected area. International Symposium ‘HUMANITARIAN DEMINING 2012’, 24–26 April, Šibenik, Croatia, Book of Papers, Nikola Pavković (editor), Zagreb: HCR-CTRO d.o.o., 7–11.
Bajić, M., Matić, C., Krtalić, A., Čandjar, Z. & Vuletić, D. (2011). Research of a mine suspected area. HCR Centre for testing, development and training Ltd., Zagreb: Sortina 1 d, 10000 Zagreb, Croatia. ISBN 978-953-99879-7-6, Publication. Retrieved from http://www.ctro.hr/en/publications
Bajić, M., Turšić, R. (2010). Operations with Advanced Intelligence Decision Support System for Mine Suspected Area assessment in Croatia and Bosnia and Herzegovina, UNMAS – GICHD Workshop “Merging Mine Action Technology and Methodology”, GICHD, Geneva; 6–8 September 2010. Retrieved 27 January 2018 from, URL: http://www.gichd.org/fileadmin/pdf/technology/Technology-Workshop-2010-C-6Sept2010-SMART-TechWS.pdf
Biljecki, Z., Pavičić, S., & Tonković, T. (2006, December). Concept and establishment of the mine information system within the CROMAC GIP project. Cartography and Geoinformation, 5(6), 76–88.
Bloch, I., Milosavljević, N., & Acheroy, M. (2007). Multisensor data fusion for spaceborne and airborne reduction of mine suspected areas. International Journal of Advanced Robotic Systems, 4(2), 173–186. ISSN 1729-8806.
CROMAC. (2010). Standard Operating Procedure – Area Reduction in SHA, Retrieved from https://www.hcr.hr/pdf/SOP%20REDKCJI%202010%20KONACAN-eng.pdf
CROMAC. (2012). Report on implementation of humanitarian demining and spent financial means in 2011 (in Croatian), Retrieved from https://vlada.gov.hr/UserDocsImages/SjedniceArhiva/61.%20-%2015a.pdf
CROMAC. (2017a). MineSituation. Retrieved from https://www.hcr.hr/en/minSituc.asp#
CROMAC. (2017b). Report on the implementation of main action and expenditure of financial assets in 2015 and 2016 (in Croatian). Retrieved from https://vlada.gov.hr/UserDocsImages/Sjednice/2017/11%20studenjici%20sje%20Vlade%20Republike%20Hrvatske//65%20-%2012a.pdf
Gentile, J., Gustafson, G., Kimesy, M., Kraenzle, H., Wilson, J., & Wright, S. (1997). Use of imagery and GIS for humanitarian demining management. Journal of Conventional Weapons Destruction, 31(28)(1), 104–109.
Government of the Republic of Croatia. (2017). Mine Action Plan for 2017 (in Croatian), Retrieved from https://vlada.gov.hr/UserDocsImages/Sjednice/2017/11%20studenjici%20sje%20Vlade%20Republike%20Hrvatske//65%20-%2012b.pdf
IMAS 04.10. (2003, January 1). Glossary of mine action terms, definitions and abbreviations. Second Edition, Amendment 7, August 2014. Retrieved from https://www.mineactionstandards.org/standards/international-mine-action-standards-imas/imas-in-english/
IMMSA. (2017). IMMSA. Retrieved from http://mwiki.gichd.org
Jelenić, D. & Šaban, S. (2000). The role of GIS in the process of humanitarian mine clearance. In D. Kereković (Ed.), GIS Croatia 2000 International Conference & Exhibition Proceedings (pp. 469–477). Hrvatski Informatički Zbor – GIS Forum.
Kostelnick, J. (2005). Cartographic recommendations for humanitarian demining map symbols in the Information Management System for Mine Action
