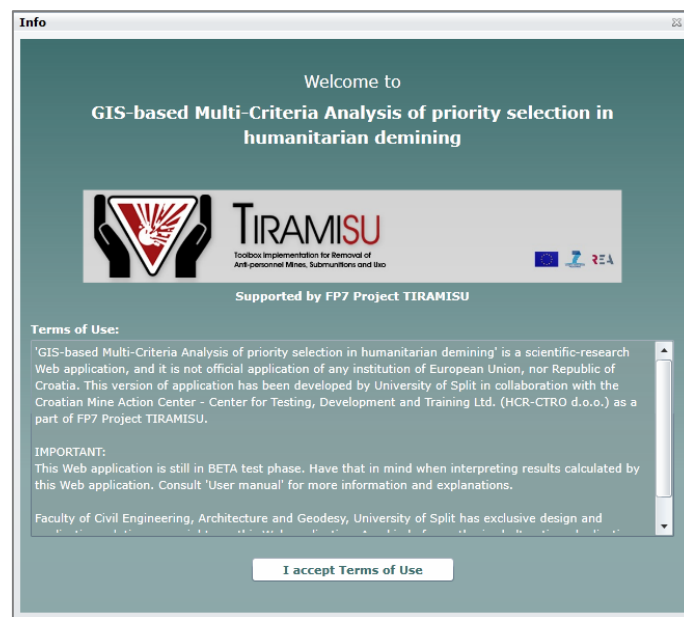


**CROATIAN MINE ACTION CENTER - CENTER FOR TESTING, DEVELOPMENT
AND TRAINING - CTDT LTD.**
(HCR-CTRO D.O.O.)

in collaboration with

UNIVERSITY OF SPLIT
FACULTY OF CIVIL ENGINEERING, ARCHITECTURE AND GEODESY

GIS-based Multi-Criteria Analysis of priority selection in humanitarian demining



- User manual -

DECEMBER 2013

CONTENT

Introduction	3
Basic Tools	5
MCA Case Study “Demining priority selection for Sisacko-moslavacka County”	8
Multi-Criteria Analysis Tool “Mine Action MCA”	12
Additional Tools	16
Acknowledgments and Contact	17

INTRODUCTION

Microsoft Silverlight Web Application

First of all, Web Application "GIS-based Multi-Criteria Analysis of priority selection in humanitarian demining" is Microsoft Silverlight application. You will be prompted to install "Microsoft Silverlight 5 browser plug-in", if you don't have it, so please do that:



After you've installed Silverlight, you will be able to run application properly.

Multi-Criteria Analysis (MCA)

MCA used in this Web Application is a special, not only Multi-Criteria Analysis (MCA) method, but also Multiple-Criteria Decision Analysis (MCDA) method called: PROMETHEE method.

Problem of priority selection in humanitarian demining is well known problem of the selection or the ranking of alternatives. Such a problem submitted to a multicriteria evaluation is not an easy problem, neither economically nor mathematically. Usually there is no optimal solution; no alternative is the best one on each criterion. In the recent years several decision aid methods or decision support systems have been proposed to help in the selection of the best compromise alternatives. In this Web Application the PROMETHEE method was chosen for treating multicriteria problem. This method is known as one of the most efficient but also one of the easiest in the field. PROMETHEE method is well accepted by decision-makers because it is comprehensive and has the ability to present results using simple ranking.

An input for PROMETHEE method is a matrix consisting of set of potential alternatives (actions) A , where each a element of A has its $f_j(a)$ which represents evaluation of one criteria:

	$f_1(\cdot)$	$f_2(\cdot)$	$f_j(\cdot)$	$f_k(\cdot)$
a_1	$f_j(a_i)$					
a_2						
...						
a_i						
...						
a_n						

Each evaluation $f_j(a_i)$ must be a real number. Using data presented in a matrix method PROMETHEE I ranks actions by a partial pre-order, with the following dominance flows:

$$\text{leaving flow: } \Phi^+(a) = \frac{1}{n-1} \sum_{x \in A} \pi(a, x)$$

$$\text{entering flow: } \Phi^-(a) = \frac{1}{n-1} \sum_{x \in A} \pi(x, a)$$

where a denotes a set of actions, n is the number of actions and π is the aggregated preference index defined for each couple of actions. The PROMETHEE I method gives the partial relation. A net outranking flow is obtained from PROMETHEE II method which ranks the actions by total pre-order:

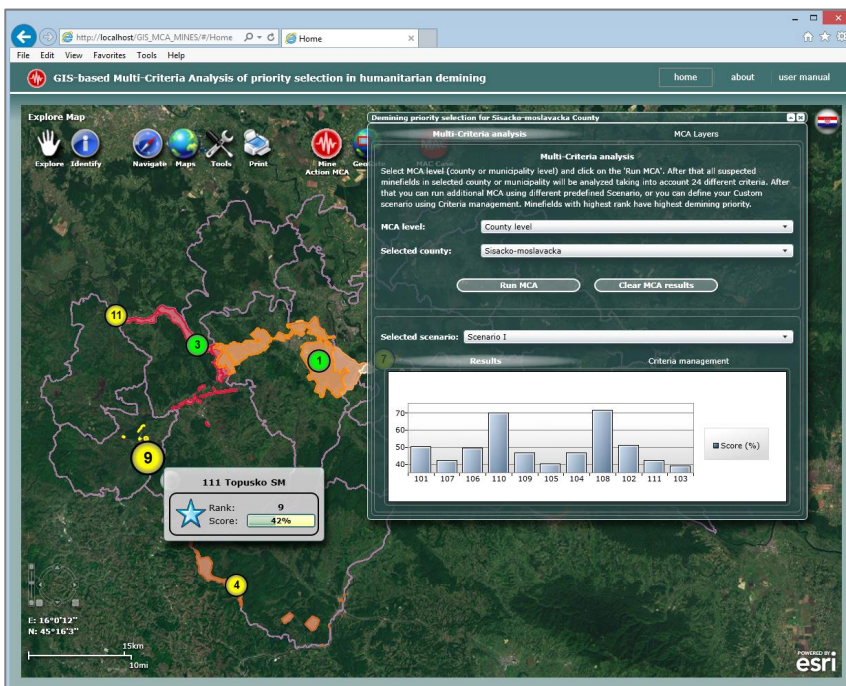
$$\Phi(a) = \Phi^+(a) - \Phi^-(a)$$

However, in this Web application a net outranking flow is expressed as absolute score in percent. In the sense of priority assessment net outranking flow represents the synthetic parameter based on defined criteria, priorities among criteria and criteria weights. Additionally, different sets of criteria weights can be used and then each set represents one scenario. Usually MCDA problems have more than one scenario.

For this Web Application an input MCA data (PROMETHEE matrix) were formed for suspected minefields in County Sisacko-moslavacka using 24 different criteria. Criteria weights were determined by experts. Example of part of MCA data presented in MS-Excel sheet:

ID	NAME	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24
B1	Dvor	7	3200	0	0	400	0	1000	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	36440	130	0
B2	Dvor	0	0	1000	40000	0	150	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	40630	0	0
B3	Dvor	0	0	0	700000	0	300	0	0	0	0	0	0	0	0	5	0	0	0	0	4000000	0	45480000	0	2
B31	Dvor	15	6000	0	0	100	300	0	0	0	0	0	1000	0	0	5	0	0	0	0	0	0	21340	0	0
B32	Dvor	8	1800	0	31000	0	250	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	31340	370	0
B4	Dvor	10	5000	0	0	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31380	150	0	
B5	Dvor	10	3000000	1500	0	0	500	2500	0	0	0	0	0	0	0	0	2500000	0	5000	3000000	3000	2502000	400	0	
B6	Dvor	10	3000000	1500	0	0	500	2500	0	0	0	0	0	0	0	0	8000000	0	20000	8000000	7000	13900000	650	0	
B7	Dvor	10	5000	1000	0	400	0	1000	0	0	0	0	0	0	0	0	0	1000	0	0	0	32050	182	0	
B10	Glina	5	30000	0	1900000	0	4000	2000	2000	1800	0	1000	0	0	0	5	2500000	3000	0	0	0	1924000	31	0	
B11	Glina	400	2000	5000	800000	7500	0	1250	0	0	0	0	0	0	5	625000	0	0	850000	0	3815000	125	2		
B12	Glina	400	2000	5000	800000	7500	0	1250	0	0	0	0	0	0	0	625000	0	0	850000	0	1344000	125	2		
B13	Glina	400	2500	6500	1598000	7500	0	1250	0	0	0	0	0	0	0	625000	0	0	850000	0	9593000	125	1		
B14	Glina	400	2000	5000	800000	7500	0	1250	0	0	0	0	0	0	0	625000	3000	0	850000	0	4303000	125	1		
B15	Glina	300	500	500	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8401	89	1	
B8	Glina	0	10000	1000	1800000	200	1000	0	2000	4000	0	500	0	0	0	8	2500000	0	0	50000	0	1824000	124	1	
B9	Glina	0	0	0	1400000	0	0	0	0	0	0	0	0	0	150000	0	0	150000	0	150000	0	149700	31	1	
B72	Gvozđ	0	0	0	200000	500	0	0	0	0	0	0	0	0	0	0	400000	300	0	400000	0	439870	93	0	

In this stage of development, MCA input data can be changed only by GIS Server Administrator. The output data (results of MCA) are presented in several ways, as it is described later:



Other Geographic Information System (GIS) data presented in Web Application are from ArcGIS Server 10.1 of University of Split. Important notice is that all suspected minefields data are data collected in 1999, few years after the war in Croatia. Suspected minefields presented in this Web Application are not realistic, because of the many demining actions in last 15 years.

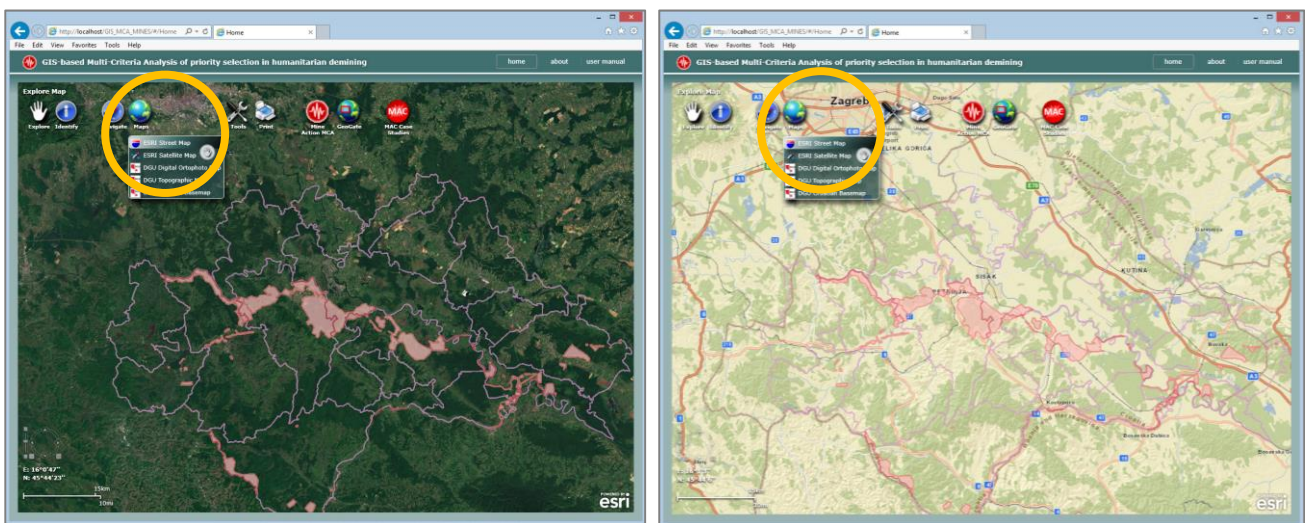
BASIC TOOLS

Web Application has its own toolbar with all functionalities:

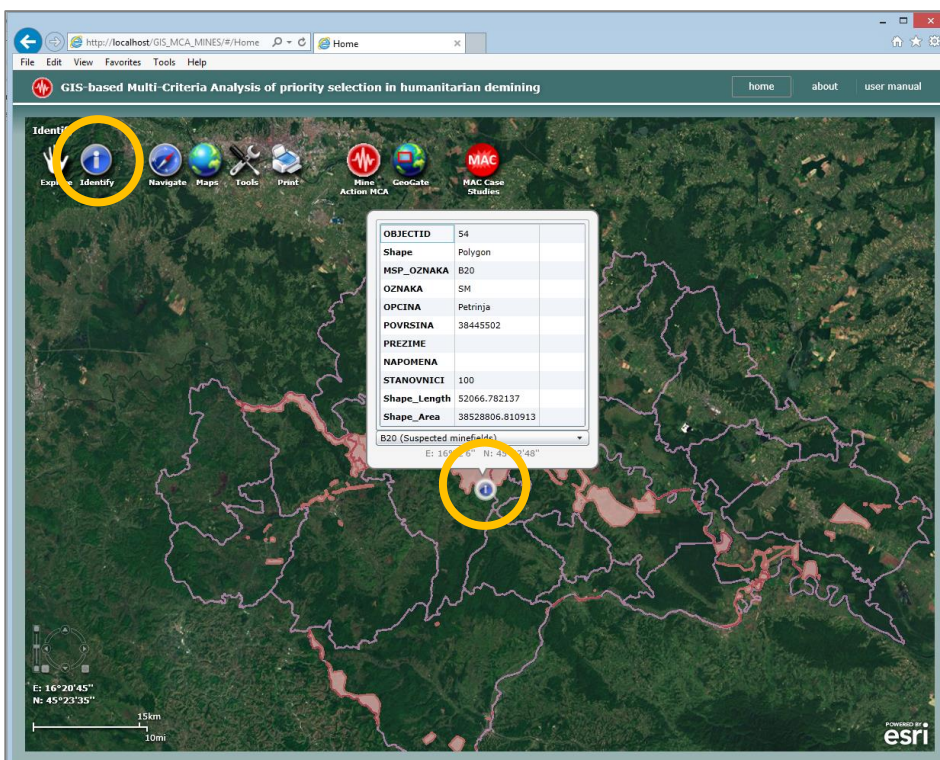


Use **Explore** tool to navigate map using mouse. Press and hold left mouse button to move map in any direction. Use mouse scroll button to Zoom In or Zoom Out map. Or you can select particular navigation tool using **Navigate** menu.

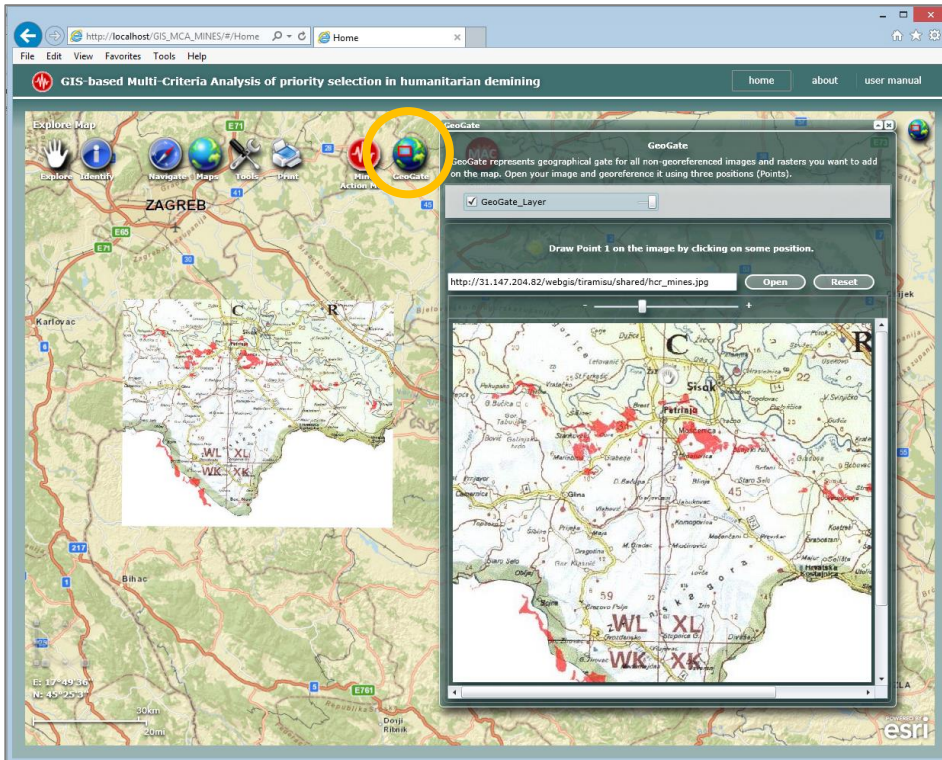
Use **Map** menu to change basemap (Satellite Map, Street Map, etc.).



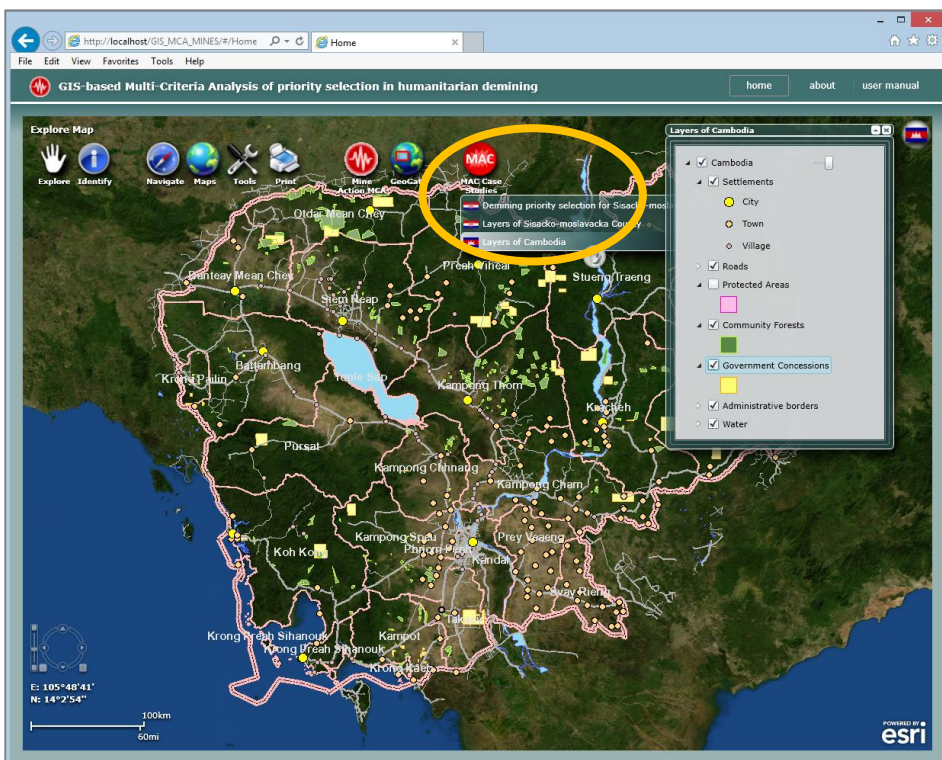
Use **Identify** tool to read feature data of GIS thematic layers:



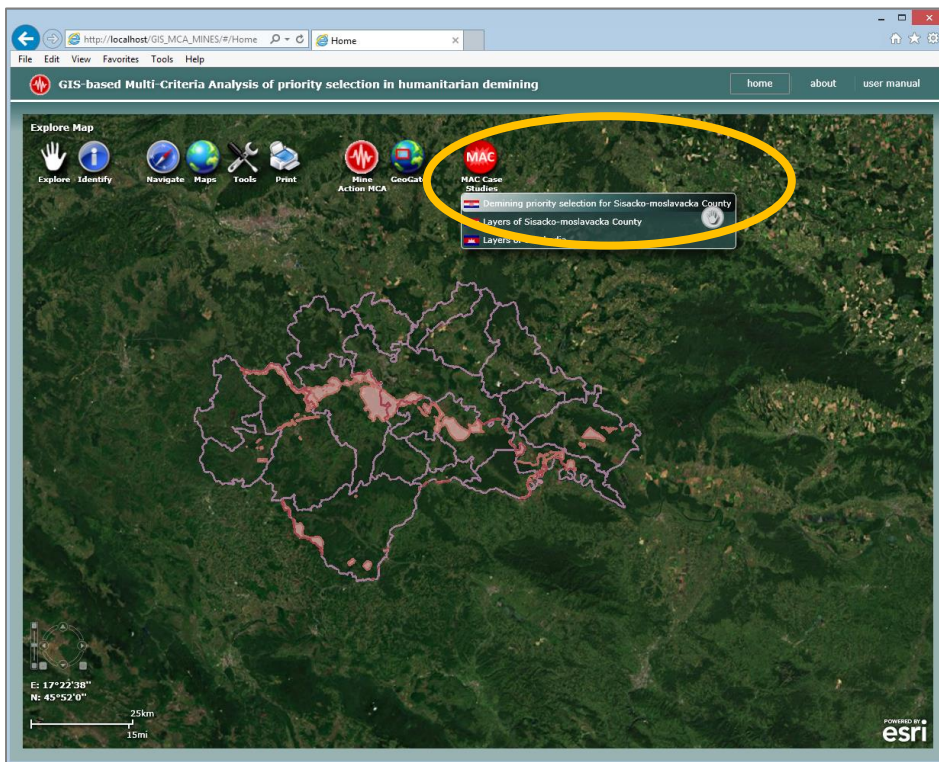
Open **GeoGate** tool to geo-reference any image (in PNG or JPEG format) from the Web using three points:



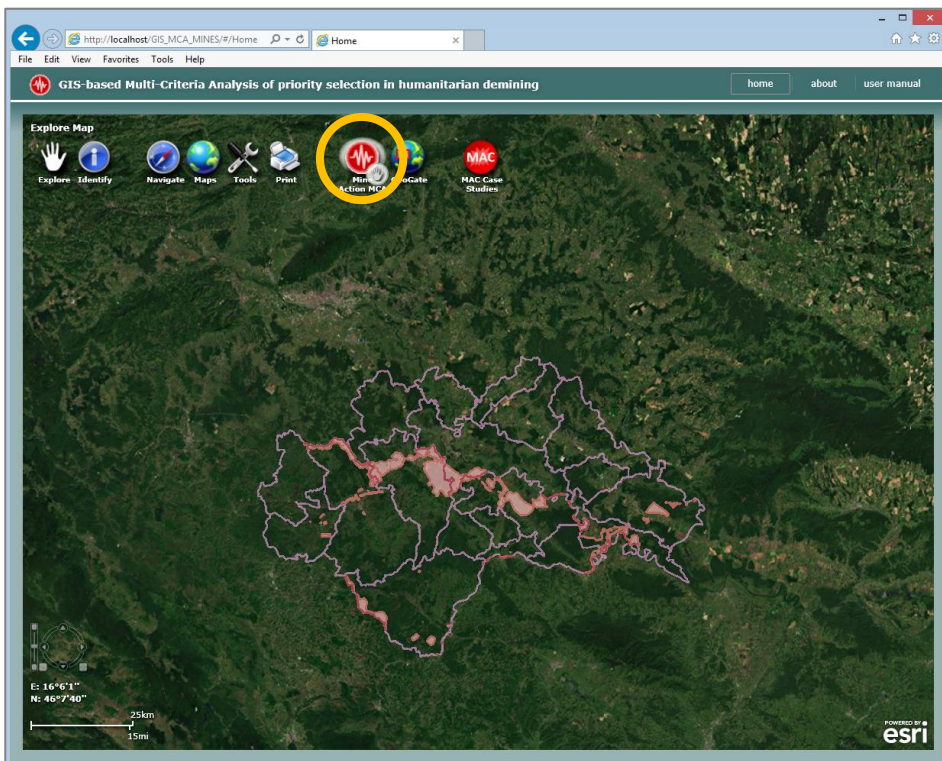
Explore **MAC Case Studies** to see some Case Study from Mine Action Community:



In **MAC Case Studies** click on **Demining priority selection for Sisacko-moslavacka County** to understand Multi-Criteria Analysis on MCA Case Study (go to Page 8):

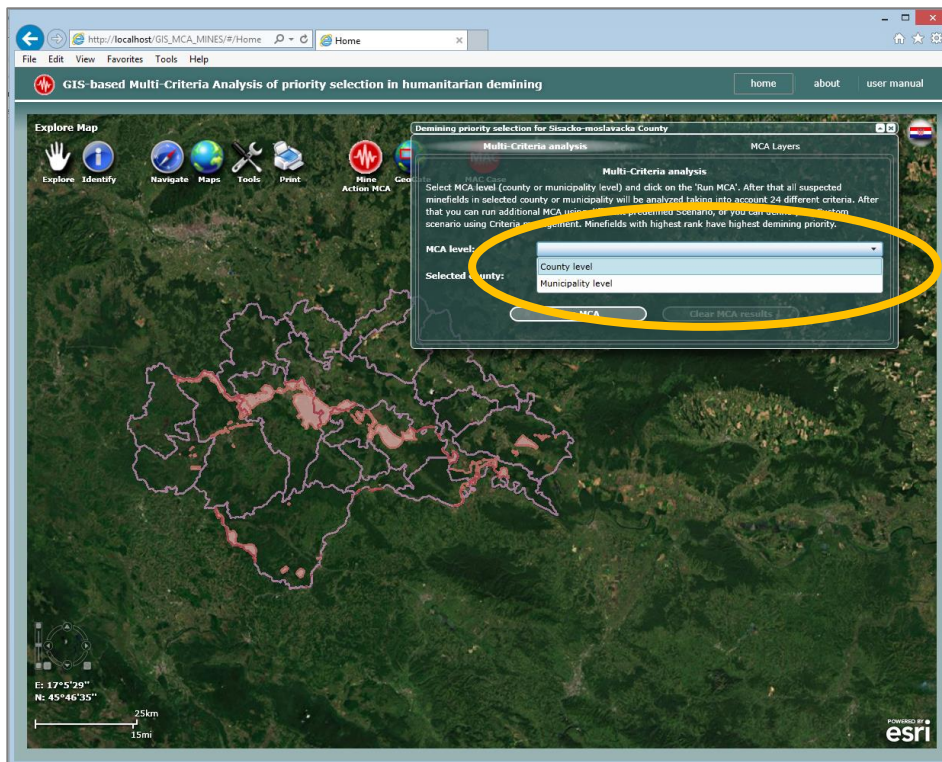


Click on **Mine Action MCA** if you are ready to use Multi-Criteria Analysis (go to Page 12):

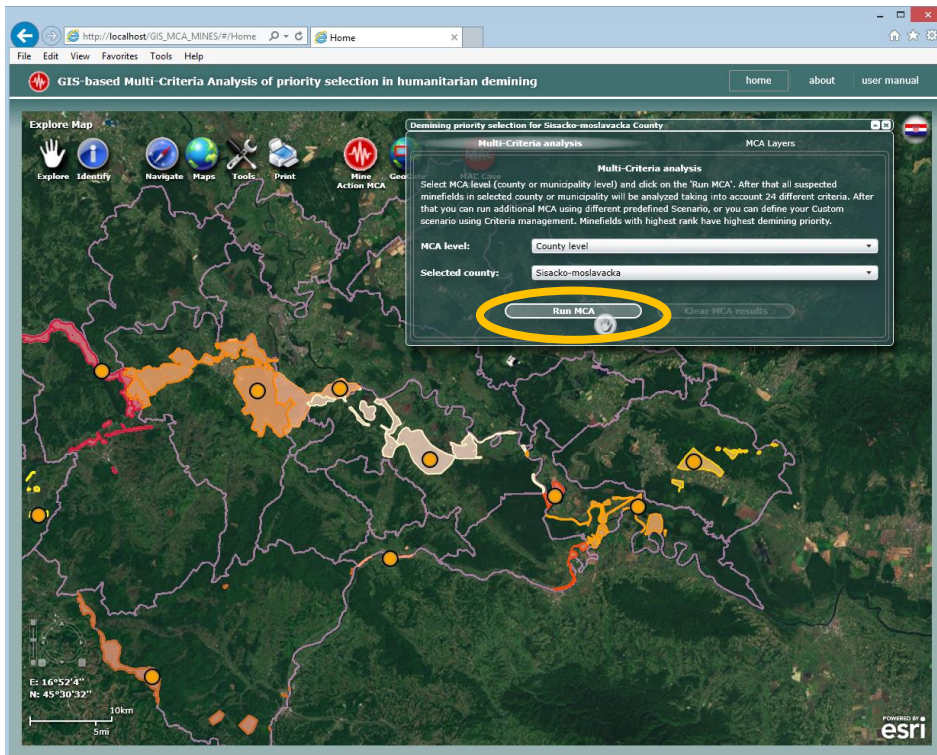


MCA CASE STUDY “Demining priority selection for Sisacko-moslavacka County”

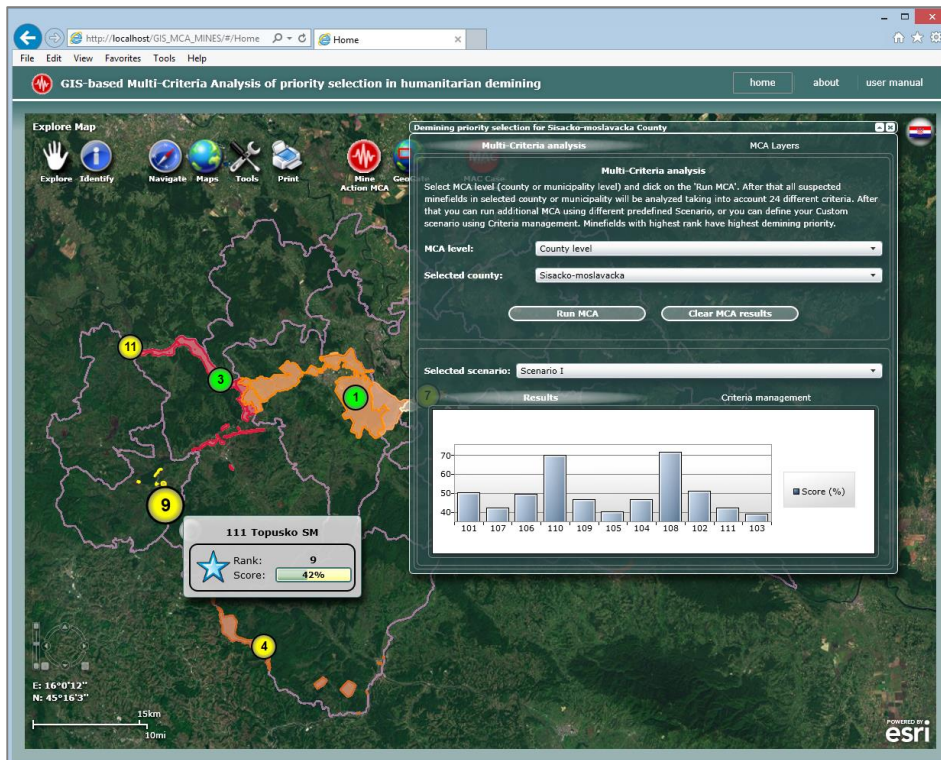
Once you’ve opened this window, first select **MCA level** you want to use (County or Municipality level):



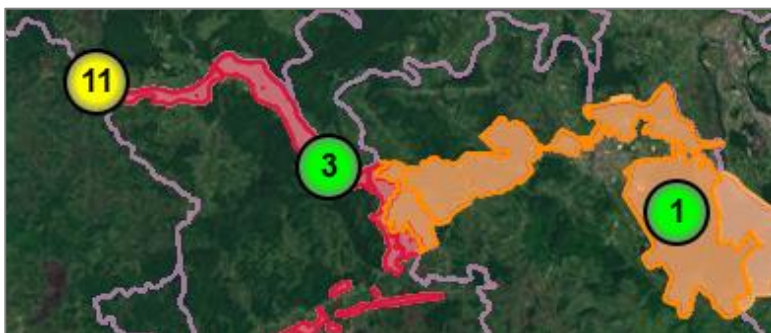
Second, click on **Run MCA** to run Multi-Criteria Analysis for selected County or Municipality:



The results of Multi-Criteria Analysis performed using PROMETHEE method are presented in several forms:



Presentation of results (ranks) on map for each action (suspected minefield). The lowest rank (1st) is the best:

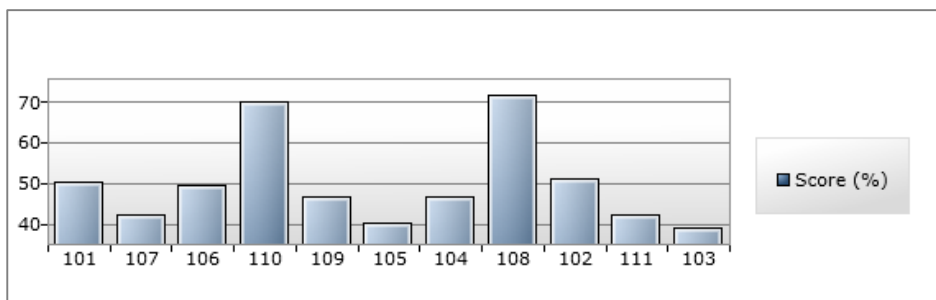


Presentation of result (rank and points) for each action (suspected minefield) when mouse flies over it:



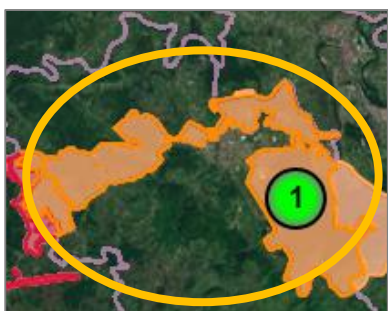
Best ranked action has 1st rank. PROMETHEE II method net flow is presented as absolute score. Scores are used to obtain how much one action is better than other one. In following example, action ranked 9th has score 42%. It is very important to check the action score and not only rank.

Presentation of result for each action (suspected minefield) on the chart:

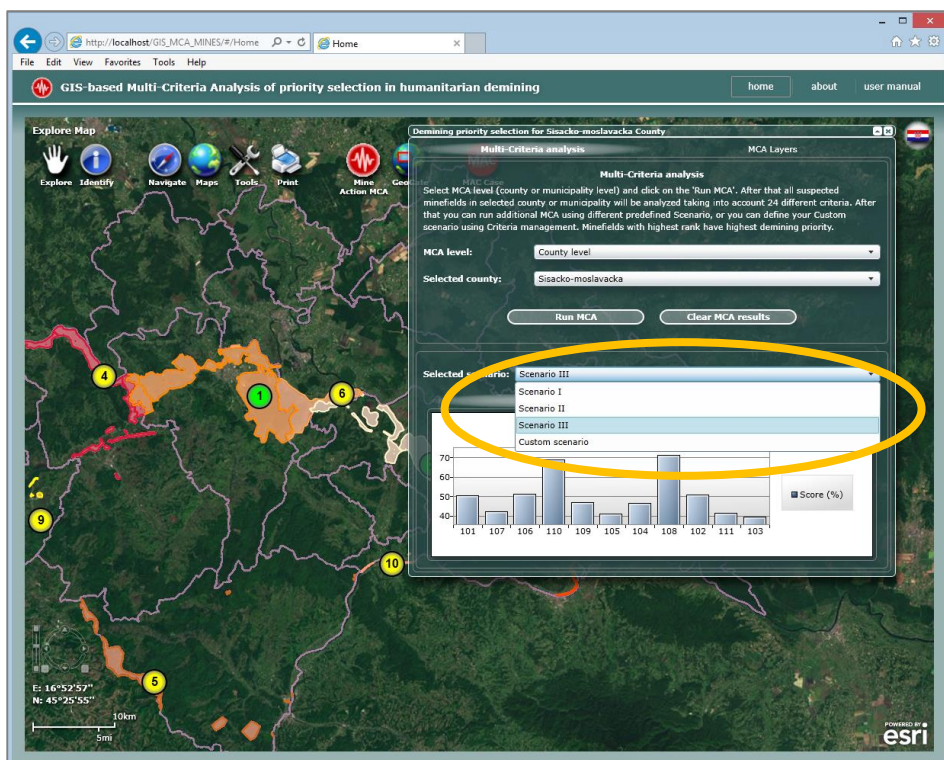


Each action (suspected minefield) is presented by its ID (for instance 107). The actions with higher score has better ranking. The action with highest score is ranked 1st. The actions with positive net flow have score higher than 50% and they are better than most of the other actions in most criteria. In this example actions 108 and 110 have very high score comparing to other actions, which means they are very similar and far better than other actions.

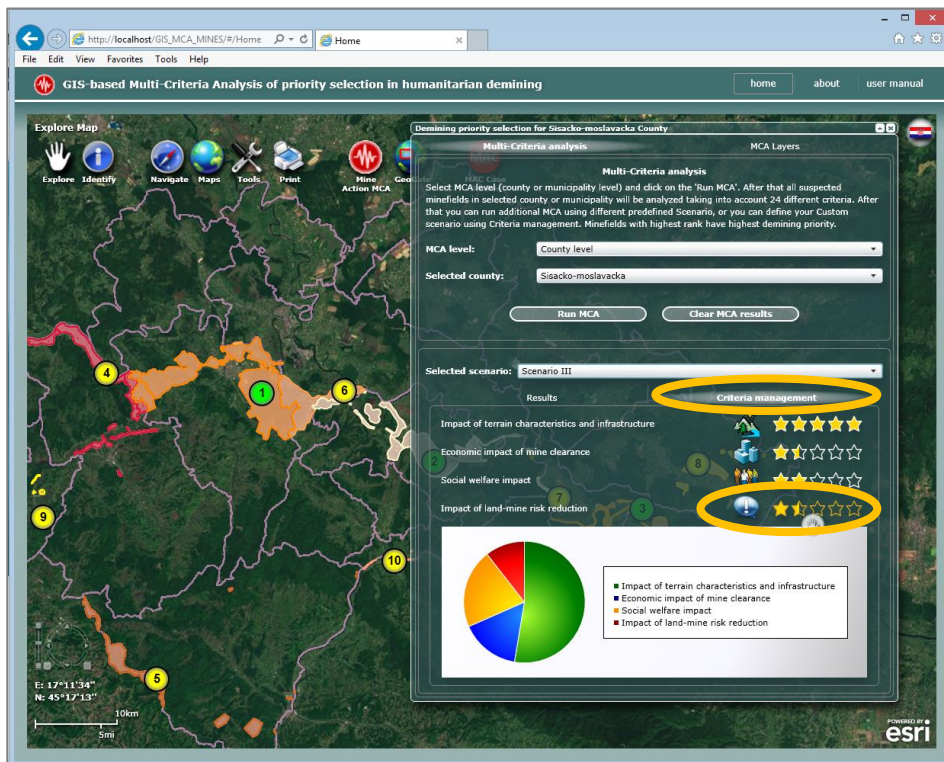
It is important to notice that some actions (suspected minefields) consists of several minefields grouped into single action, so they have mutual rank symbol. They are represented on the map with the same color:



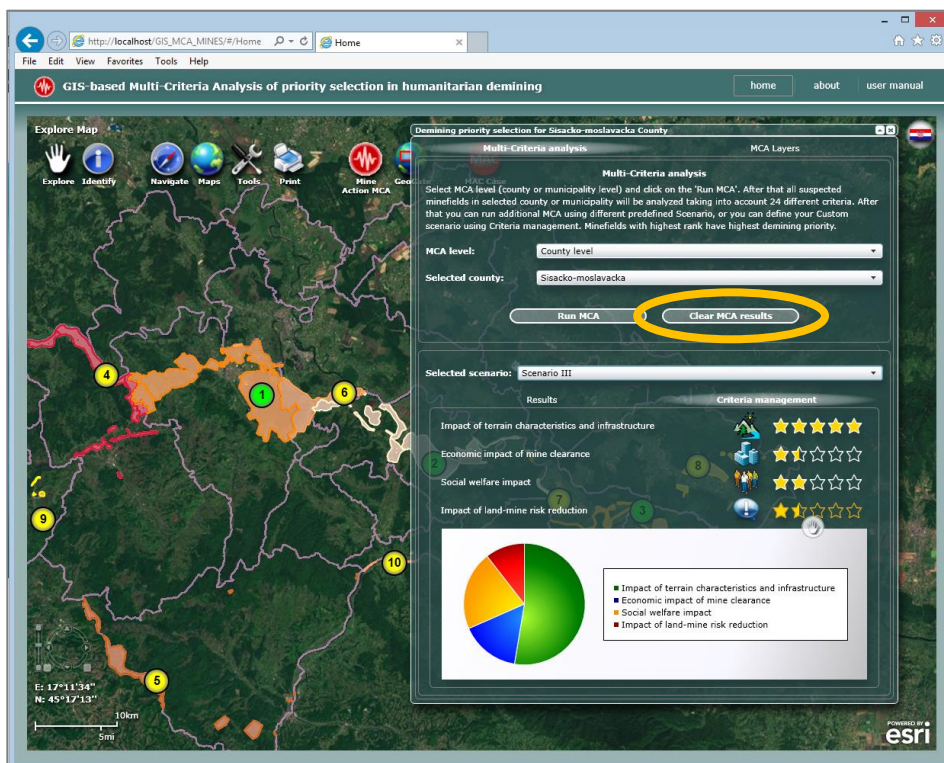
It is also possible to select different predefined Scenario (each Scenario has different criteria weights):



Next step is to use custom scenario using **Criteria management**. All criteria are grouped into four groups and it is possible to change impact of each group, i.e. to change criteria weights:

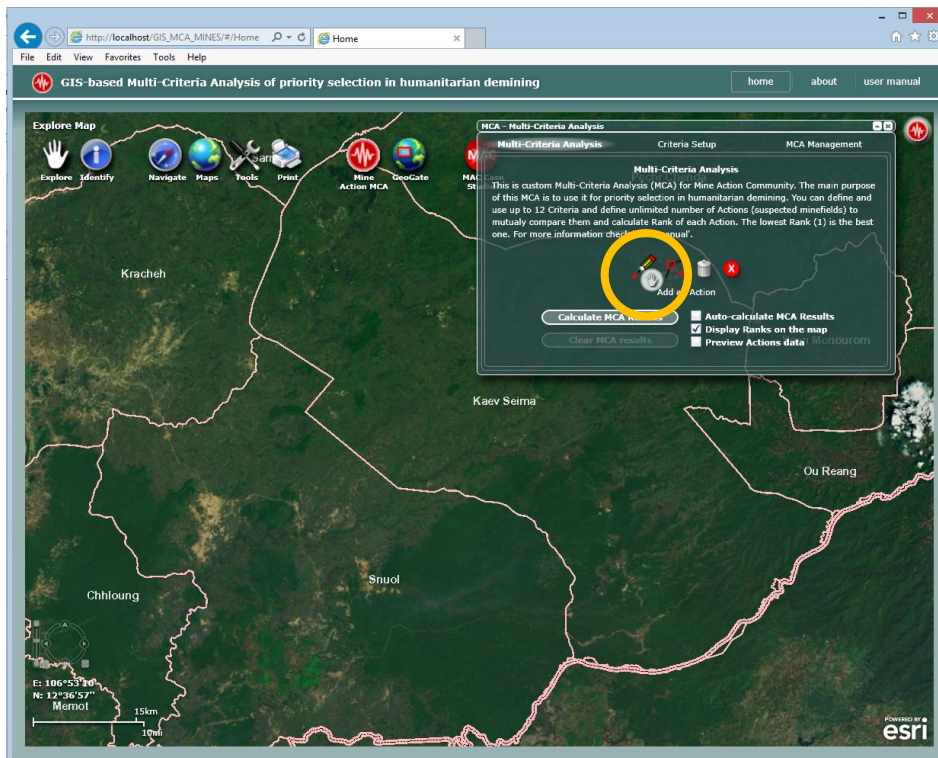


Finally, use **Clear MCA results** to remove results of Multi-Criteria Analysis:



MULTI-CRITERIA ANALYSIS TOOL “Mine Action MCA”

Once you’ve clicked on **Mine Action MCA** icon, a MCA window will open. First, select **Add an Action** tool:



Draw the first Action (suspected minefield or group of suspected minefields somewhere on the map:



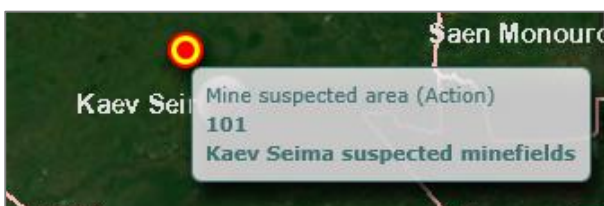
Define the Action name:

Input Action name

Action name: Kaev Seima suspected minefields

OK

An Action has been added, and after that you can draw all the Actions:



Under **Criteria Setup** define your Criteria: Name, Type and Weight. You can use up to 12 Criteria. If you don't want to use some criteria, just uncheck them:

Criteria Setup Panel:

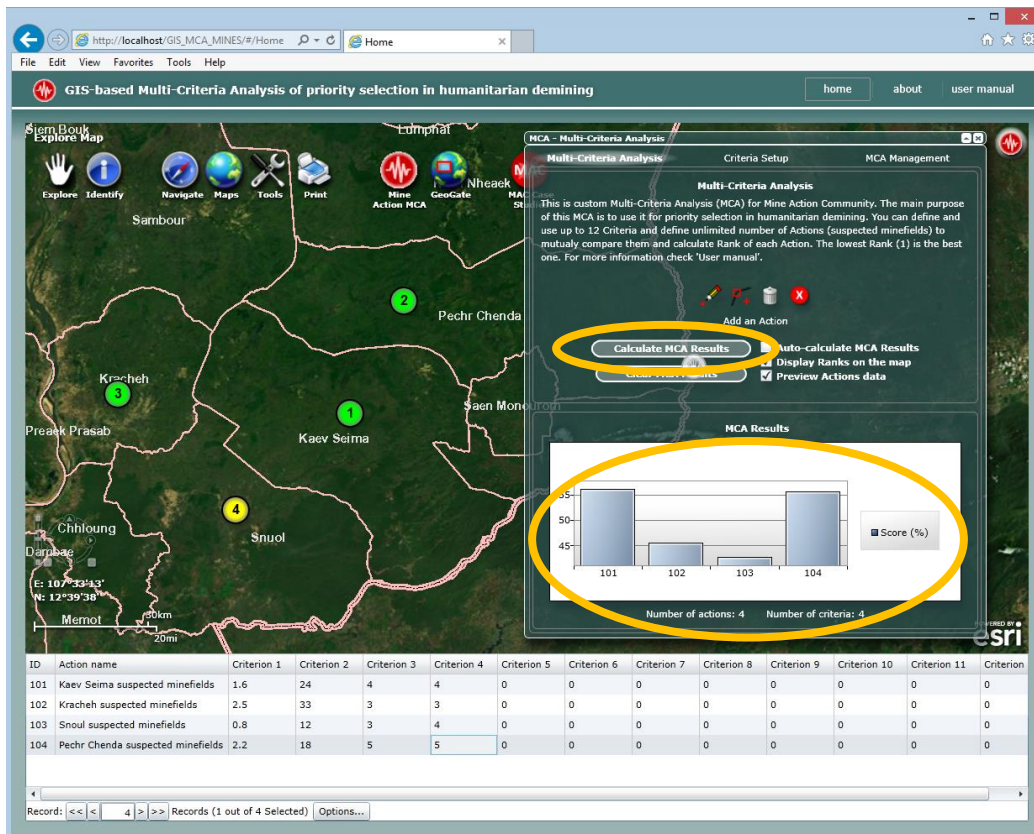
- ☒ Criterion 1: Demining Cost (million \$)
Type: ☐ Maximize ☐ Minimize
Weight: ★★★★★
- ☒ Criterion 2: Mines and UXOs Victims (number of people)
Type: ☐ Maximize ☐ Minimize
Weight: ★★★★★
- ☒ Criterion 3: Economical Impact (1-5 scale)
Type: ☐ Maximize ☐ Minimize
Weight: ★★★★★
- ☒ Criterion 4: Social Impact (1-5 scale)
Type: ☐ Maximize ☐ Minimize
Weight: ★★★★★
- ☐ Criterion 5: CS
Type: ☐ Maximize ☐ Minimize
Weight: ★★★★★

ID	Action name	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8	Criterion 9	Criterion 10	Criterion 11	Criterion 12
101	Kaev Seima suspected minefields	0	0	0	0	0	0	0	0	0	0	0	0
102	Kracheh suspected minefields	0	0	0	0	0	0	0	0	0	0	0	0
103	Snoul suspected minefields	0	0	0	0	0	0	0	0	0	0	0	0
104	Pechr Chenda suspected minefields	0	0	0	0	0	0	0	0	0	0	0	0

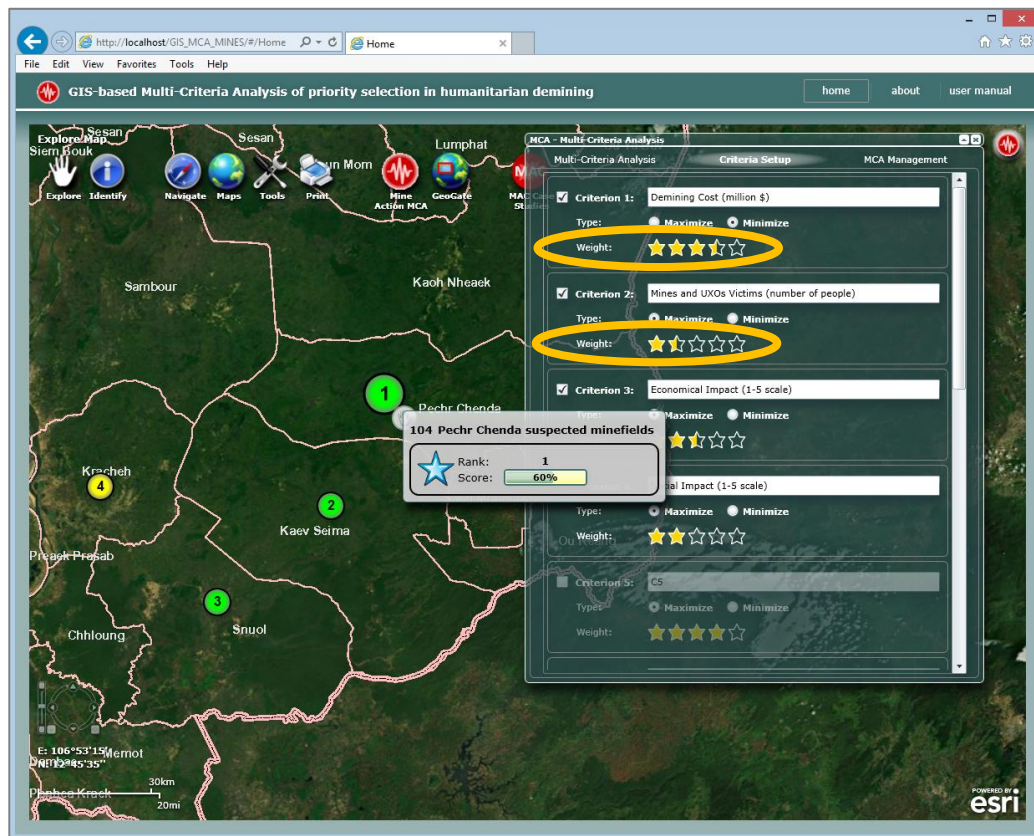
Input Actions evaluations for each of used criteria (N.B.: data used in this example are fictional):

ID	Action name	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8	Criterion 9	Criterion 10	Criterion 11	Criterion 12
101	Kaev Seima suspected minefields	1.6	24	4	4	0	0	0	0	0	0	0	0
102	Kracheh suspected minefields	2.0	20	3	3	0	0	0	0	0	0	0	0
103	Snoul suspected minefields	0.8	12	3	4	0	0	0	0	0	0	0	0
104	Pechr Chenda suspected minefields	2.2	18	5	5	0	0	0	0	0	0	0	0

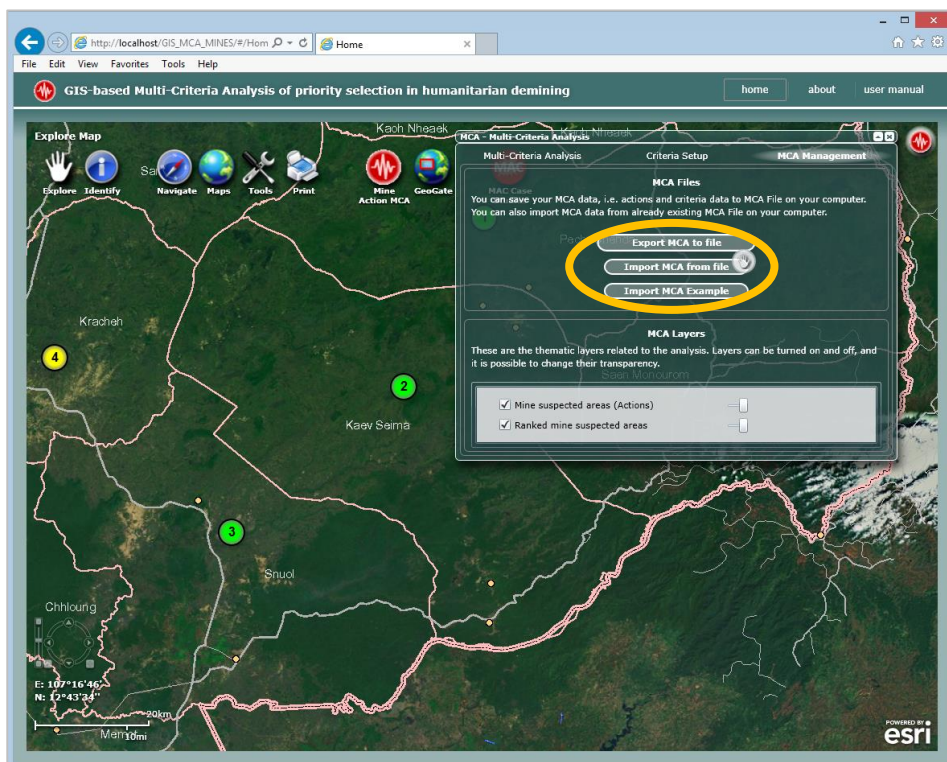
Obtain MCA results by clicking on **Calculate MCA Results**:



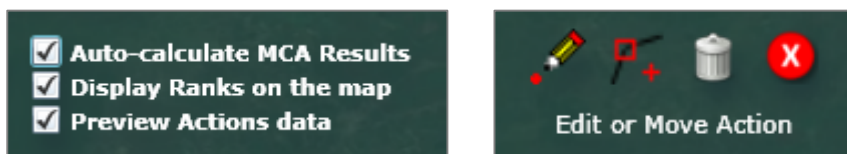
You can change Criteria weights and check the effect on MCA results:



Under **MCA Management** you can save your MCA data by exporting it to the MCA file on your computer, and the same MCA file can imported next time you use Web application, or import one MCA Example:



You can also use additional MCA tools:



Check *Auto-calculate MCA Results* if you don't want to click on *Calculate MCA Results* each time you change something (criteria weight, action data, etc). And you can move or delete Actions using available tools.

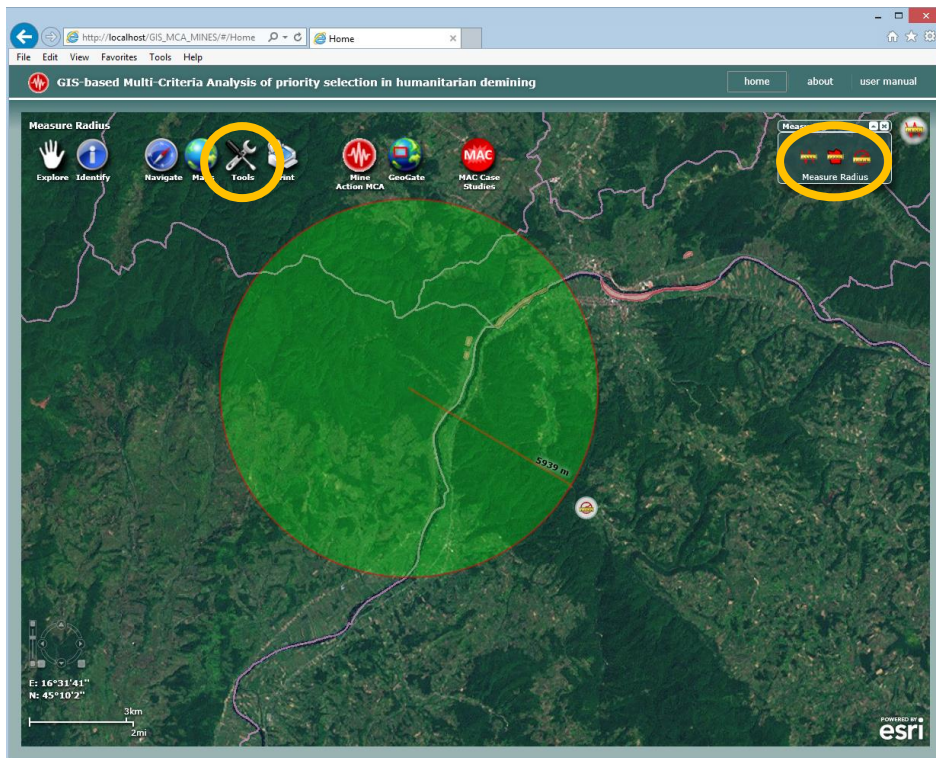
Important MCA tip about Criteria Type:



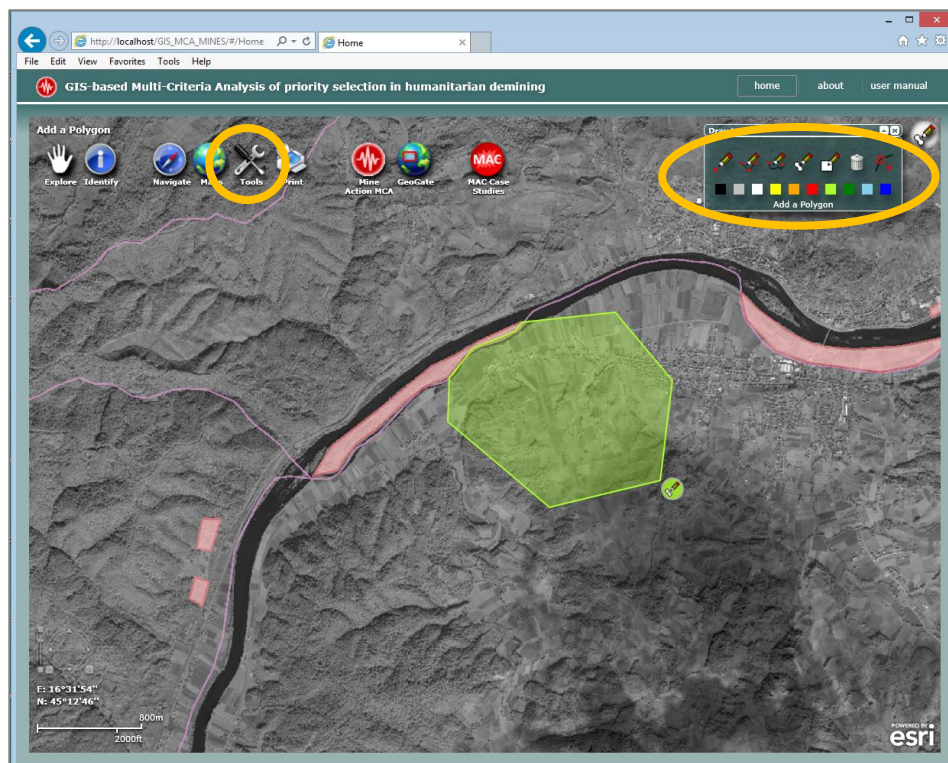
In this example criterion *Demining Cost* is set to *Minimize* because the cheapest demining actions will be the first one to do. However, criterion *Mines and UXOs Victims* is set to *Maximize* because areas with highest number of victims will have highest demining priority. Criteria Type depends on the aim of MCA!

ADDITIONAL TOOLS

From **Tools** menu select **Measuring** to use several measuring tools:



From **Tools** menu select **Drawing** to use several drawing tools to perform custom drawings on the map:



ACKNOWLEDGMENTS AND CONTACT

Research and development of Web Application "GIS-based Multi-Criteria Analysis of priority selection in humanitarian demining" have been done by **University of Split** in collaboration with the **Croatian Mine Action Center - Center for Testing, Development and Training Ltd. (HCR-CTRO d.o.o.)**. This Web application is supported by **FP7 Project TIRAMISU**:



Furthermore, if you have any questions about Multi-Criteria Analysis, PROMETHEE method, Geographic Information Systems or Decision Support Systems, do not hesitate to contact:

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