Journal of Conventional Weapons Destruction

Volume 21
Issue 2 *The Journal of Conventional Weapons Destruction Issue 21.2*

Article 5

July 2017

Using Mobile Geographic Information Systems to Improve Operational Efficiency, Data Reliability, and Access in Mine Action

Paul Rittenhouse
James Madison University (JMU)

Lindsay Aldrich
Center for International Stabilization and Recovery at JMU (CISR)

Recommended Citation

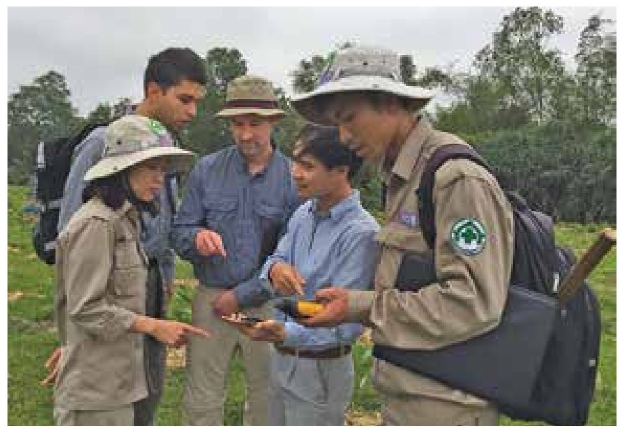
Rittenhouse, Paul and Aldrich, Lindsay (2017) "Using Mobile Geographic Information Systems to Improve Operational Efficiency, Data Reliability, and Access in Mine Action," *Journal of Conventional Weapons Destruction*: Vol. 21 : Iss. 2 , Article 5.
Available at: https://commons.lib.jmu.edu/cisr-journal/vol21/iss2/5

FEATURE

USING MOBILE GEOGRAPHIC INFORMATION SYSTEMS TO IMPROVE OPERATIONAL EFFICIENCY, DATA RELIABILITY, AND ACCESS IN MINE ACTION

by Paul Rittenhouse and Lindsay Aldrich [James Madison University Department of Integrated Science and Technology and Center for International Stabilization and Recovery]

The inherently complex field of mine action, with its many political, financial, and physical considerations, is also a spatial, data-driven field; and as a result, geographic information systems (GIS) stand to play a major role. Spatial data can help address questions such as: Where are the hazardous areas and what has been cleared or cancelled? Where have teams already surveyed? Where should they go next? How many square meters have been cleared? Due to the complexities surrounding assigning tasks and prioritization, standard operating procedures (SOP), quality assurance/quality control (QA/QC) and database design, GIS often gets limited to high-level planning, database cataloging, and end-of-task analysis and reporting. With the improvement of mobile technologies and location-based services, GIS is poised to play a bigger role in the day-to-day operations of landmine and unexploded ordnance (UXO) clearance.



Survey and IM personnel with JMU/CISR comparing traditional vs. mobile data entry during the CAST pilot phase in Vietnam. *All images courtesy of CISR.*

Standard GIS Applications

Mine action centers and implementing partners have varying systems for investigating, reporting, and remediating suspected hazardous areas. Non-technical and technical surveys have different SOPs and accuracy requirements. If one were to describe field survey in simplistic terms: teams survey areas and document the geographic location and relevant information about their survey on paper notes and/or forms in the field, and then ultimately enter the data into electronic forms or databases from the office. The timeframe in which the data is migrated from paper to electronic forms or databases depends on, but is not limited to, the results of the field surveys and program-specific QA/QC protocols. Later, information management personnel use the electronic database to harvest data back out into GIS desktop platforms for mapping, analysis, planning, or reporting. This system works and is successful, as evidenced by the many mine action programs effectively using these methods around the world. Despite this success, there are some common drawbacks with this method, leaving room for improved efficiency, reliability, and opportunities for analysis.

Potential for data collection errors. When survey teams manually record coordinates and supporting data in the field and staff later transcribe these into paper or electronic forms, there is a significant risk for data errors. Coordinates can be logged incorrectly and attributes can be incorrectly assigned.

Loss of efficiency. Redundant data entry costs time. Discovering, tracking down, and fixing transcription errors also takes time. Time lapses in data entry of days, weeks and even months can cause backlogs in information processing and affect operational decision making and reporting

Loss of access. When data remains in paper form, it is more difficult for managers, directors, and stakeholders to access, evaluate, and use the data to coordinate efforts.

Early integration of GIS into the survey process can help mitigate these issues by reducing the access points at which human error may occur, and reducing the time to input data, thereby allowing for internal data analysis sooner without circumventing the set QA/QC process flow.

Operators are commonly using some form of GIS technology for reporting after tasks and QA/QC are complete, but in

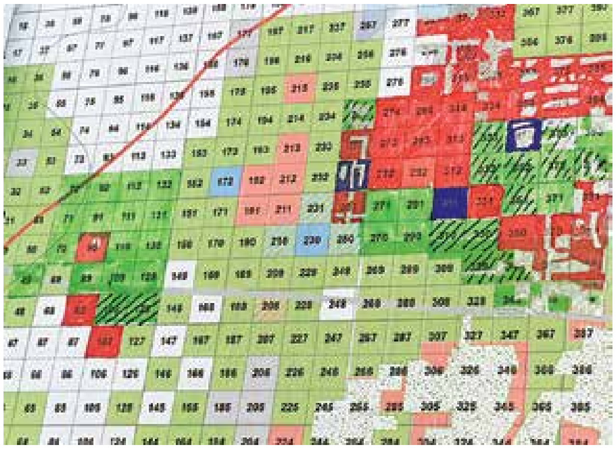


Figure 1. Example of a hand-shaded survey task map.

order to maximize the potential of this technology, programs can integrate GIS on the front-end for planning as well. Then, promptly synchronized GIS data can inform:

- quick, informal analysis;
- coordination of activities between field team leaders;
- timely, end-of-day or early morning field operation planning discussions; and
- prompt identification of new survey boxes.

Therefore, by entering data into a tablet or other mobile GPS-capable device, decision-makers have access to more data in close to real time for planning and greater flexibility of daily operations.

Case Study: CAST Mobile GIS Solutions

The Center for International Stabilization and Recovery (CISR), with funding from the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA) utilized Esri's ArcGIS Online platform and Collector App to develop CAST (**C**ISR **AGO S**urvey **T**ool). This is an integrated GIS data collection tool that allows humanitarian mine/UXO clearance operators to record spatial and qualitative information directly into geodatabases using mobile technology.

How does it work? During a non-technical or technical survey, an operator uses a mobile phone or tablet with Esri's Collector App to securely access CAST in the field and fill out their unique digital, GIS-based form.

CAST uses the GPS capabilities on a mobile device to capture spatial data to record new or update previously collected information. If online, this data is immediately updated to the cloud. If offline, it is stored locally and synchronized when the device is back online. This cloud-based data is immediately available to other online (or synchronized) mobile devices and desktop computers running ArcGIS Online (AGO) or ArcGIS Desktop. As a result, field operators, team leaders, information managers, and other stakeholders have early access to field data across a variety of platforms.

Benefits of CAST. Using mobile devices to collect field data directly into geodatabases has immediate impacts on survey efficiency. As seen in Figure 1, traditional means of collecting data in the field often include updating task maps by shading survey grids and filling out paper forms to note findings.

Using mobile GIS tools such as CAST in the field (Figure 2) not only allows personnel to fill out data forms with both open responses and preordained choices, but potential errors from manual (or multiple) data entry are reduced. Field sketches of task maps that were previously manually edited are now digitally updated program-wide. These updates appear immediately if there is a cellular connection in the field, or teams may utilize the offline synchronization features in remote areas where cellular connectivity in the field may be unreliable or non-existent.

Because CAST operates over ArcGIS Online, and is therefore integrated and accessible across multiple platforms, fellow team members can see recently synchronized survey progress in the field, while information managers can access findings online and start processing and evaluating information sooner. Additionally, managers with assigned levels of access may view digital dashboards that provide GIS-driven, up-to-date progress reports rather than relying on tabulated reports that may be impacted by the time delays associated with traditional data entry.

CAST is one example of how utilizing mobile GIS technology early in the demining process can improve mine action survey operations by providing detailed data collection and mapping of landmines and UXO in post-conflict areas where civilians are at risk. CAST is efficient by improving the reliability and accuracy of current field data collection methods.

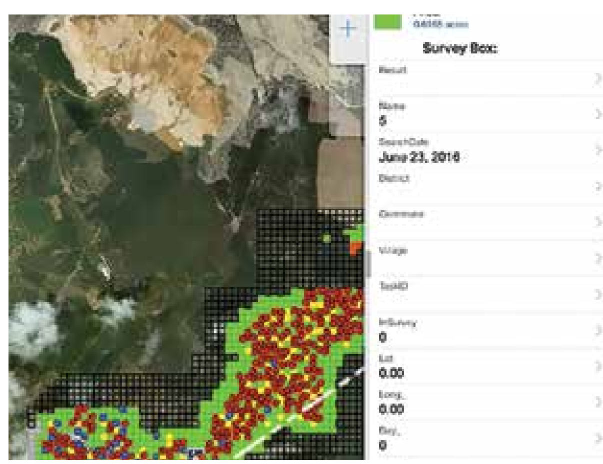


Figure 2. Sample CAST data-entry form.

It is accessible in that personnel in various organizational capacities can quickly access survey data through the many integrated platforms. It is a tool that is both flexible and customizable to meet the data collection methods and international standards of the conventional weapons destruction (CWD) community. Data can also be easily exported from CAST into common data file formats such as an Excel table or .csv for upload into operators' broader information management and reporting systems.

Potential challenges. Although utilizing mobile GIS technology in the field increases efficiencies overall, programs will need to plan for several contingencies and start-up costs when applying this technology, whether using CAST or otherwise. Environmental factors such as extreme heat or humidity could cause changes in mobile device performance. For example, during the pilot phase of the CAST development, survey teams in Vietnam working in summer months found that a tablet would occasionally begin to overheat and temporarily shut down to protect its systems. The team navigated this issue by having multiple tablets or other mobile devices available and loaded with the survey application. Therefore, any program using mobile devices for survey will not only need to plan for the start-up cost of mobile devices for survey team members, but they should also budget for a few extra devices if operating in areas with extreme heat. The paper survey data collection method costs less, but a program should consider the efficiencies to be gained with this investment.

Besides the cost of mobile devices, programs will also need to invest time and potentially some funds in training staff to use a specific mobile survey tool. Each user needs to be trained in the application interface, such as accessing the application, logging in, recording data and synchronizing collected data with the cloud. However, an advantage is that with limited hands-on training, team members of varying levels of experience with computer technology quickly learn to use simple mobile applications such as Esri's Collector app (on which CAST is based). The key is for the training to be hands-on and to have a follow-on component for users to ask more questions after engaging with the technology for a time.

Conclusion

While countries clear mines/UXO, operators and support organizations from around the world continue to examine current methodologies and develop new strategies to improve the success of clearance efforts. One such strategy is the continued integration of mobile GIS technology into CWD programs. These technologies allow spatial analysis to have greater impact in both day-to-day operations and reporting tasks. Data collected in the field is reliable and is more readily accessible. Managers can evaluate and report on field surveys, allowing timely and effective planning for new tasks, and team leaders can better coordinate with each other in the field. Taking GIS tools and analysis to the next level in this way improves planning, reporting, and stewardship, which furthers national program goals and ultimately contributes to safer communities.

Authors' note: During the pilot development of CAST, survey teams in Vietnam successfully used a beta version of the mobile survey tool to survey millions of square meters of land and map the geolocation of hundreds of explosive hazards for safe demolition. We would like to acknowledge and thank our colleagues with NPA Vietnam and Project RENEW who collaborated with JMU CISR on the pilot project and provided extremely valuable ideas and feedback, which led to the development of CAST.

Paul Rittenhouse
Department of Integrated Science and Technology
James Madison University

Paul Rittenhouse is the geospatial projects coordinator and a geographic science instructional faculty member with the Department of Integrated Science and Technology in James Madison University's (JMU) College of Integrated Science and Engineering (CISE). He earned a Masters of Teaching in Science Education from the University of Virginia's Curry School of Education, and a Bachelor of Arts in both Biology and Psychology from the University of Virginia. At JMU he manages the Geospatial Semester—a program where high school students earn college credit while applying GIS analysis to real world applications. He also teaches introductory GIS and GIS for Humanitarian Assistance courses at JMU. For the past two years, he has been the technical director for CISR in the development, testing, and implementation of mobile GIS tools for mine action.

Lindsay Aldrich
Senior Project Manager/Program Coordinator
Center for International Stabilization and Recovery

Lindsay Aldrich is the senior project manager/program coordinator at CISR, managing grant-funded projects aiding the conventional weapons destruction community, such as global GIS and mapping services, disability rights and victim assistance,and mine/ERW risk education. She also supports CISR's Senior Managers' Course in ERW and Mine Action, assisting four courses to date. She holds a Master of Public Administration from JMU and a Bachelor of Arts from Ashland University. Lindsay was the 2012-2013 Frasure-Kruzel-Drew Memorial Fellow for Humanitarian Demining in the Office of Weapons Removal and Abatement in the U.S. Department of State's Bureau of Political-Military Affairs (PM/WRA).