CASE STUDY 5.2

USING AI AND SATELLITE/DRONE IMAGERY TO DETECT UNEXPLODED ORDNANCE IN CAMBODIA, CZECH REPUBLIC, AND UKRAINE

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There is growing use of artificial intelligence (AI) technologies and remote sensing in post-conflict settings to support the "demining" of unexploded bombs. Machine learning and computer vision AI algorithms can improve both the accuracy and precision of detecting unexploded ordnance (UXO), which is a necessary first step for any demining project that aims to safely remove UXO in post-conflict areas. The approaches are still being developed.

Lin et al. (2020) used a two-stage machine learning algorithm to detect Vietnam War-era bomb craters in Cambodia from satellite images.[137] This AI method increased true bomb crater detection by more than 160 percent over standard methods. By combining declassified U.S. military records with satellite data, Lin *et al.* found that 44 to 50 percent of the bombs in the area studied may remain unexploded. A commercial satellite—multispectral WorldView2—image of a 100-square-kilometer area near the town of Kampong Trabaek in Cambodia was chosen as the study site. This site was the target of carpet bombing by the U.S. Air Force from May 1970 to August 1973.

A two-stage random forest machine learning process was used in developing this AI UXO detection technology. In the first stage, AI algorithms were used that have been previously developed to detect meteor craters on the moon and planets. The second stage of the process builds on the intricacies of how bomb and meteor craters are different by considering the novel features of bomb craters, including their shapes, colors, textures, and sizes, as shown in FIGURE 5.5.

Declassified military data indicated that 3,205 general purpose bombs – known as carpet bombs – were dropped in the area analyzed for this study. This information, combined with demining reports and the results of the study, suggests that from 1,405-1,618 unexploded carpet bombs may still be unaccounted for in the area. That represents 44-50 percent of the bombs dropped there. While this AI method improved detection of UXO in Cambodia, the second "demining" step of actually removing UXO involves costly investments that still need to be fully implemented to save the lives of many farmers living in this area who continue to lose their lives regularly from the UXO.

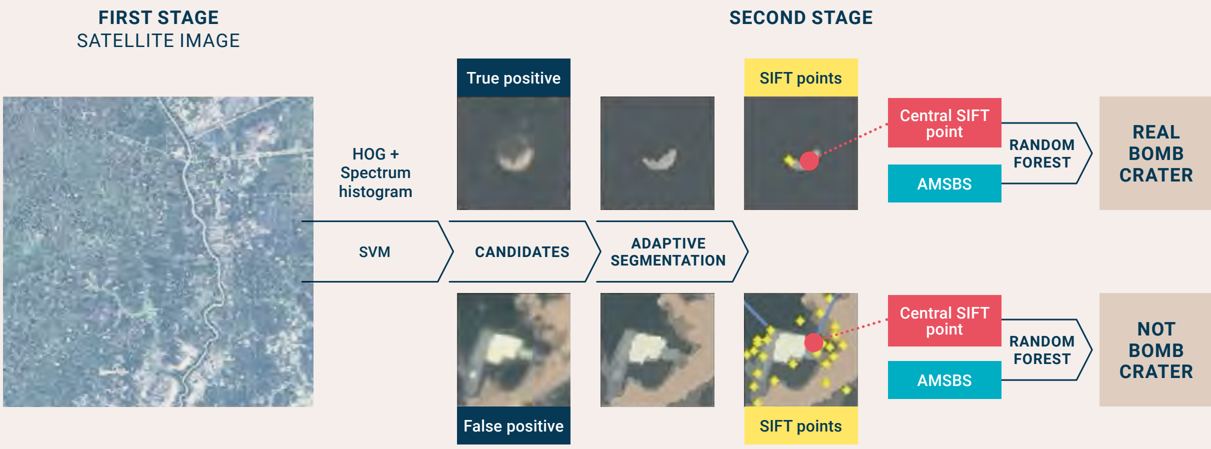
Duncan *et al.* (2023) improved upon the random forest machine learning approach used by Lin *et al.* (2020) by applying deep learning algorithms in a field site in Ukraine that was bombed in 2014.[138] Duncan *et al.* estimates revealed over 22,000 craters in the subregion occupying 1.2 km^2, or 0.14 percent of the region, primarily comprising agricultural fields.

In Northwest Czech Republic, Dolejš *et al.* (2020) applied a convolutional neural network deep learning model on eight Second World War (WWII) aerial bombing crater sites via Airborne Laser Scanned LiDAR-derived digital terrain models with different spatial resolutions.[139] They found that sub-meter resolution data combined with deep learning AI methods can outperform traditional methods.

Kussul *et al.* (2023) further improved the AI method by demonstrating that data fusion AI algorithms that combine data from multiple streaming satellites in real time can further improve demining capacity to detect UXO in a continuous, daily to weekly timescale.[140]

While these AI methods are improving rapidly, harnessing the information generated by these AI technologies to directly support removal of UXO in post-conflict situations needs to be further investigated.

FIGURE 5.5: WORKFLOW OF THE TWO-STAGE FRAMEWORK FOR BOMB CRATER DETECTION.



Source: Lin et al. 2020.