data-driven demining using drones, photogrammetry, and 3d modeling technologies in Old Mosul, Iraq

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With funding from the United States Department of State, Bureau of Political-Military Affairs, Office of Weapons Removal and Abatement (PM/WRA), Tetra Tech’s Weapons Destructions Support Services (WDSS) program clears explosive hazards (EH), such as improvised explosive devices (IEDs) and unexploded ordnance (UXO), in some of the world’s most difficult environments. Tetra Tech’s WDSS task order in Iraq uses technology—drones, photogrammetry, and 3D modeling—to make smart, data-driven decisions to safely clear EH in the ancient city of Mosul.

In 2022, Tetra Tech began the monumental task of clearing Old Mosul, the site of the last stand of the Islamic State (IS) Caliphate. In 2016, an Iraqi-led coalition entered the Old City to liberate the area from IS. The Battle for Mosul lasted 8 months, with heavy aerial bombardment and close urban combat. The long war decimated thousands of historic buildings and contaminated the Old City with thousands of IEDs, UXO, and other explosive remnants of war.

Myriad factors complicate the clearance of the Old City. Millions of metric tons of rubble clog narrow, ancient streets. Buildings are multi-storied, constructed with historic materials, and usually include a basement below street level. IS occupied the buildings, manufactured IEDs, planted an array of complex explosive booby traps, and left thousands of explosives-laden suicide belts littered throughout the rubble. Remnant structures are often structurally unsafe due to crumbling walls and missing roofs. The dense nature of the city and the delicate nature of its historic structures limit the use of large, heavy machinery.

Before clearance work began, Tetra Tech employed aerial photogrammetry to create an extremely accurate 3D model of the Old City. Unmanned aerial vehicles (UAVs, or drones) collect highly detailed, geo-referenced photographic imagery and elevation data. This model allowed the team to create an innovative, comprehensive clearance plan by accurately characterizing damaged buildings, measuring volumes of rubble and the width of streets, and identifying occupied homes.

After creating a clearance plan, Tetra Tech began a methodical, phased approach, prioritizing streets and staging areas for strategically placing heavy machinery. Imagery from UAVs allowed demining experts to identify potential EH from the air before reaching them on foot, further facilitating a data-driven approach to decision-making. Slow, meticulous access to cleared streets then allowed skilled deminers entry to rows of damaged historic buildings.

Identification and geolocation of inhabited structures in a post-conflict urban environment allow our teams to provide targeted educational outreach by identifying those most at risk within the community. Families are often forced to reoccupy homes surrounded by damaged structures and extant EHs. Using pre- and post-conflict aerial imagery, our team identifies inhabited homes and delivers in-person outreach to those who need it most.

Tetra Tech also uses UAVs to assess the structural integrity of individual damaged buildings in the Old City. This allows safety specialists to generate site-specific safety risk assessments, establish standoff distances, and equip clearance teams with appropriate personal protective equipment for safe and efficient clearance.

UAVs are also instrumental in the daily detection, marking, and reporting of EH before a deminer enters a building or area. The scale of devastation and destruction in Old Mosul means that many areas are initially inaccessible. Aerial imagery and mapping allow remote reconnaissance, identifying hazards that may pose significant risks to Tetra Tech clearance teams and residents of the community. The quality of imagery and geolocation data allows for the identification and location of surface-laid or partially buried EHs.

Lastly, the 3D model is populated with real-time clearance information: locations, photos, and make and model of EHs, including UXO, IEDs, suicide belts, booby traps, artifacts, and buildings of historic or cultural importance. This unique body of knowledge is invaluable for analysts studying urban guerilla warfare and the strategies and last stand of the IS caliphate.

As rubble and debris are slowly cleared away, and hundreds of explosive items are safely removed, a path toward a brighter future lies ahead for the people of Old Mosul, led by the innovative use of drone technology and data-driven processes. Tetra Tech has invested in training 14 Iraqi demining specialists to fly, collect, and process UAV imagery to perpetuate this effective planning and operational tool for years to come.