

Cooperative Demonstration of Technology on Munitions Related Contamination - Long version

Military forces have always needed space to train. It's crucial for preserving combat readiness, developing skills and capabilities, and to keep one step ahead of potential adversaries. It's particularly important now, as NATO faces a more assertive Russia, growing instability in the Middle East and North Africa and brutal attacks by ISIL and other terrorist groups on member states. The majority of training of NATO troops is carried out on military ranges. These large areas of land sometimes thousands of acres in size, are necessary for soldiers to practice with a full range of weapons.

- "Our soldiers need to train. The weapons that most nations are using now are getting more and more sophisticated. You need more and more time with those weapons, actually firing them, using them in simulated combat operations, using them with Joint Forces. You've got vehicles moving you have air support and all sorts of things going on. You have to be accommodated to that type of scenario and if you don't have these ranges - especially the larger ranges - you're at a deficit as far as training is concerned. You're going into combat without the necessary training to ensure you're going to stay alive."

These areas of land need to be maintained in a sustainable manner. One issue threatening their lifeline is contamination. Military units conduct live-fire training with a wide variety of munitions, that contain constituents that may have adverse impacts on the environment and human health. The military range in Massachusetts in the United States is 22,000 acres in size. Below the ground lies the primary ranking water supply for Cape Cod, an area with 200,000 inhabitants. The soil here is very porous, so material can easily migrate down into the water table. In the 1980s the groundwater was found to be contaminated with toxicants from a decaying weapons disposal pit and jet fuel from a nearby Air Force Base. The site was closed down.

- "It's gotten into the groundwater. A lot of people United States have drilled wells, wells that go down in the ground. This is sort of like a personal water supply. And when those wells get contaminated, people just don't have an option, because if the aquifer is contaminated, the groundwater is contaminated. You just you have to buy water essentially."

To control risks and support range sustainability, it's important to recognize the types of residues that are released from different types of munitions during training. Some are more harmful than others. In order to quantify potential contamination NATO, has gathered some of the best scientists in this field and designed a cooperative demonstration of technology, to show NATO and partner nations how best to characterize military training ranges for potentially contaminating munitions constituents, to ensure the sustainability, of these ranges.

"You see that more nations struggle with that issue as environmental regulations, environmental rules they continue to grow in various NATO nations and partner nations, which means all nations are facing the same problem. We have already achieved a lot of results, we have achieved a lot of good procedures, developed good procedures, develop good tools, and now there's the right point in time

to share that knowledge that we have developed within the NATO science and technology organization framework."

The defence Academy of the United Kingdom, more than 30 representatives from 16 NATO nations and partner nations, undertook a course in military range characterization, to give them the skills needed to assess a range for potential contamination. The process starts with the sampling of soil and water.

- "We sample to find out the total amount or mass of metals or energetic, residues that are on the base, to make sure that it's safe. We're not going to know, what the concentration of contaminants are, unless we actually collect a sample and take it to the laboratory for analysis. We can't tell out here in the field concentration levels in the part per million level. So we have to take a sample to send it to the analytical laboratory. Then once we know how much is out here, we can make a decision there's this amount of contamination pose a risk to the soldiers training or to people living around the area or to animals that may be migrating or grazing in the area. With water sampling you have to be careful, because the water is not the same everywhere. It could be different like in a pond from the top to the bottom of a pond, or a stream from the left to the right side of his stream. Especially if you have some kind of source or runoff on one side, you sample on the other side you may miss it. So for any type of stream or pond, you want to be sure you collect increments, or sample from everywhere within it, to be sure that you represent it."

One of the pioneers of multi increment sampling is the scientist Mary Ann Walsh, in the 1980s she was asked to investigate, why waterfowl were dying on a military training site in Alaska.

- "We sampled the site at the time we did not find any explosives, but we found one sample that gave off a vapor cloud. That was an indication of white phosphorus. White phosphorus is used by the army as a smoke producing munition. You know it makes the big white cloud. It's been known for a long long time, that it's toxic by ingestion and it only takes white phosphorus the size of a grain of sand, that's enough to kill a duck."

Another expert in range characterization is Sonia T Bhutto, she was one of the first to test military ranges in Canada for contamination.

- "So we had to convince the military people and we built a burn tree. And now they are bringing the excess propellants back at the magazine stores in a good burn tree. And all of this contaminated stuff go to dangerous good. it doesn't go to dust from water anymore. So we want to keep our range open. We don't want to lose any range in Western Canada. We have a range which spans over **to provenza's** the air force trail in coal lake. So it's really important to keep these assets healthy. In order for our military to be in a readiness States forever. So what these people are doing and behind me, they're collecting multichemical sample in a 50 by 50 grids. We call that a decision unit. We decide what could be contaminated here you need to take at least 100 subsample. In a very specific way."

The multi increment sampling method gives a more accurate determination of the massive contamination in a given area. Once all the samples are taken, they're bagged up and sent to the laboratory for analysis.

"So we've got the sample it's all dried. In the next step is sieving. And we use the the 2 millimeter sieve. anything smaller than 2 millimeters will go through the grass. We sometimes keep the organic matter, we sometimes keep depending on what we're looking at for. a r moss we always keep, because moss is very good at retaining material residues on the surface. You run this through the sieve. We don't force it through. And the material you see here, would be the material that we go with the next step when we do the grinding. Generally you know from the area where you're taking the sample, what you're going to see. If it's a firing point, where they're firing anything from a pistol to a hundred and fifty five millimeter howitzer, to some of the even the big rockets that we've chests at the 8-inch rockets, that we use in the US. Those areas have certain propellants that they use. So it's a propellant that we're looking for the components, or propellants, could be nitroglycerin, dye nitrate, all sorts of different things. Ammonium perchlorate in the rocket motors, things like that. Those are the type of compounds we would look at a firing point. Now in an impact area, something different. Those are explosives things like TNT, everybody's heard of TNT, there's RDX, there's HMX, and this there's newer compounds that we're now looking at."

The sift and dried soil is then placed in a grinder to shrink the size of the sample particles. Energetics particles will be reduced in size and spread throughout the matrix of the soil sample. A 10-gram sub sample of the ground soil is then taken using multi increment sampling - just as the original sample was taken. This small sub sample represents an area containing thousands of tons of soil. The next step is to extract the explosives in the soil into a solvent. In this case Acetonitrile.

"Sandy soil with very high concentrations of explosives, the extraction time may be quite short. If it's a clay soil, with very low concentrations of explosive, extraction time is long. The overnight extraction is a good compromise for the majority of soils that we worked out with."

The tangrams subsample is then mixed with water and filtered before injected into a chromatography instrument, to measure the concentration of explosives in the soil extract. This whole process was new to most of the course participants.

- "I'm working in a joint range where you can find the Air Force for air-to-ground firing. And as well as the Army for ground-to-ground firing. And I commend the air-to-ground port and we are cleaning the range, doing a lot of stuff, but we never measure the soil pollution by the way we described this week. So we will have to work on it I think."

- "at this moment we have the protocol for testing the soils and waters, but it's not a systematic approach like the the methods we have seen here. And we wanted to improve to upgrade our capabilities in that field."

- "By teaming up all together all of the countries learns a lot from each other and we don't repeat the mistakes and and we know what to look for, if we go to an anti-tank raids. Now someone from Serbia, I may go back to his range and he will he will know it will be looking for example for HMX in the impact area and it will be looking for public residue. Not in front of the firing position, behind because those shoulder rockets, the fire of course you have a little propellant emitted there, but there they have an open-mount behind. And by luck with example we did we install a decision unit behind, just to see if it was so heavily contaminated because you have a bad blast."

"The NATO connected forces initiative requires NATO members to effectively function as an integrated force. A key component of the CFI is an increase in size and tempo of joint military training on ranges in Europe. To meet this goal, ranges must be monitored to assure their continued availability. The long-term aim is to create a NATO standard. Requiring all members to carry out tests on their ranges.

- "This particular activity range remediation could literally save billions of dollars, to any one of our nation's militaries and keep operational ranges in action, for a much greater part of the time. I hope that it will allow us do not waste money on cleaning up ranges. So that NATO nations can modernize as they need to. Ultimately what we're trying to do, is not waste money, field better equipment, and train the young soldiers, sailors, airmen and Marines, in our forces better. The land space we have in the world, is the land space we have. Every time we lose a range, we lose the ability to train some of our young forces."