Journal of Conventional Weapons Destruction

Volume 19
Issue 2 *The Journal of ERW and Mine Action*

Article 14

July 2015

Observations on Cluster Strike Patterns in Laos

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Observations on Cluster Strike Patterns in Laos

Cluster strike footprints are being surveyed and subsequently cleared in Laos. Little information is available regarding the nature of cluster munition strike patterns. If more evidence from different types of strike footprints is collected, analyzed and distributed, operators will be better prepared for future survey and clearance tasks.

by Roly Evans [Norwegian People's Aid]

In early 2014, Norwegian People's Aid (NPA) in Laos conducted an analysis of U.S. bombing data from the Theater History of Operations Reports (THOR) database alongside confirmed hazardous areas (CHA) that were identified through a Cluster Munition Remnant Survey (CMRS) and subsequently cleared. This analysis underlined the need to accurately and routinely record all cluster strike evidence during survey and clearance as detailed in IMAS 07.11 Land Release.[1]

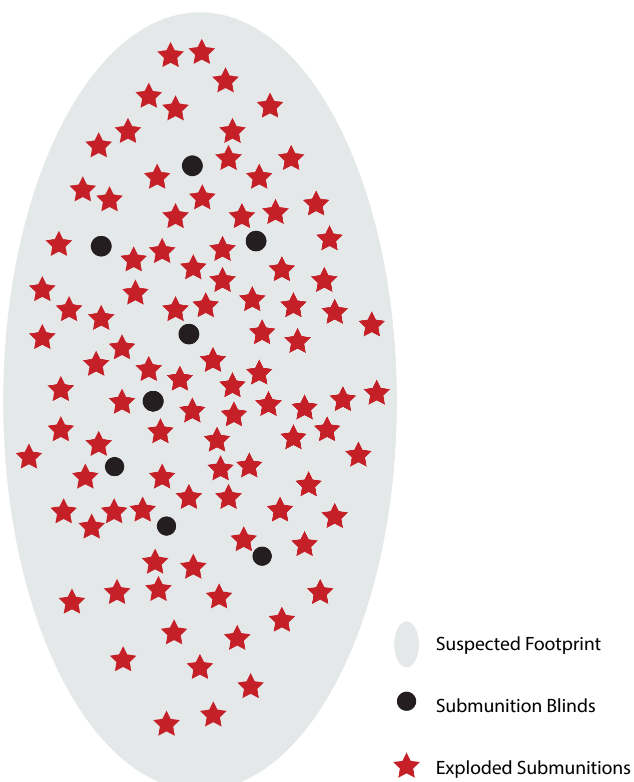
Although nonmilitary clearance of cluster strikes has been conducted since the early 1990s, surprisingly little information is available concerning the nature of cluster strike footprints. NPA, *Forsvarets Forskningsinstitutt* (FFI) and Colin King Associates conducted a detailed study in 2007 that analyzed a number of separate M85 Dual Purpose Improved Conventional Munitions (DPICM) strike patterns in Lebanon alongside trials conducted in Norway.[2] FFI has also published a study.[3] However, little research has been done since.

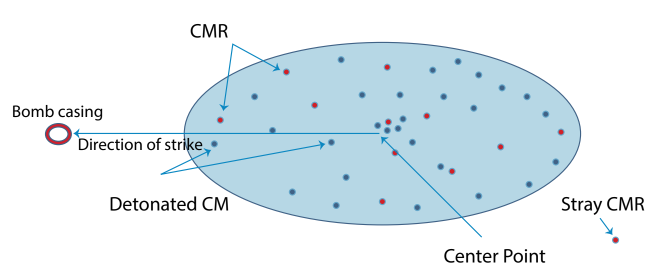
Some operators accurately record cluster strikes during the survey and clearance process. Unfortunately, evidence recording is not standardized, and what is recorded is not widely circulated. More remains to be learnt from recording and analyzing differing cluster strike footprints. What sort of footprint patterns do different cluster munitions make on the ground? What range of footprint surface areas are observed for differing types of cluster munitions? What range of failure rates are observed for differing types of cluster munitions? At what depths do we typically find different submunitions in different soil conditions? How do differing submunitions degrade over varying weather conditions and periods of time? If more evidence from strike footprints was collected, collated and distributed, operators would be better prepared for future survey and clearance.

Cluster Munition Strike Footprints

Regardless of the delivery means, cluster munitions often form recognizable spread patterns on the ground. These are often referred to as footprints or strike footprints. Whether by means of aerial cluster bomb, artillery projectile, rocket or mortar, cluster strikes were believed to form similar footprint patterns. However, anecdotal evidence from Israeli and U.S. pilots suggests this may not necessarily be the case.

Oval pattern. In clearance circles, many believed that cluster munitions created a rough oval pattern of one form or another. It was thought that any carrier munition that separates from its means of delivery and functions above the ground will usually result in some sort of oval shape or ellipsoid dispersion of submunitions. This is most apparent in ribbon armed, DPICM strike patterns. The height at which cluster munitions open, along with the linear momentum of the carrier munition,





Figures 1 (left) and 2 (right). Examples of oval pattern cluster strikes.
All figures courtesy of NPA.

Isreali Air Force (IAF) 107 Squadron Cluster Bomb Units 58 strikes Al Mazzeh near Damascus (Syria) clearly showing the Donut effect, 11 October 1973. Three individual strikes are clearly visible and a further one is discernible just above the two on the left.
All photos courtesy of http://www.fresh.co.il.

Two CBU 58s, probably set to open at above 2000 feet, suppressing 57mm anti-aircraft fire during an attack by F4 Phantoms of 107 Squadron IAF on Al Mazzeh near Damascus, 11 October 1973.

Overlapping CBU 58 strikes Dimasqh, Syria, 16 October 1973.

Overlapping CBU 58s dropped near the Suez Canal, 19 October 1973.

affects the dispersion of the submunitions. The dispersion pattern elongates along the trajectory of the carrier munition. Although not the most recent, the most numerous examples of this pattern were observed in southern Lebanon. Spin-stabilized cluster munitions from Cluster Bomb Units (CBU) were also widely believed to form a rough, oval footprint. Fin-stabilized cluster munitions, such as PTAB 2.5Ms or PM-1s, might form a tighter, more circular pattern. The Geneva International Centre for Humanitarian Demining cluster munition resource page illustrates how topography can have an additional, distinct effect.[4]

Observations tend to be anecdotal, since the recording of individual cluster munitions—which is required to accurately map patterns—can sometimes be impractical. This was the case during the initial emergency-clearance efforts in Lebanon in 2006. A number of operators attest that an oval strike pattern of sorts was usually identifiable. If no pattern was identifiable it was assumed that this was a mixture of patterns since targets were often subjected to multiple strikes, sometimes of differing cluster munitions. As a very general rule, DPICM footprint lengths were estimated at 1.5 times the width.

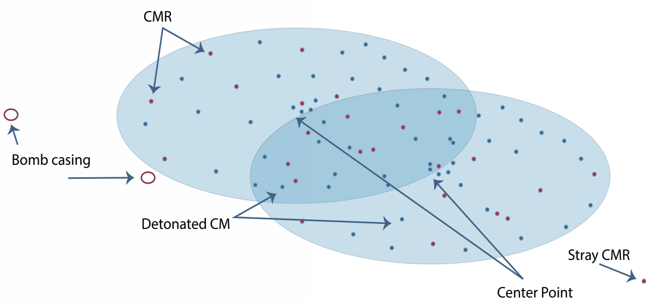


Figure 3. Example of mixed footprints.

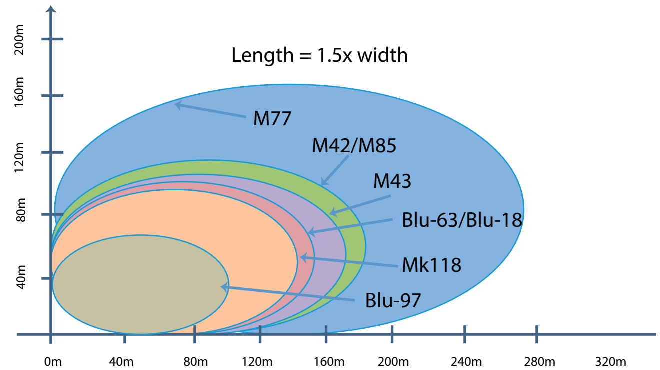


Figure 4. Varying cluster-munition oval footprint sizes.

Donut pattern. During research in Laos, many former U.S. pilots provided anecdotal accounts of using cluster munitions. Pilots overwhelmingly claimed that spin-stabilized submunitions, such as the BLU-26, -36, -54, -61 and -63, tended to migrate away from the aiming point after being released from the dispenser. This had the consistent effect of creating a donut pattern on the ground, i.e., fewer submunitions would land in the center of any given cluster strike. This effect was also widely noted by Israeli Air Force pilots using CBU-58s against targets in Syria and Egypt during the Yom Kippur War in October 1973. Moreover, all pilots confirmed that dive bombing was the most common method of delivery because it maximized accuracy.

Mixed footprints. Cluster footprints frequently overlap when areas are subjected to multiple strikes. In fact, most CHAs in Laos are from overlapping footprints. Even when not repeatedly targeted, some areas would still sustain multiple strikes since pilots sometimes dropped two CBUs simultaneously, and these could overlap.

Overlapping footprints make donut patterns difficult to discern. The effect resembles a messy Venn diagram. Nevertheless evidence from the 1973 Yom Kippur War suggests that patterns can be discerned in mixed or multiple strikes.

Evidence of the donut pattern is rarely found on the ground during clearance today. Patterns are subject to change during intervening decades, as farmers and scrap-metal hunters move submunitions. While a single footprint in the jungle might show this pattern, such CHAs will likely be a low priority for technical survey and clearance. However, in order to confirm the donut pattern, technical survey and clearance teams will need to record accurately the position of each bomblet found.

Oval footprint size. Oval cluster strike footprints vary in size according to the particular cluster munition used. NPA and FFI produced the information in Table 1 (page 63) in 2007 as a rough guide to the comparative, average sizes of some cluster munitions' footprints.

As an oval is roughly 80% of the rectangular parameters given for the size of a footprint, the BLU-63 (CBU-58) footprint in the NPA and FFI diagram is approximately 12,000 sq m.[5] It is reasonable to assume that CBU-24 footprints are roughly the same size as CBU-58 footprints. The United States Air Force Armament Development and Test Center believed CBU-24 footprints were slightly tighter.[6,7] Other sources approximate an oval footprint size of 192,000 sq m.[8] This is almost certainly an overestimate.

Footprints in Laos

According to THOR's U.S. bombing data, 81.45% of all submunitions dropped on Laos were spin-stabilized submunitions such as the BLU-26, -36, -54, -61 and -63. Moreover, 71.29% of all cluster munitions were either CBU-24 or CBU-29s, meaning submunitions such as the BLU-26 or the BLU-36. The Laos' National Regulatory Authority's Information Management for Mine Action database (as of February 2014) suggests that 78% of all found cluster munitions are spin-stabilized. If items reported as "**bombies**" are added to this figure, the total exceeds 79%, which is remarkably close to the 81.45% suggested by U.S. bombing data.

So far, the average CHA size surveyed by NPA is about 4.4 ha. The average number of CBU-24 and CBU-29 submunitions used per strike was 5.01. This might point to an average footprint surface area of 8,782 sq m as a rough indicator. Notably, individual footprints often overlap. Therefore if we divide an average CHA size by the average number of dispensers used per strike we could possibly underestimate the individual average footprint size. As more CHAs are surveyed and subsequently cleared, a wider range of evidence will be available to assess footprint sizes. Each CHA should be assessed to estimate whether it is a multiple strike or a single footprint.

Failure Rates

If all submunitions are recorded when found, and the footprints mapped, an informed assessment can be made of how many cluster dispensers were used from the patterns evident on the GIS map. By knowing the number of submunitions on the ground, and by estimating the number of cluster munitions used, estimated failure rates can be determined. With this information, overall contamination within an area or country can be estimated more accurately, especially if benchmarks exist such as U.S. bombing data or evolving survey information against which the range of failure rates can be calculated. As more CHAs are surveyed and cleared, the range of data and the probability of accurate estimates will increase. Failure rates for spin-stabilized submunitions are believed to still be classified. During testing of CBU-58, a 5% failure rate was expected. There is some evidence it could reach as high as 26%.[9] The Congressional Research Service is only willing to place a very broad implied failure rate when making estimates for Laos. "Estimates of the number of unexploded submunitions from cluster bombs, range from 8 million to 80 million."[10] Without access to complete test data for common dispensers such as the CBU-24, identifying strike footprints in

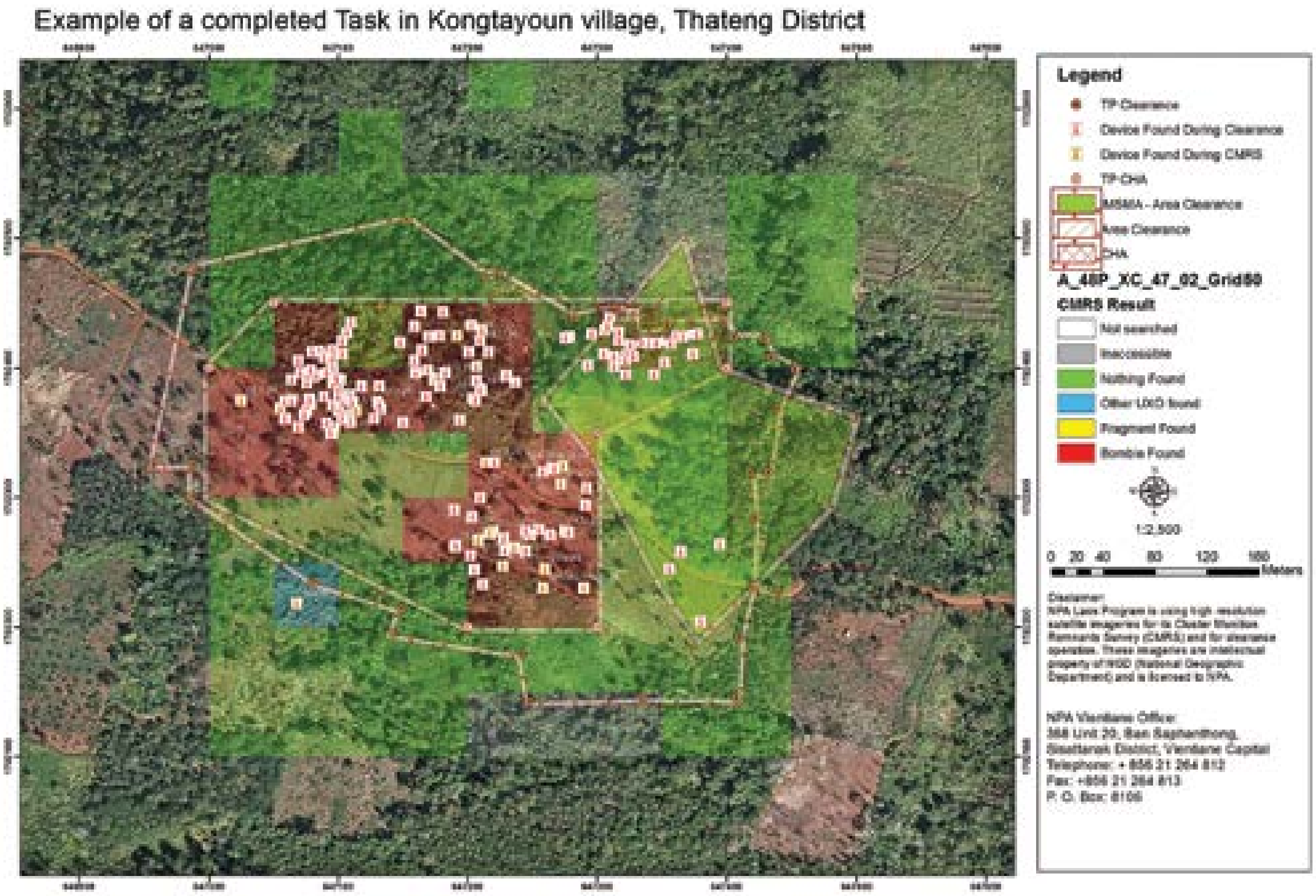


Figure 5. Example of a completed task in Kongtayoun village, Thateng District.

areas without human interference through technical survey, subsequent clearance and by counting the number of unexploded bomblets remains the only means of estimating operational failure rates.

Laos Case Studies

Since 2011, NPA has surveyed over 2,000 CHAs in the Sekong, Saravan and Attapeu provinces of Laos. Locations of all submunitions were recorded when found. Some of these CHAs were subsequently cleared, providing a clearer picture of ground contamination. Although most CHAs are mixed strikes, deducing individual footprints with at least some degree of assurance is reasonable. Several case studies in Laos point to some interesting initial data.

In 2011, NPA conducted CMRS and clearance of a CHA near Kongtayoun village in Thateng district, Sekong province. A CHA of 71,250 sq m was surveyed during CMRS; 29 items were found at this stage. Almost all were BLU-26s. Another 316 BLU-26s were found during clearance. Figure 5 shows both cluster munitions found during CMRS and clearance. The final polygon was 122,785 sq m. A 50 m fade out was conducted.

The GIS image suggests four possible strike footprints or groups of overlapping footprints in this CHA. The actual area of contamination was significantly less than 122,785 sq m. The four suspected footprints—ranging in size from 4,186 to 10,874 sq m—only cover 27,692 sq m, 22.6% of the final polygon. A CHA near Luckkao in the southeast of Thateng district, Saravan province, shows strikes that have been subject to prolonged cultivation over decades.

The CHA from CMRS was 72,000 sq m, and a total of 19 BLU-26s were found during this survey stage. Subsequent clearance of a 113,680 sq m polygon found another 180 BLU-26s. The area of the actual footprints totaled 53,786 sq m—47.3% of the cleared area. The CHA probably contained four strikes, perhaps more. Prolonged cultivation of the area likely affected the spread of cluster munitions on the ground.

The patterns observed can also be seen at another CHA near Kongtayoun village. CMRS and clearance were conducted in association with an agricultural development task in August 2011. The initial CMRS found 84 BLU-26s. A large CHA of 159,891 sq m was drawn and was three to four times the average CHA size (4.4 ha) of the areas found by NPA in Laos. Clearance enlarged the polygon by 62.3% to 259,533 sq m when another 760 BLU-26s were found. The total cluster munitions for the final clearance polygon (including CMRS items found) was 844 BLU-26s.

Table 1 (page 63) summarizes key information from the 10 footprints estimated in three separate CHA case studies. While representing a small data sample, the table indicates a range of values that will be improved upon as more CHAs are surveyed through CMRS and subsequently cleared.

The small sample suggests CBU-24 and -29 strike footprints involve surface areas in a range of 2,224–29,480 sq m. Mixed strikes

Figure 6. Confirmed Hazardous Area near Luckkao.

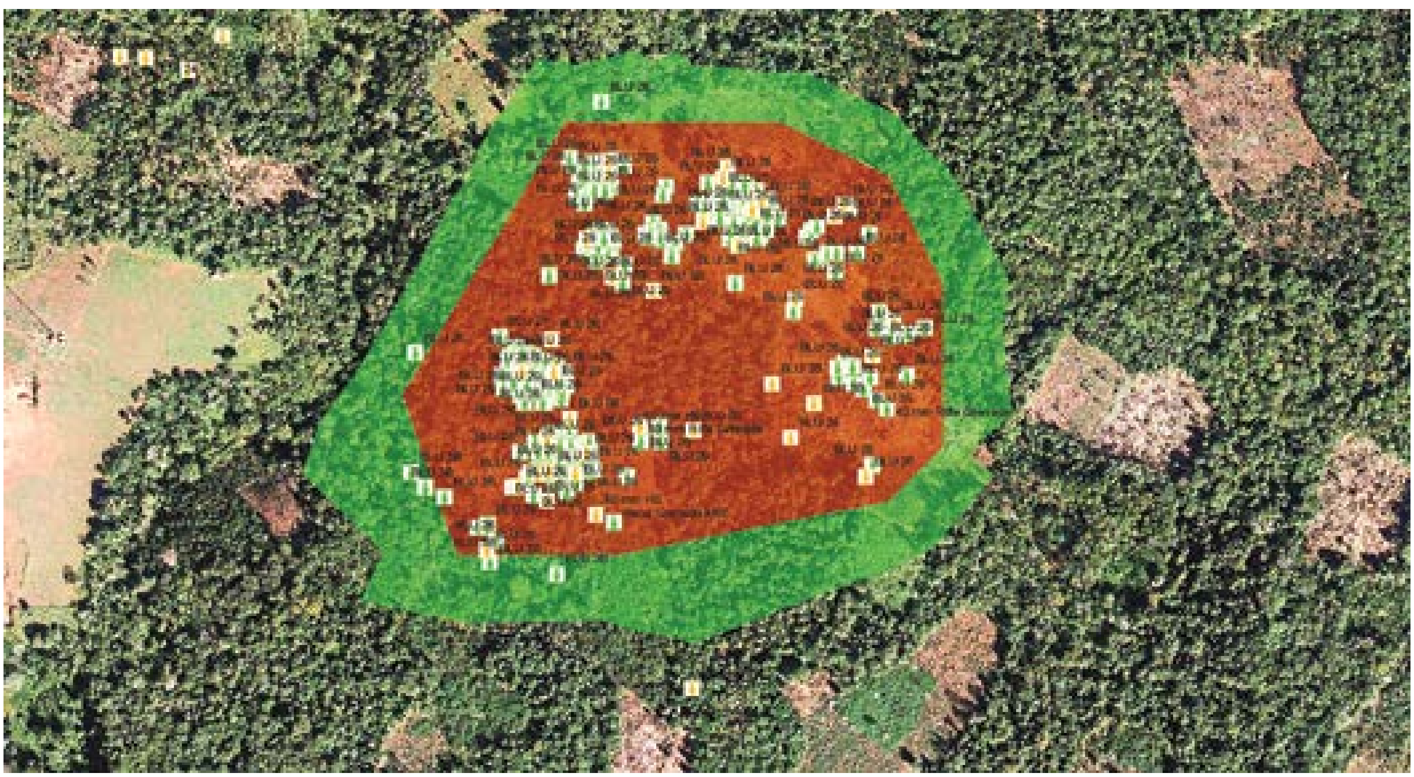


Figure 7. Confirmed Hazardous Area near Kongtayoun village.

CHA Name	CHA Surface Area	CHA BLU 26 Density m²/cm	Footprint Surface Area m²	BLU 26s Found During CMRS	BLU 26s Found During Clearance	Total BLU 26 Found	Implied Failure Rate %	Footprint Density m²/cm
Kongtayoun 1	122,785	391	4,186	2	48	50	7.52	83.72
Kongtayoun 1			10,874	20	44	64	9.62	169.91
Kongtayoun 1			6,317	6	137	143	21.5	44.17
Kongtayoun 1			6,316	7	50	57	8.57	110.81
Kongtayoun 2	259,533	591	11,105	20	185	205	30.83	54.17
Kongtayoun 2			4,544	9	98	107	16.09	42.47
Kongtayoun 2			4,255	20	107	127	19.1	33.5
Luckkao	113,680	534	2,224	1	11	12	1.8	185.33
Luckkao			29,480	8	101	109	16.39	270.46
Luckkao			22,082	9	83	92	13.83	240.02
Average			10,138.3	10.2	86.4	96.6	14.53	123.46

Table 1. Confirmed Hazardous Area case study footprint data.

possibly account for the larger footprints. The estimated average is 10,138 sq m, although the possible mixed strike footprints could be artificially inflating this number.

Inside the footprints, the bomblet densities range from 33.5 to 270 sq m per bomblet. The average failure rate of 14.53% is only an indicator; similarly, these figures represent only estimates. Some evidence suggests that failure rates can be higher. The actual overall bomblet density for the three CHAs in the table are one BLU-26 bomblet per 391 sq m for Kongtayoun 1, one BLU-26 per 591 sq m for Kongtayoun 2 and one BLU-26 per 534 sq m for Luckkao, because clearance between footprints and the 50m fade out distance. Other items such as BLU-3/Bs were found but were not included in these figures.

Conclusion

This article touches upon a developing field of study, reflecting a small portion of the research conducted to date. Although limited, existing evidence points to some possible trends. Further work remains to be done in order to understand footprints for the CBU-24 and CBU-29 as well as all other submunitions. In Laos, footprints that are surveyed and subsequently cleared, specifically in areas of low human impact (i.e., uncultivated, remote jungle areas), are likely to give the clearest view.

In order to improve understanding of cluster strike footprints, all cluster munitions found during survey and clearance should be accurately recorded as per IMAS 07.11—some operators already do this. However too much evidence goes unrecorded and is therefore lost. Through informed estimates of the number of cluster munitions used on a given footprint, implied failure rates can be calculated. Other details, such as the depth at which differing submunitions are found, should also be recorded. Better contamination estimates for a given area or country can then be calculated and recalculated as more evidence is gathered.

Hopefully, strike patterns or footprints for a number of different cluster munitions can be shared more in the years ahead. If a detailed database of various cluster strikes found worldwide was available, operators could better prepare for survey and clearance tasks. Improving the collective understanding of cluster munition footprints would surely benefit the sector as a whole.

See endnotes page 67

(This article is derived from a longer research paper detailing observed patterns for a range of cluster munitions found in Laos.[11] The author wishes to thank Mohammed Qasim for his assistance in analyzing data during the research for this paper).

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