Targets of opportunity

Analysis of the use of depleted uranium by A-10s in the 2003 İraq War

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Front cover: Task Force 2-69 Armor, 3rd Brigade Combat Team, 3rd Infantry Division from Fort Benning Georgia: One of two A-10 Warthog planes circles past smoke from burning Republican Guard barracks in northern Baghdad. April 8, 2003.
Photo by: David Leeson/The Dallas Morning News.

About PAX
PAX means peace. Together with people in conflict areas and concerned citizens worldwide, PAX works to build just and peaceful societies across the globe. PAX brings together people who have the courage to stand for peace. Everyone who believes in peace can contribute. We believe that all these steps, whether small or large, inevitably lead to the greater sum of peace. See also www.paxforpeace.nl

About ICBUW
The International Coalition to Ban Uranium Weapons (ICBUW) campaigns for a ban on the use of uranium in all conventional weapons and weapon systems and for monitoring, health care, compensation and environmental remediation for communities affected by their use. See also www.icbuw.org

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A joint investigation by PAX and İCBUW

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1. Executive summary

The US and UK have acknowledged firing 116,000kg of depleted uranium (DU) ammunition in the 2003 Iraq War. Just over 45% of this was fired by one platform, the US A-10 Thunderbolt II ground attack aircraft. The chance release of targeting data from 1,116 sorties flown by A-10s between March 20th and April 15th 2003 has for the first time made it possible to reconstruct where the aircraft fired DU, what they fired at and how many rounds they used.

The analysis in this report reveals that in 2003 DU use was widespread across Iraq. While the majority of strikes were outside or on the outskirts of heavily populated areas, those strikes that were in towns and cities often saw proportionately more DU used. Significantly, the data confirm that only 33% of the A-10s' targets were tanks or armoured vehicles, with the weapons also used against light vehicles, buildings and unmounted troops.

Before its entry into service, a legal review of the A-10s' radioactive, chemically toxic and incendiary DU ammunition placed restrictions on its use: civilian areas were to be avoided, as were troops, and the weapons were only to be used against armoured targets, unless other weapons were unavailable. However, because of the design of the A-10's 30mm cannon, its pilots are incapable of selecting between DU and high explosive ammunition once in flight. The ammunition belts are loaded before take-off, making the aircraft disproportionate by design. Recent and contemporary conflicts are very different to the Cold War context for which the aircraft and its ammunition were designed and, since 1991 A-10s have been documented using DU against a far wider range of targets than armoured vehicles alone.

The data in this report brings the number of sites in Iraq confirmed to have been contaminated

with DU from 350 to more than 1,000. While the Iraqi government has taken steps to identify and clear some sites the work is far from complete, with efforts likely to have been slowed by the continuing insecurity in the country. Unlike explosive remnants of war, there are no formal obligations on the states that use DU or are affected by it to clear contamination and assist affected communities.

The recently declassified documents discussed in this report demonstrate that the US government had policies in place to monitor DU use and the locations of contamination, and that they were sensitive to the risks DU posed to civilians, their own personnel and their relations with other states. Yet little information has been made available on what efforts they made to clear DU contamination beyond their own facilities; target location data, and information on past clearance is critically important to Iraq as it seeks to address the legacy of the two conflicts.

The need to increase data sharing and cooperation to address DU and other toxic remnants of war has been raised by repeated UN General Assembly resolutions and more recently by the International Law Commission and the UN Human Rights Council. The report concludes by analysing state practice on DU management by the US and UK in the wake of the 2003 conflict in order to examine whether new norms are being created.

This report reveals that the claim by the proponents of DU weapons that their use is restricted to the specific task of destroying armoured vehicles is demonstrably false: a fact that should further increase the existing stigmatisation on the use of the weapons. We also hope that the data in this report will be of use to the Iraqi authorities, and to the demining organisations, researchers and affected communities seeking to address the legacy of DU use in the 1991 and 2003 conflicts in the absence of formal post-conflict clearance obligations.

2. Introduction

Depleted uranium (DU) is a by-product of the uranium enrichment process, which contains proportionally less of the fissionable uranium isotope U235, and more of the isotope U238 than natural uranium[1]. As a material it is highly dense and pyrophoric, meaning that it has an incendiary effect upon impact, with small particles burning in the presence of oxygen. This effect can generate environmentally persistent particles that can spread between tens and hundreds of metres from the target. Fragments and intact rounds may litter affected sites or remain in soils. DU is used by a number of states in armour-piercing-incendiary ammunition fired by tanks, armoured fighting vehicles and aircraft.

DU weapons have been controversial since their first major use in the 1991 Gulf War. Radioactive and chemically toxic, DU use creates hotspots of persistent contamination that present a hazard to communities long after conflict ends, particularly for pregnant women, as well as children. Buildings and civilian infrastructure have regularly been targeted with DU and its use can contaminate soils and groundwater and create vast quantities of contaminated military scrap[2]. In recent years a wealth of new research has demonstrated that DU is both genotoxic – it can damage DNA – and carcinogenic[3]; just part of a large and growing body of data that was unavailable when the legality of the weapons was reviewed prior to their entry into service.

1 For further information on DU, and an overview of key issues, see: http://www.bandepleteduranium.org/en/overview

2 PAX (2014) No solution in sight for Iraq's radioactive military scrap: http://www.paxforpeace.nl/stay-informed/news/no-solution-in-sight-for-iraqs-radioactive-military-scrap

3 ICBUW (2014) Malignant Effects: depleted uranium as a carcinogen and genotoxin: http://www.bandepleteduranium.org/en/docs/216.pdf

Effectively managing DU's post-conflict legacy places a significant financial, political and technical burden on affected states and, in common with other forms of radioactive contamination, its presence or suspected presence often has a profound psychological impact on communities. Unsurprisingly, the dispersal of DU in conflict runs counter to internationally recognised radiation protection norms.

During the last 15 years, domestic and regional parliaments have called for restrictions on DU's use and between 2007 and 2016 the weapons have been the subject of six UN General Assembly resolutions, which have been supported by an overwhelming majority of states. The resolutions have sought to establish norms on transparency, international assistance and have highlighted the necessity of precaution in the use of the weapons[4].

The small number of states that still retain DU weapons argue that they are legal because they are not banned[5]; that they pose no risk to civilians in spite of little effort to study their impact on communities following conflicts[6]; and that they are militarily necessary for the specific role of destroying armoured vehicles[7]. This report focuses on one type of DU munition, fired by one US platform and in one conflict. But in doing so it identifies serious flaws in the case made by the US and other DU users as they seek to justify DU's continued use in the face of international opposition.

4 UN General Assembly resolutions 62/30, 63/54, 65/55, 67/36 and 69/57.

5 US Department of Defense (2016) Law of War Manual http://www.defense.gov/Portals/1/Documents/DoD_Law_of_War_Manual-June_2015_Updated_May_2016.pdf

6 Parrish, RR, (2010) Impacts of Depleted Uranium to the natural environment: A report commissioned by the Natural Environment Research Council for the UK Ministry of Defence, submitted to NERC and MoD.

7 US Department of Defense (2016) Law of War Manual http://www.defense.gov/Portals/1/Documents/DoD_Law_of_War_Manual-June_2015_Updated_May_2016.pdf

3. Recommendations

Transparency

The early location of DU contaminated sites is critical for the implementation of measures to reduce the risk of civilian exposure. This requires the swift release of detailed targeting data to national authorities, relevant international organisations and demining organisations. The UK performed better on transparency and data sharing than the US following 2003, where the US's refusal even to share information with UN bodies hampered post-conflict assessments. It is likely that the US is still holding data on the use of DU by land platforms in the conflict and this should be made available without delay in order to facilitate clearance activities.

Clearance and assistance

The government of Iraq has made clear that it requires support from the international community and international organisations to address DU contamination from the 1991 and 2003 conflicts. UN General Assembly resolution 69/57 in 2014 encouraged states to provide assistance to affected states, in particular in identifying and managing contaminated sites and material. Donors and international organisations must ensure that Iraq has the technical capacity and resources it needs to effectively manage contamination and to assist affected communities.

Formalise post-conflict DU management obligations

The absence of clear international obligations for the post-conflict management of DU places civilians at risk of unnecessary exposure and leaves affected states with a significant financial, technical and political burden in the wake of conflicts. Peacetime regulatory frameworks, international radioactive waste management guidelines, the emerging norms on data sharing, assessment, clearance, recovery and monitoring, as well as the principles being examined by the International Law Commission and UN Human Rights Council could all provide guidance on the

possible scope and structure of obligations. Whether specific obligations should be developed, or whether DU should be included within an existing framework – such as Protocol V of the Convention on Certain Conventional Weapons – should be urgently considered by states.

Ban DU weapons

This report details the reality of DU use in conflict, while promoted and legally justified as an anti-armour weapon, the reality has proved very different in recent conflicts. This has placed civilians at increased risk of exposure, as have the lack of formal post-conflict obligations, the cost and complexity of DU management and the persistent refusal of some DU users to publicise where the weapons have been used and what efforts have been undertaken to deal with contamination.

The uncontrolled dispersal or DU in conflict runs counter to the most fundamental radiation protection norms and, in spite of the ceaseless assurances of those that use the weapons, is unlikely ever to go unchallenged by the dictates of public conscience – as they are all too well aware. DU has no place in conventional weapons and the only lasting solution to the unacceptable threat its use poses to civilians is a global ban.

4. About this report

The need for greater transparency over where DU weapons have been used and in what quantities has featured in UN General Assembly resolutions since 2010[8]. Unlike some remnants of war, the locations of DU strikes are often difficult to locate visually within the landscape. This is particularly true for DU munitions fired by aircraft - a problem documented by the UN Environment Programme (UNEP) in its fieldwork in the Balkans[9].

Clearance work, and efforts to minimise the risks the weapons pose to civilians and to demining staff are therefore incumbent on the swift release of accurate data from those that use the weapons. It is therefore no coincidence that Coalition partners in the 2003 Iraq War – the conflict dealt with by this report - requested such data from the US authorities, due to concerns over the risks DU posed to their personnel[10].

In general, armed forces that have operated in areas where DU has been used have provided

8 ICBUW (2010) 148 states call for transparency over depleted uranium use in UN vote: http://www.bandepleteduranium.org/en/148-states-call-for-transparency-over-depleted-ura

9 UNEP (2003) Depleted Uranium in Bosnia and Herzegovina: Post-Conflict Environmental Assessment: http://www.unep.org/disastersandconflicts/portals/155/disastersandconflicts/docs/dup/BiH_DU_report.pdf

10 Zwijnenburg, W. (2013) In a State of Uncertainty: impact and implications of the use of depleted uranium in Iraq norms, PAX: http://www.paxforpeace.nl/media/files/hazard-aware.pdf

British MoD expert examines DU contaminated anti-aircraft gun near Basrah, Iraq (2003)

clear instructions to their own personnel on how to minimise potential exposure to DU[11].Yet traditionally, civilians or local authorities in DU contaminated areas have not benefitted from risk awareness guidelines or had access to bio-monitoring following potential exposures – as military personnel have had.

During the Iraq War, data collection was acknowledged as important by the US, as were the political implications of DU weapons' use, which by 2003 had already become internationally stigmatised: *"Knowledge of the use and disposition of DU munitions and DU delivery systems is important to the safety and well-being of coalition military personnel, as well as civilians in combat areas. It is also very important from a geopolitical standpoint*[12]*."*

Although recognising that targeting data was critical for minimising civilian harm, the US has historically been slow or reluctant to share such data with the relevant international organisations, national authorities and civil organisations that could identify and implement harm reduction measures for civilians. This was also the case with DU use in the 2003 Iraq War.

With the assistance of George Washington University's National Security Archive, we managed to obtain data on 1,116 sorties from the 2003 conflict, where PGU-14/B 30mm DU ammunition

11 Zwijnenburg, W. (2012) Hazard Aware: Lessons learned from military field manuals on depleted uranium and how to move forward for civilian protection normsPAX: http://www.paxforpeace.nl/publications/all-publications/hazard-aware

12 Letter dated 12th September 2003 from 1st Marine Expeditionary Force to Marine Forces Central Command, Accounting for depleted uranium (DU) munitions and equipment destroyed by DU munitions during Operation Iraqi Freedom; courtesy of the George Washington University National Security Archive.

was fired by US Air Force A-10 ground attack aircraft. Of these, 333 did not provide engagement location coordinates, however data were available on DU use and locations for 783 of the sorties.

The sorties saw the use of 227,008 rounds of "Combat Mix" ammunition, which for the 2003 conflict, is understood to have been a mixture of PGU-14/B Armour Piercing Incendiary DU ammunition and PGU-13/B High Explosive Incendiary (HEI) ammunition combined at a ratio of 4:1[13]. At a ratio of 4:1, the total number of DU rounds fired over the 1,116 sorties would have been 181,606. Each PGU-14/B round contains 298g of DU, therefore the total mass of DU expended was a little over 54,000kg. This represents 45.7% of the total DU – 118,000kg – that US and UK forces have acknowledged firing in the 2003 Iraq War. The bulk of this was fired by the US, with the UK responsible for firing 1,900kg.

The targeting data contained in this report increases the number of sites known to have been contaminated with DU in the 2003 Iraq War from in the region of 350 – according to the Iraqi authorities - to around 1,133. However, the data only relates to rounds fired by A-10s, and not to the other two US land platforms and one other air platform that used DU in the conflict.

The US has argued that: *"Although it was relatively easy to track aviation DU expenditures during the war, tracking the latitude and longitude of individual tank's DU rounds fired during combat is nearly impossible. Given that DU was used in ammunition fired by the Abrams tank, Bradley Fighting Vehicle, USAF A-10, and USMC AV-8B Harrier, it is not practical to attempt to locate all fired DU rounds that may be in Iraq*[14]*."* Nevertheless, in 2003 all US command centres were instructed to record and track the locations where DU was fired[15].

The credibility of the claim that firings from land platforms – or rather their intended targets - couldn't be tracked is questionable. The UK released data from its use of 120mm tank ammunition in the Basrah area during the 2003 conflict. Although there was some confusion on their part over whether the data related to firing points or impact points – locations potentially separated by many kilometres[16], Challenger 2 tank crews had nevertheless retained data of some relevance to subsequent clearance efforts. Internal documents also showed that tank crews had on occasion fired rounds to clear the chambers of their guns instead of reloading. In spite of the apparent difficulties with land platforms such as the Bradley and Abrams, the US did manage to provide data to the Dutch MoD, whose troops were based in Al-Muthanna province, outlining specific coordinates where 25mm and 120mm DU rounds were fired[17].

If the US, as the British did, retained data on firing or target points for land platforms for the 2003 conflict, it should release this to the Iraqi authorities and relevant organisations as a matter of urgency. Access to the missing data is of critical importance for the post-conflict management

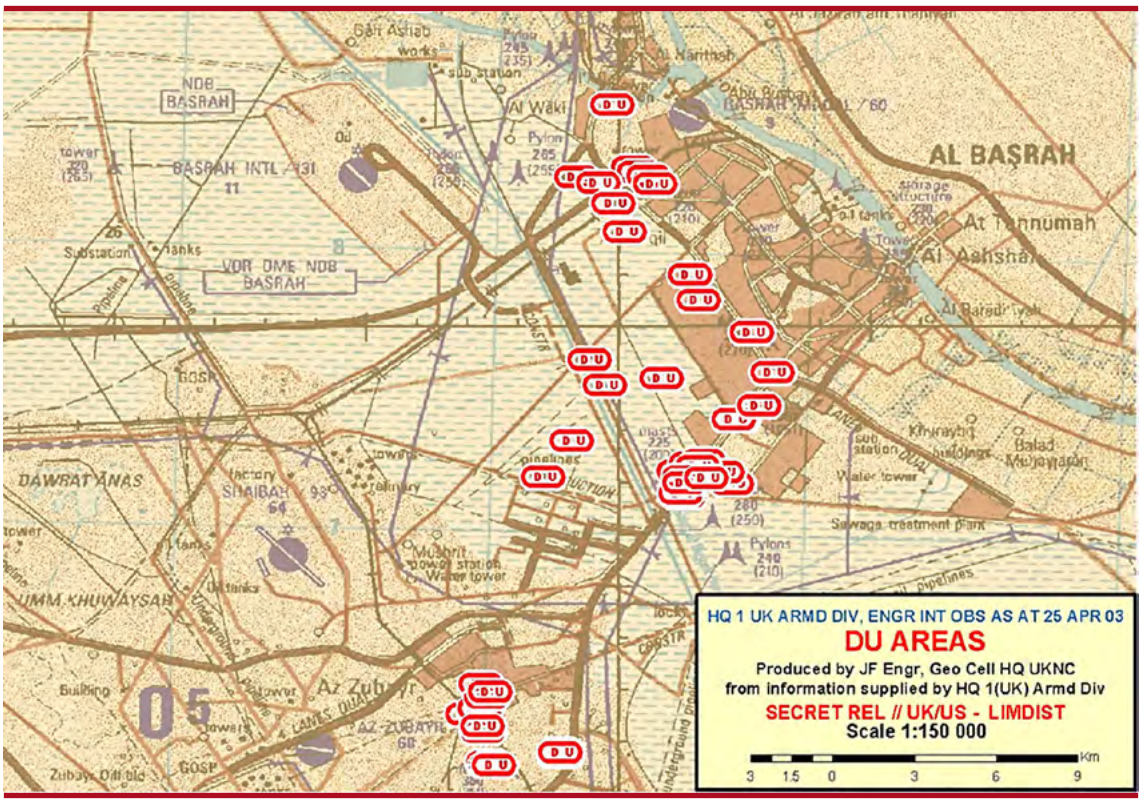
13 The precise ratio of DU to HEI ammunition in the USAF's Combat Mix may vary between conflicts, estimates for the Balkans included 4:1 to 5:3. The 4:1 figure in this report is sourced from US CENTCOM's own summary of DU use in the 2003 conflict.

14 Letter dated 12th September 2003 from 1st Marine Expeditionary Force to Marine Forces Central Command, Accounting for depleted uranium (DU) munitions and equipment destroyed by DU munitions during Operation Iraqi Freedom; courtesy of the George

15 Ibid

16 UK Ministry of Defence (2003), Minutes of the 10th meeting of the MoD's Depleted Uranium Working Group.

17 Zwijnenburg, W. (2013) In a State of Uncertainty: impact and implications of the use of depleted uranium in Iraq, PAX: http://www.paxforpeace.nl/media/files/hazard-aware.pdf



Map of UK Challenger 2 DU firing coordinates around Basrah, Iraq 2003.

of DU contamination in Iraq, with at least 62,000kg thought to still be unaccounted for from the 2003 conflict. Just as troublingly, the US has stated that no targeting data on the 286,000kg of DU it fired in the 1991 Gulf War are available - from any platform[18]. Again the implications for efforts to address contamination and minimise civilian harm are obvious.

In 2014, Iraq – the most heavily DU affected country on Earth – called for assistance from the international community in dealing with contamination from both the 1991 and 2003 conflicts[19]. It is our hope that the data in this report will be of use to the government of Iraq and the demining community in mitigating and minimising the threat that DU contamination continues to pose to the Iraqi people and their environment.

Unlike antipersonnel land mines, cluster munitions and other explosive remnants of war, at present there are no formal obligations on affected or DU using states to clear these toxic remnants of war and identify and assist those affected. It is our view that the global consensus opposed to DU weapons should be urgently employed to achieve this objective.

18 Declassified letter dated 12th September 2003 from 1st Marine Expeditionary Force to Marine Forces Central Command, Accounting for depleted uranium (DU) munitions and equipment destroyed by DU munitions during Operation Iraqi Freedom; courtesy of the George Washington University National Security Archive.

19 UN General Assembly (2014), A/69/151, Effects of the use of armaments and ammunitions containing depleted uranium, Report of the Secretary-General.

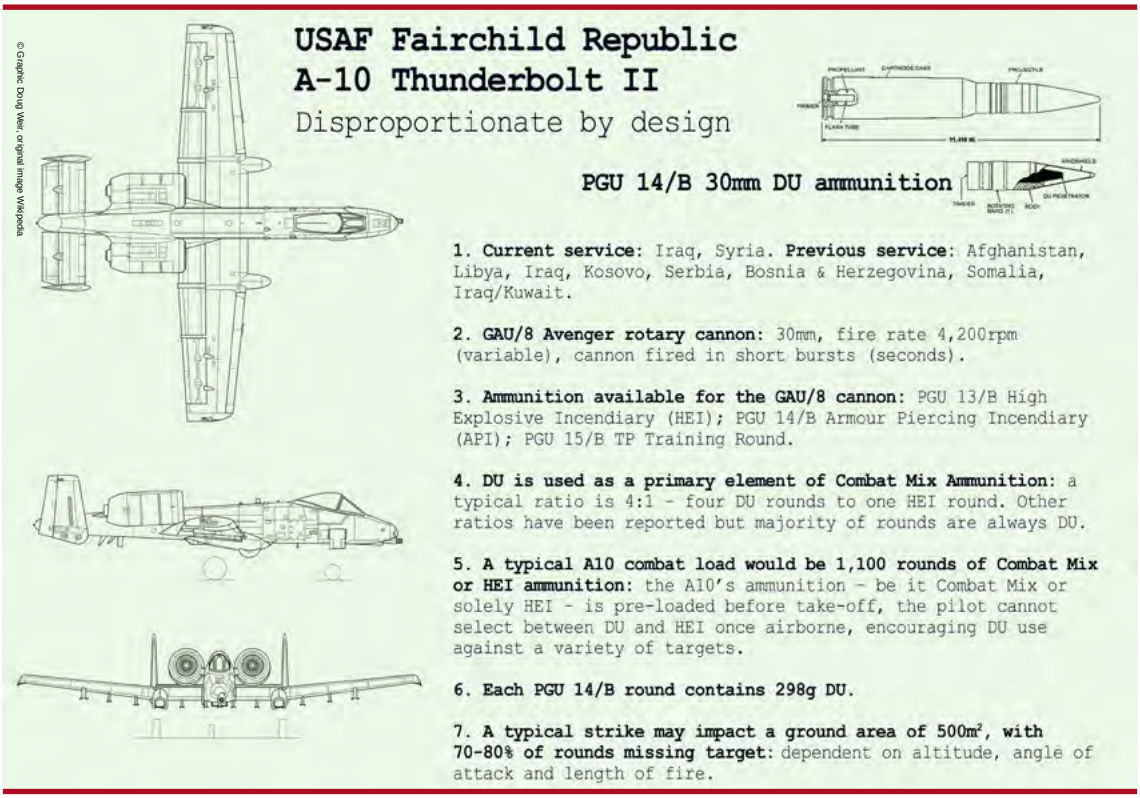
5. The USAF A-10 Thunderbolt II - disproportionate by design

This report focuses on one specific platform, the US Air Force's A-10 Thunderbolt II ground attack aircraft, which entered service in 1977. Designed primarily for close air support, and armed with a large rotary cannon to engage armoured vehicles, it has been a common component of US overseas operations since the 1991 Gulf War. Internationally, it was one of the earliest platforms for which DU ammunition was developed, and it was intended that the ammunition would allow A-10s to destroy Soviet tank columns, attacking armoured vehicles from above where their armour was thinnest.

Because of its recurrent deployments, the A-10 has been responsible for more DU contamination than any other platform worldwide, both by mass fired and quantity of rounds. However the operational characteristics of its DU use are markedly different to that envisaged during the development of the aircraft and its weapon system. The closest it has got to the role that it, and its DU ammunition, were designed for, was the 1991 Gulf War, where it was credited with destroying 987 tanks and 501 armoured personnel carriers. However the vast majority of these targets, including 900 tanks, were destroyed by the Maverick missiles that the A-10's carried[20]. In a sign of things to come, in 1991 the A-10s also engaged and destroyed 926 artillery pieces, 1,106 trucks, Scud missile sites, surface to air missile sites and two helicopters[21].

20 Fahey, D (2003) Science or Science Fiction? Facts, Myths and Propaganda In the Debate Over Depleted Uranium Weapons: http://www.wise-uranium.org/pdf/dumyths.pdf

21 Jacques, D (2010) A-10 Thunderbolt II (Warthog) Systems engineering case study, US Air Force Center for Systems Engineering.



Later in the 1990s, A-10s would be deployed over Bosnia & Herzegovina, Serbia and Montenegro and Kosovo[22]. The picture that had begun to emerge in 1991 would develop further with DU used against buildings, telecommunication sites, towed guns and light military vehicles – in addition to its limited use against tanks. The data on the 2003 Iraq War in this report demonstrates a similar pattern, with troops, aircrafts, boats, cars, trucks, missile launchers, mortars, defensive positions, storage sites, buildings, encampments, fortifications, bunkers, observation posts, staging areas, control towers and compounds all subject to attack with DU munitions.

The most important factor that has influenced the expansion of A-10 target types is perhaps the platform's greatest flaw. Once the aircraft is airborne, the pilot cannot select between ammunition types on the pre-loaded belts that feed its cannon. The decision on whether to load the aircraft with its Combat Mix of DU and HEI ammunition, or with HEI alone, must be taken at the airbase. It is perhaps inevitable that military planners anticipating that the aircraft may be faced with armoured vehicles will err on the side of caution and load Combat Mix, but in doing so this policy has clearly led to the gratuitous and militarily unjustified use of DU against targets for which HEI ammunition alone would have likely proved sufficient. For Iraq in 2003, the net result of the USAF's policy was perhaps as many as 1000 contaminated sites, a significant post-conflict radioactive waste management problem and a far greater likelihood of civilians being exposed to DU.

An additional factor has been the changing nature of conflict. The A-10, and its ammunition, were products of the Cold War. It was anticipated that the A-10 would be deployed against

22 ICBUW (2010) A Question of Responsibility: the legacy of depleted uranium use in the Balkans: http://www.bandepleteduranium.org/en/docs/134.pdf

advancing Soviet tanks on the plains of Germany, yet the 2003 war saw the widespread use of DU against unarmoured targets in or near populated areas; due in part to the tactics of the Iraqi Army and the Fedayeen[23]. The military interventions and quasi-international conflicts that have occurred since the 1990s are very different to the military scenarios envisaged in the 1960s and 1970s. Similarly the humanitarian justifications for recent conflicts are rightly increasing focus on the conduct of operations, and in this sense the A-10 and its DU ammunition could be viewed as dinosaurs doing a mammal's job.

5.1 DU's promotion solely as an anti-armour weapon

The nature of recent DU use by the A-10s stands in stark contrast to the picture often painted of the military necessity for employing DU by the US and other militaries. In efforts to promote the legitimacy and utility of the weapons, the official line is that the PGU-14/B DU round is first and foremost an anti-armour weapon, and one that is only used when the circumstances demand it.

Most recently this was seen in allegations over DU use in the conflict against Islamic State in Syria and Iraq. When a US military spokesperson was challenged over the question of its use, their response was: *"If the need is to explode something - for example a tank - [depleted uranium] will be used*[24]*."* A further response from a separate spokesperson again framed the munitions solely as an anti-armour weapon: *"There is no prohibition against the use of Depleted Uranium rounds, and the [U.S. military] does make use of them. The use of DU in armor-piercing munitions allows enemy tanks to be more easily destroyed*[25]*."* Investigations into whether the US has used DU in Syria, in spite of assurances that it wouldn't[26], are ongoing at the time of writing.

For the US and other DU users, the legitimacy of DU is wholly dependent on their ability to promote the utility and necessity of the weapons for the purposes of defeating armour. They fully understand the international opprobrium associated with the weapons, and indeed have been acutely aware of it since the 1970s. Even before the 1991 Gulf War, when the US was considering whether to choose between DU and its widely used alternative tungsten, perception was noted as a critical issue for the combat use of DU: *"Public relations efforts are indicated, and may not be effective due to the public's perception of radioactivity. Fielding and combat activities present the potential for adverse international reaction*[27]*."*

For the A-10, DU has increasingly become a blunt tool and one with ramifications for international relations. This perhaps helps explain the at times ambiguous statements that have followed accusations of use in recent conflicts, such as Somalia, Afghanistan, Libya and most recently Syria.

23 Council on Foreign Relations (2003) Iraq: What is the Fedayeen Saddam? http://www.cfr.org/iraq/iraq-fedayeen-saddam/p7698#p1

24 Al Jazeera (2015) US deploys DU aircraft to Middle East: http://www.aljazeera.com/humanrights/2014/10/us-deploys-du-aircraft-middle-east-201410287450282932.html

25 Ibid

26 War is Boring (2015) A-10s Leave Controversial Ammo at Home During Middle East Strikes, Pentagon says depleted uranium rounds are not required against Islamic State: https://warisboring.com/a-10s-leave-controversial-ammo-at-home-during-middle-east-strikes-c5f6654fc6d6

27 Picatinny Arsenal (1990) Kinetic energy penetrators, environmental and health considerations, Appendix D: http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA395638

5.2 Legal restrictions on the use of PGU-14/B ammunition ignored

A review of the legality of the A-10's PGU-14/B DU ammunition was undertaken prior to its entry into service in March 1975[28]. The review considered the prohibition against unnecessary suffering, the prohibition on poison and the test of proportionality. Coming in the closing stages of the Vietnam War, it had a particular focus on the incendiary nature of DU weapons.

While the review found that the weapons did not breach existing international humanitarian law (IHL), it did require that restrictions be placed on how and where they should be used because of their incendiary qualities, it also noted that the use of DU would present "international and national political issues".

In considering whether the weapons could be used against military personnel – the prohibition against unnecessary suffering, or whether they would be likely to be breach IHL, the review argued that, (original emphasis): *"…depleted uranium weapons should not be directed solely against persons if alternate weapons are available and can be used".*

Similarly, conscious of the chemically toxic and radioactive nature of DU, but confident that: *"… the depleted uranium munitions are designed to be used against hard targets, and depleted uranium is selected and used for this purpose,"* the review argued that in order to avoid the restrictions on the prohibitions against unnecessary suffering and poison, a further specific restriction was needed. Its proposal: *"This munition is designed for use against tanks, armored personnel carriers or other hard targets. Use of this munition solely against personnel is prohibited if alternative weapons are available."* The review also called for precautions to minimise fires and *"disproportionate injury to civilians or damage to civilian objects"* from their incendiary effects.

The review utilised the recommendations from a working group to determine the potential risks to *"friendly civilian populations"* from the *"inhalation, ingestion, or implantation"* of DU in combat situations where its use was widespread. The working group had found that contamination could be locally significant and as such the review suggested once again that the weapons' use be: *"…restricted, to the extent possible, to its use against hard targets."*

The review preceded the combat use of DU and therefore the advisory working group's dataset would have been limited. Nevertheless it has since been vindicated by assessments of sites contaminated by A-10s in active conflict, where contamination has indeed been locally significant and has required remedial clearance measures and long-term monitoring to minimise exposure risks to civilians[29].

More fundamentally, the data contained in this report clearly demonstrate that the restrictions proposed in the review have been largely ignored. The ammunition has been used against personnel, it has been used in built-up civilian areas and the inability of the pilot to select between DU and HEI ammunition once in flight has all but guaranteed that it has been used against a far wider range of targets than originally intended - and currently advertised.

28 USAF (1975) Legal review of PGU 13 and PGU 14/B ammunition by Judge Advocate General Major General Harold R. Vague.

29 See for example the clearance activities of the Serbian government in: ICBUW (2010) A Question of Responsibility: the legacy of depleted uranium use in the Balkans: http://www.bandepleteduranium.org/en/docs/134.pdf

6. Analysis of the targeting data

Building a comprehensive picture of all the locations where DU has been used in Iraq requires the utilisation of data from multiple sources. According to the Iraqi Ministry of the Environment's Radiation Protection Centre (RPC), there are between 300 and 350 known DU contaminated sites, although information on these locations has not been publicised or shared. Past efforts by PAX to identify DU sites have used a variety of sources, ranging from research undertaken by Iraqi academics, open source data collection, the firing coordinates that were provided to UNEP by the UK and information released through a Dutch FOI request.

Limitations

Although the analysis of the A-10 firing data in this section is an important step towards identifying how DU was used and where it was fired, the picture remains incomplete. Location data for DU fired in the 1991 conflict - some 286,233kg - is unavailable. For 2003, and as noted above, no targeting data has been made available by the US for DU fired by the Abrams tanks, or the Bradley AFV. While the US has stated that recording such data from land platforms is impossible, three coordinates were provided to the Dutch MoD in Al Muthanna province. These accounted for 730 M919 25mm rounds and 38 120mm rounds, demonstrating that the coordinates of DU fired by land systems were recorded, contrary to US claims.

6.1 Methodology

The analysis undertaken for this report is primarily based on data held by the George Washington University National Security Archive. The targeting data, which is appended to a USCENTAF report entitled '*Depleted Uranium - Accounting for depleted uranium munitions and equipment destroyed by depleted uranium munitions*' runs to 30 pages of A-10 firing coordinates. The report appears to be the product of a policy discussed in Section 8.2, whereby the US sought to ensure that lessons were learned and intended to make a record of its DU use public. The copy held by George Washington University, which dates from late 2003 or early 2004, has been redacted for public disclosure as a FOIA release in 2010[30] together with other documents on the conflict quoted in this report - but as far we are aware has not previously been in the public domain[31].

Each page of the targeting data is divided into 10 columns (see Table 1). Each column in the table provides detailed information on each specific strike.

Table 1:
Information classes, A-10 firing data

ATO	Starts with the letter N, follows alphabetical order, ends with Z and starts again later with A till N1
Date	Notes the date of attack
Call Sign	Call sign of the aircraft
AC Type	Type of aircraft, in this case all A-10
Type Ord	Type of ordnance fired: 30mm Combat Mix
Nbr Ord	Number of ordnance fired
FAC Name	Provides general description of target site
DMPI Name	Designated Mean Point of Impact
DMPI Lat	DMPI Latitude
DMPI Long	DMPI Longitude
DMPI Coord	DMPI Coordinates
Remarks	Describes visual impact report by pilots after the attack

Other documents in the FOIA release includes more detailed information on the strikes but this could not be connected to the dates of the individual strikes in the first 15 pages. This information refers to, among other things, the impact of the weapons used, altitude of the plane, the angle of the strike and the munition's fuse.

30 CENTCOM FOIA reference 10-0086, request by Roger Strother, National Security Archive: http://www.governmentattic.org/4docs/CENTCOM-FOIA-CaseLogs_2007-2010.pdf

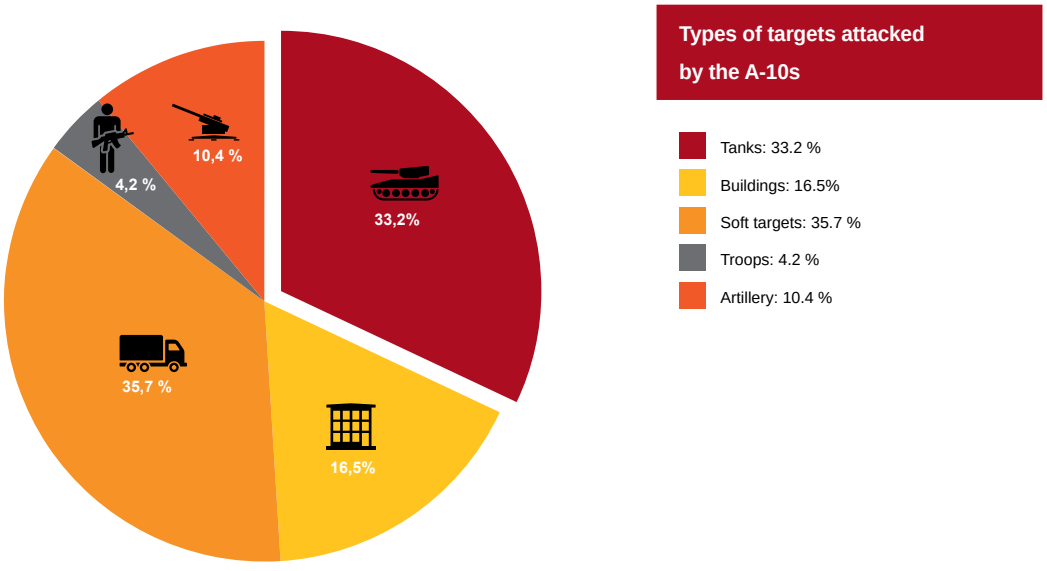
31 The US Center for Constitutional Rights, IVAW, PAX and ICBUW had also submitted US FOIA requests for information held on strike data and clearance efforts but with limited success: https://ccrjustice.org/home/press-center/press-releases/veterans-and-human-rights-attorneys-seek-information-toxic-weapons

6.2 Type of targets attacked with DU by A-10s

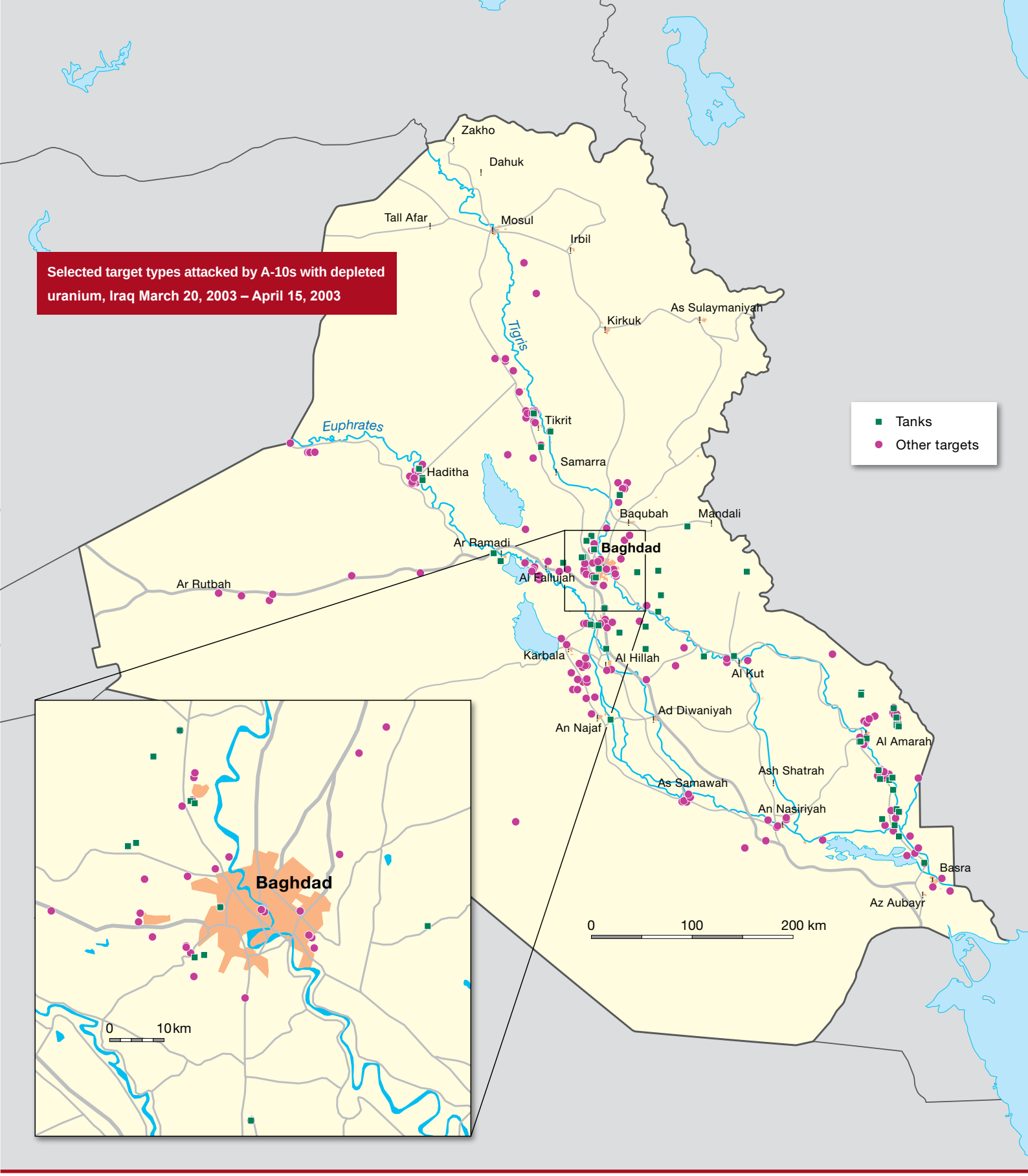
To obtain an overview on the type of targets attacked with DU by the A-10s, the data were categorised into five different target types, as seen in Table 2. The target types were taken from the columns FAC_Name and DMPI Name.

Table 2:
Description target categories

Target category	Types of targets	Total per category
1. Tanks/armoured vehicles	Tanks, armoured vehicles, armour and tanks in revetments	371
2. Artillery and anti-aircraft guns	Artillery, anti-aircraft guns	116
3. Troops	Troops, troops in revetments	47
4. Soft targets	Aircrafts, boats, cars, trucks, missile launchers, mortars, defensive positions	398
5. Buildings	Storage sites, buildings, encampments, fortifications, bunkers, observation posts, staging areas, control towers, compounds.	184



The analysis shows that of the 1,116 targets attacked, 371 were tanks and armoured vehicles, constituting just 33% of all targets engaged. An important finding given that the PGU-14/B 30mm was developed, legally justified and is still promoted as an anti-armour munition. If Category 2



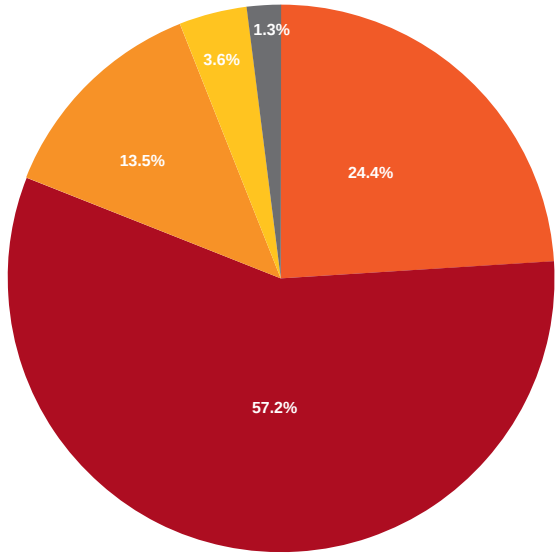
is included in the anti-armour section, as some of these artillery targets may have been tracked artillery and thus constitute armoured-type targets, it would only amount to 43.6% of all targets, still less than half of all targets in the data available. Of the 1,116 targets, 47 were troops or troops in revetments, constituting 4.2% of the targets: the 1975 legal review for the PGU-14/B proposed that direct attacks on personnel were to be avoided if other weapons were available.

6.3 Quantity of DU ammunition fired by A-10s

For each target, the column *Nbr Ordnance* provides the quantity of 30mm munitions fired at each target. For the purpose of this research, the number of 30mm rounds fired has been divided into five categories, as seen in Table 3, providing a breakdown of the intensity of munitions' use.

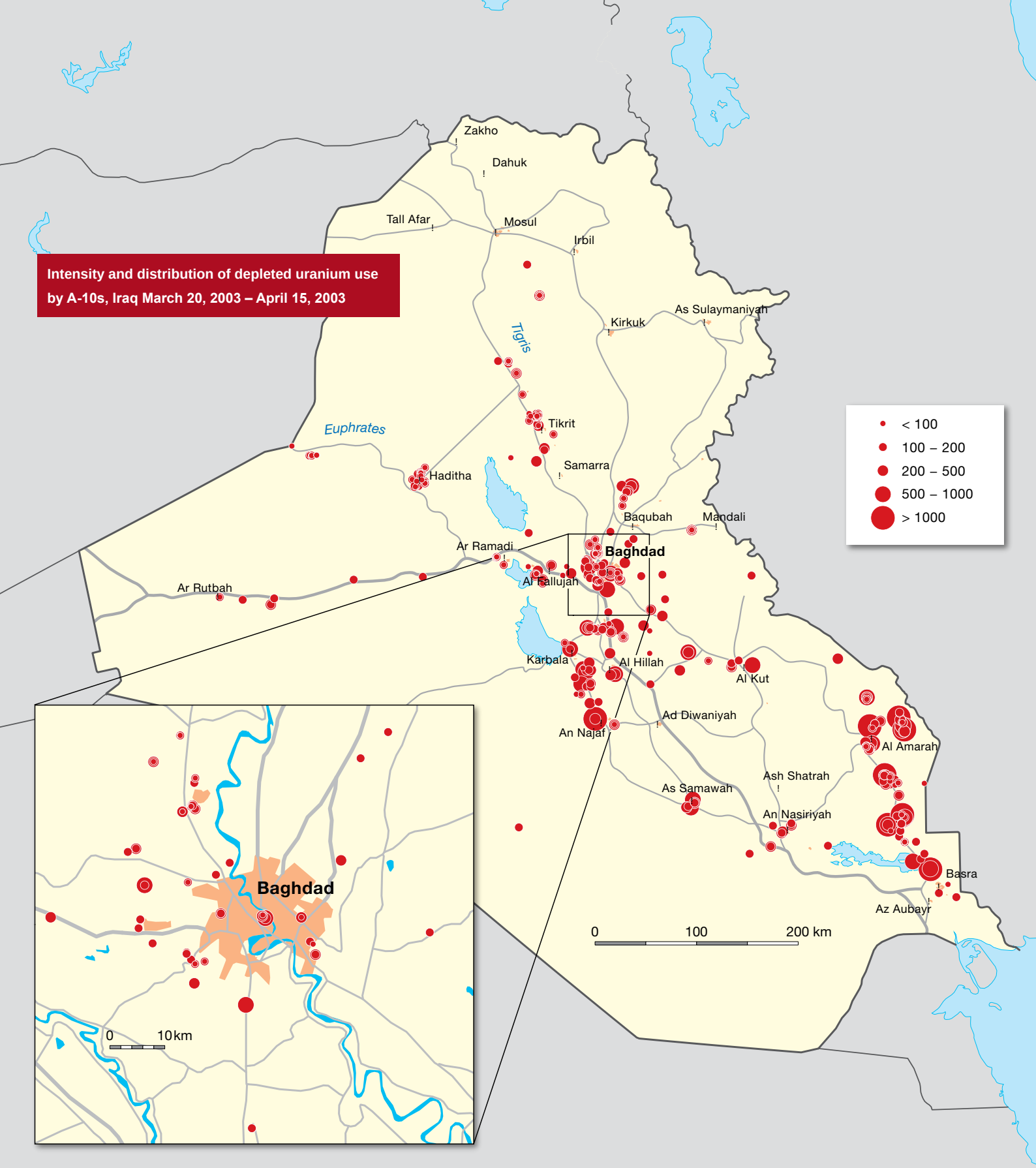
Table 3:
Categorising intensity of 30mm use

Intensity category	Quantity of Combat Mix fired	Total sites per category
I	0-100 rounds	272
II	101-250 rounds	637
III	251-500 rounds	150
IV	501-1000 rounds	40
V	1000+ rounds	15



Proportion of sites categorised by intensity of 30mm use

- Category I = 24.4%
- Category II = 57.2%
- Category III = 13.5%
- Category IV = 3.6%
- Category V = 1.3%


Intensity and distribution of depleted uranium use by A-10s, Iraq March 20, 2003 – April 15, 2003
Zakho
Dahuk
Tall Afar
Mosul
Irbil
Kirkuk
As Sulaymaniyah
Tigris
Euphrates
Tikrit
Samarra
Haditha
Baqubah
Mandali
Ar Ramadi
Baghdad
Al Fallujah
Ar Rutbah
Karbala
Al Hillah
Al Kut
Ad Diwaniyah
An Najaf
Al Amarah
Ash Shatrah
As Samawah
An Nasiriyah
Basra
Az Aubayr
< 100
100 – 200
200 – 500
500 – 1000
> 1000
0
100
200 km
Baghdad
0
10km

The data on latitude and longitude were compiled and loaded into ArcGIS to provide an overview of the locations where DU was fired. The results can be seen in the intensity Map on page 25 .

During the 2003 conflict, the Iraqi armed forces were positioned on the outskirts of towns and cities or as mobile units. As a result, a large proportion of the A-10 strikes were conducted outside densely populated areas. The map shows the progress of US forces across Iraq from the south towards Baghdad, attacking targets of opportunity where needed. Specific locations of intense use can be seen around the city of Amara in Missan province; south of Hindiyah; in the vicinity of Baghdad airport; to the north of Tikrit; and near the strategic Hadithah dam in western Iraq.

While the majority of strikes took place outside populated areas, the analysis nevertheless shows that a substantial number of strikes within the usage intensity categories 3 and 4 in Table 3 took place inside populated areas. These include southwest and eastern Baghdad, and inside and near Al Mussayib, As Samawah, Nasiryah and Basrah. The use of PGU-14/B ammunition in these areas may have breached the restrictions proposed in the 1976 legal review and will undoubtedly have increased the likelihood that civilians would have been exposed to DU contamination.

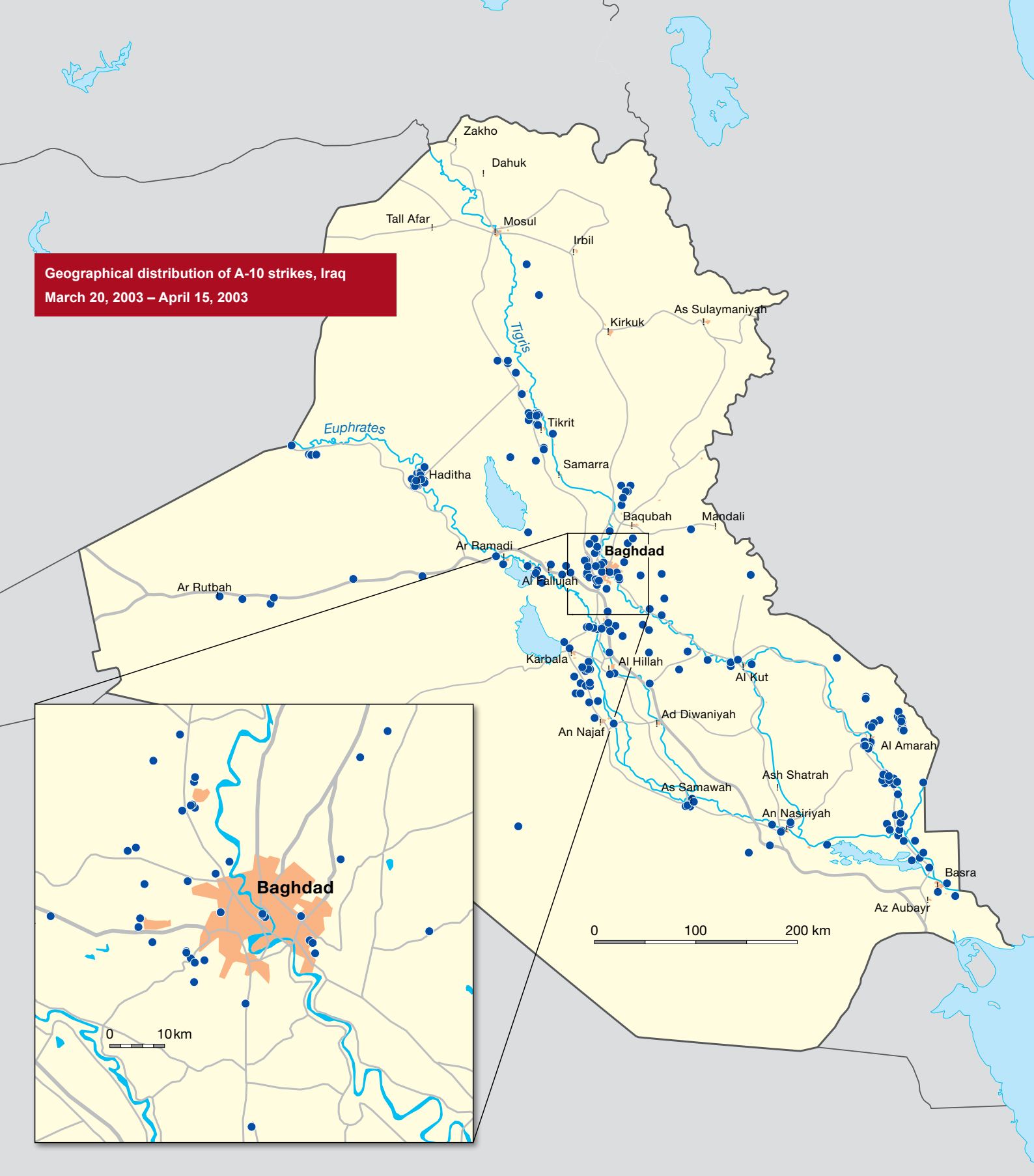
Interestingly, only one strike took place in Fallujah, with a further four in the desert to the south of the city. Studies into increased rates of congenital birth defects reported in Fallujah have speculated that DU may have been a contributing factor[32]. As a result ICBUW had earlier sought data on DU use in the city and in 2011 received a response coordinated by CENTCOM, which claimed that: "*…data relating to the expenditure of rounds fired containing uranium was not collected prior to July 2004*[33]*."*

The 2011 response appeared to confirm that no DU had been used in Operation Phantom Fury (November and December 2004) but claimed that no records would have been kept at the time of Operation Vigilant Resolve (April 2004) or the main conflict phase in 2003. The data in this report clearly demonstrate that records on use in and around Fallujah during the main combat phase in 2003 were indeed kept and that the claim from CENTCOM in 2011 was therefore false.

The limited use of DU in Fallujah in 2003 could suggest that the reported rise in congenital birth defects in the city may be unconnected to DU use. However without further clarification on DU use in the two subsequent operations in the city, questions will continue to be raised. It is entirely possible that DU stocks had been removed from the theatre following the conclusion of the main conflict phase but rather unlikely that no records on A-10 activities were retained in 2004.

32 According to researchers this has been the case, see: M. Al-Sabbak et al., Metal Contamination and the Epidemic of Congenital Birth Defects in Iraqi Cities, 89 Bull. Environ. Contam. Toxicol. 937 (Sep. 2012), available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3464374/pdf/128_2012_Article_817.pdf; Samira Alaani et al., Four Polygamous Families with Congenital Birth Defects from Fallujah, Iraq, 8 Int. J. Environ. Res. Public Health 89 (Dec. 2010), available at http://www.mdpi.com/1660-4601/8/1/89; while the WHO in cooperation with the Iraqi Ministry of Health conducted a nationwide survey on the potential increase of CBDs and found no links, as indicated in its FAQ http://www.emro.who.int/irq/iraq-infocus/faq-congenital-birth-defect-study.html, however the WHO has yet to publish the full dataset and methodology from the study, and has been accused by health experts of politicising their study findings;.See https://www.theguardian.com/environment/earth-insight/2013/oct/13/world-health-organisation-iraq-war-depleted-uranium

33 CENTCOM (2011) Letter in response to a FOIA request by Ms Gretel Munroe regarding DU use in Fallujah: http://www.bandepleteduranium.org/en/docs/160.pdf


Geographical distribution of A-10 strikes, Iraq
March 20, 2003 – April 15, 2003
Zakho
Dahuk
Tall Afar
Mosul
Irbil
Kirkuk
As Sulaymaniyah
Tigris
Euphrates
Tikrit
Samarra
Haditha
Baqubah
Mandali
Ar Ramadi
Baghdad
Al Fallujah
Ar Rutbah
Karbala
Al Hillah
Al Kut
Ad Diwaniyah
An Najaf
Al Amarah
Ash Shatrah
As Samawah
An Nasiriyah
Basra
Az Aubayr
0
100
200 km
Baghdad
0
10km

A-10 firing PGU-14/B at the Ministry of Planning, Baghdad April 4, 2003

6.4 Footprint of PGU-14/B use

Of the information available on the 1,116 strikes recorded in the FOIA data obtained from George Washington University, 783 coordinates had sufficient data to allow further analysis of target locations. Out of the 1,116 targets, the majority were non-armoured, primarily soft targets such as trucks, cars, buildings, boats and defensive positions. If the 4:1 ratio cited for the A-10's Combat Mix is correct, a total of 181,606 PGU-14/B DU rounds were fired. Divided by the 1,116 targets, this is an average of 163 rounds fired per target.

It has been estimated that 70-80% of 30mm rounds miss their target during A-10 strafing runs with its cannon, this means that between 127,124 and 145,284 PGU-14/B DU rounds may have ended up in soil, buildings or debris. When impacts were on soft targets – such as the soil surface, penetrators may be intact in surface soils or up to a depth of two metres. Impacts with hard targets such as concrete, buildings or rocks may have fragmented the rounds or in some cases generated particulate. This variability makes confidently predicting the precise exposure risks to civilians at any given location problematic.

7. The current status of DU clearance in Iraq

The use of DU by the US and the UK in 2003 resulted in widespread localised contamination in Iraq, much of which was caused by the use of A-10s attacking a wide variety of targets. DU contamination from land platforms such as tanks and armoured vehicles largely centred on southern Iraq, where DU was used during fighting as Coalition forces made their way towards Baghdad. With the exception of the 51 coordinates released by the UK around Basrah[34], and the three sites obtained from the Dutch MoD[35], no information on the locations of DU fired by land platforms has been released. However, open source intelligence and some studies by Iraqi researchers have sought to identify the locations of potentially contaminated sites[36].

Contamination in 2003 added to that caused by the 1991 Gulf War, after which the Iraqi authorities had undertaken some assessment of sites and made efforts to isolate and remove contaminated tanks and armoured vehicles. The renewed use of DU heightened Iraqi concerns and led to the involvement of the IAEA and UNEP in efforts to determine the scale of the problem, however this was hampered by a lack of access to US targeting data[37].

34 See: Freedom of information request to UK MoD by D. Weir, available at https://www.whatdotheyknow.com/request/depleted_uranium_hazard_awarenes

35 Zwijnenburg, W. (2013) In a State of Uncertainty: impact and implications of the use of depleted uranium in Iraq, PAX: http://www.paxforpeace.nl/media/files/hazard-aware.pdf

36 Ibid and Zwijnenburg, W. (2014) Laid to Waste: depleted uranium contaminated military scrap in Iraq, PAX: http://www.paxforpeace.nl/media/files/pax-rapport-iraq-final-lowres-spread.pdf

37 IAEA (2010) Radiological conditions in selected areas of southern Iraq with residues of depleted uranium, Report by an international group of experts: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1434_web.pdf

Photos from an Iraqi research report showing spent PGU-14/B rounds on soil surface (l), and (r) PGU-14/B rounds embedded in a building in southern Iraq, 2005.

Some post-conflict survey work has been documented by UK forces, where limited efforts were made to identify and isolate contaminated vehicles in their area of operations in southern Iraq. UK policy was that: *"Whilst [the] MoD has no long-term legal responsibility to clean-up DU from Iraq, it will do so on an opportunity basis, i.e., obvious surface-lying fragments will be removed from the battlefield as they are discovered*[38]*."* Demining organisations have informed PAX that the UK provided instruction and basic equipment for removing surface-lying DU in Missan province, where they collected a number of 30mm rounds and handed them over to a UK base. The UK MoD has refused to disclose how much DU this policy removed from Iraq, or its eventual fate.

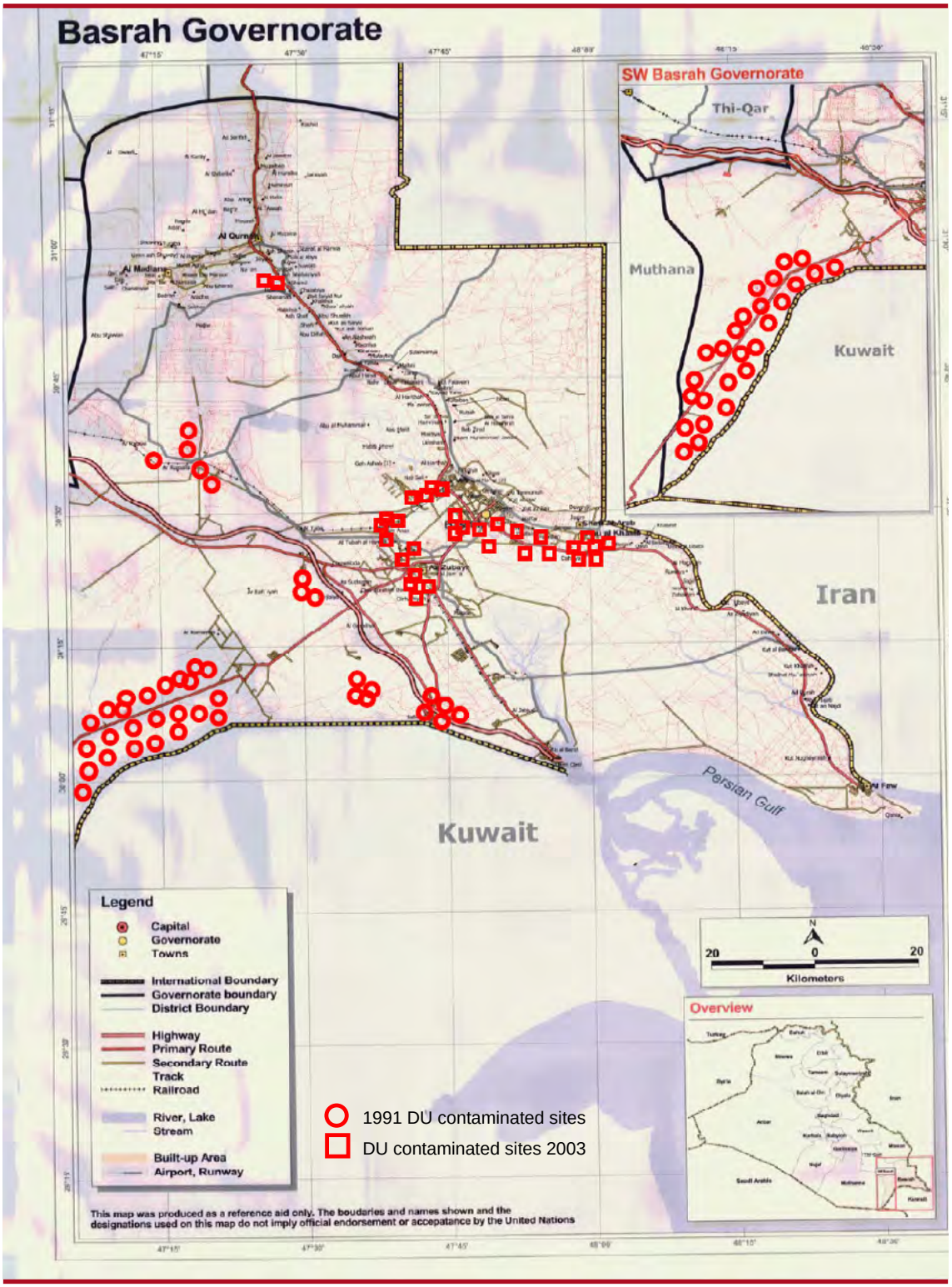
As a result of the post-conflict insecurity in Iraq, technical assistance on DU from UN agencies took the form of training personnel from Iraq's Ministry of the Environment in the identification and assessment of contaminated sites at workshops in Geneva and Amman. These staff formed the core of the ministry's Radiation Protection Centre (RPC), which has subsequently worked on operations to clean-up contaminated scrap, soils and DU fragments at sites. Publicly the RPC has acknowledged that between 300 and 350 sites are known and in the process of being remediated, at an estimated cost of US$100,000 per site. The sites often require complex operations to remove military scrap, debris and tonnes of contaminated soil for safe disposal[39]. Tackling DU contaminated military scrap and scrap metal sites is a priority for the Iraqi government, as highlighted in its 2013 National Environment Strategy and Action Plan for Iraq[40].

The Iraqi government remains committed to activities to identify, clear and remediate DU

38 Ministry of Defence (2003) Current policies and activities relating to clearance of unexploded ordnance (UXO) and depleted uranium (DU) in Iraq: http://www.iraqinquiry.org.uk/media/233440/2003-07-02-paper-mod-current-policies-and-activities-relating-to-clearance-of-unexploded-ordnance-and-depleted-uranium-in-iraq.pdf

39 The Guardian (2013) Iraq's depleted uranium clean-up to cost $30m as contamination spreads: https://www.theguardian.com/environment/2013/mar/06/iraq-depleted-uranium-clean-up-contamination-spreads

40 Ministry of Environment Iraq (2013) The National Environmental Strategy and Action Plan for Iraq (2013 – 2017): http://faolex.fao.org/docs/pdf/irq155814E.pdf



Sites assessed by Dr Khajak Vartanian, Basrah 2005

contaminated sites[41]. However, in light of the ongoing conflict with Islamic State and with it new cases of environmental damage – such as deliberate oil releases and fires – it is likely, and partly understandable that DU will be considered a lower priority by the government; a further reminder of the importance of the timely release of targeting data and for early remediation following conflicts.

DU contamination in Iraq continues to be a problem for governmental, commercial and humanitarian demining operators. Cross contamination of DU and cluster munitions and other ERW is not unusual. However the handling and disposal of spent DU munitions, fragments and contaminated materials requires expertise and specialist equipment. This makes access to targeting information particularly important for demining operators in order to prevent unnecessary exposures to personnel and to ensure DU is dealt with appropriately.

Norwegian People's Aid in Iraq have called for more data on DU use as they are dealing with cross-contamination in their battle area clearance operations, they also wish to include DU in their risk awareness programmes for local communities[42]. Increasing interest in DU has recently seen an update to the International Mine Action Standards Technical Note on DU[43]. Intended to provide clearance operators with more accurate information on how to recognise and manage DU, the updated note takes advantage of the field experience of UNEP and national authorities in the Balkans.

Speaking at the UN General Assembly's First Committee in 2014, Iraq said that it: *"…is highly concerned about using weapons and ammunition in wars and armed conflicts that contain DU, and also concerned about its negative effects on human beings and environment."* Iraq continued by urging: *"…UN member states and the relevant international organizations, especially the International Atomic Energy Agency, World Health Organization, UN Environment Programme, and research centres and academic studies to carry out in-depth studies about the environmental and health effects of DU and the ways to address these effects*[44]*."*

An urgent question for Iraq, its people and demining agencies, is whether the US and UK hold more data from the 2003 conflict that could help accelerate the assessment and clearance of DU contaminated sites and help inform risk awareness programmes for affected communities.

41 For a more complete overview of Iraq's historic and most recent policies and projects see Zwijnenburg, W. (2014) Laid to Waste: depleted uranium contaminated military scrap in Iraq, pp 42-54: http://www.paxforpeace.nl/media/files/pax-rapport-iraq-final-lowres-spread.pdf

42 Ibid, pp 30-31.

43 IMAS (2015) Technical Note 09.30/ 02 Version 3.0, Clearance of Depleted Uranium (DU) hazards: http://www.mineactionstandards.org/fileadmin/MAS/documents/technical-notes/NEW_TN_09.30.02_2015_Clearance_of_DU_Hazards__V.3.0_.pdf

44 Government of Iraq, statement on explosive remnants of war and depleted uranium weapons during UN General Assembly First Committee, 2014.

8. Post-conflict obligations for the management of DU

At present, and in contrast to explosive remnants of war[45], there are no specific international legal obligations on the users of DU weapons, or national authorities, to assess and clear intact or fragmentary DU rounds or DU contaminated materials. As DU is used in testing and training in peacetime, the question of whether it should be controlled in this way can be answered by considering the domestic peacetime frameworks that seek to minimise the risks these practices pose.

Such guidance on the regulation and control of DU contaminated sites can be found in the peacetime practices of a number of states, where DU use and disposal is subject to internationally recognised radiation protection standards and domestic environmental regulations. While national standards vary, the need to assess, remediate and monitor sites contaminated with DU remains largely the same regardless of jurisdiction.

A recent example can be found in the licence provided to the US Army by the US Nuclear Regulatory Commission for 15 of its domestic installations where historical DU contamination is thought to be present[46]. The licence not only restricts each site's holdings to 125kg (equivalent to 431 PGU-14/B rounds) but places restrictions on the activities at each site intended to reduce the risk of DU dispersing into the environment or posing a risk to health[47]. It should be noted that

45 Protocol V (explosive remnants of war) of the Convention on Certain Conventional Weapons is not currently thought to cover DU weapons.

46 US NRC (2016) Materials license SUIC-1593 to United States Army Installation Management Command: http://adamswebsearch2.nrc.gov/webSearch2/view?AccessionNumber=ML13259A062

47 United States Federal Register (2016) Vol. 81, No. 59 / Monday, March 28 https://www.gpo.gov/fdsys/pkg/FR-2016-03-28/pdf/2016-06947.pdf

the US Army had fought the imposition of the licence for a decade, in spite of having a number of US facilities already under regulatory oversight[48].

8.1 How DU users frame their post-conflict obligations

In the absence of formal post-conflict obligations, DU users have adopted a flexible and at times ambiguous approach to data sharing, clearance efforts and the provision of assistance. On the one hand wishing to be seen to be doing the right thing while on the other doing as little as possible, and avoiding publicising precisely what has been done so as to avoid establishing precedents. A situation illustrated by the private and public views below from the UK MoD in 2003.

In declassified documents released as part of the UK's Iraq War Inquiry, the UK had interpreted the absence of formal obligations as meaning that: *"Up until the new situation in post-conflict Iraq, the UK has followed the legal position on clean-up of DU; a nation which has fired DU in conflict is under no legal obligation per se to return to the region post-conflict to clear up any DU that remains. The legality of this issue has developed through custom: there are no special policies of conventions which address clearance of DU residue*[49]*."*

However In public the UK MoD had accepted it had a "moral obligation" to assist with DU clearance: *"Legally, we have no obligation to clean up the remains of the DU we used. It's the responsibility of the new regime in Baghdad. But morally we do recognise an obligation, as we have in the past. We helped in the removal of DU from Kosovo. We'll be helping in any way we can, specifically by providing money for the clean-up, and by making available records of where the ammunition was fired*[50]*."* In July 2003, the UK MoD, under scrutiny from the media and parliament, were forced to review their policy regarding DU clearance, having established that they were now an occupying power[51].

In spite of states' efforts to avoid establishing clearance precedents for DU and other remnants such as Agent Orange, there are signs that new norms are beginning to emerge. In 2016, the International Law Commission indicated that "toxic and hazardous remnants of war" should be removed or rendered harmless by parties to a conflict and this normative principle may be subject to further development in future[52]. The Commission has also proposed principles on

48 ICBUW (2016) US Army's depleted uranium licencing saga highlights post-conflict contradictions: http://www.bandepleteduranium.org/en/us-armys-depleted-uranium-licencing-contradictions

49 Ministry of Defence (2003) Current policies and activities relating to clearance of unexploded ordnance (UXO) and depleted uranium (DU) in Iraq: http://www.iraqinquiry.org.uk/media/233440/2003-07-02-paper-mod-current-policies-and-activities-relating-to-clearance-of-unexploded-ordnance-and-depleted-uranium-in-iraq.pdf

50 BBC (2003) UK to aid Iraq DU removal: http://news.bbc.co.uk/1/hi/sci/tech/2970503.stm

51 UK Ministry of Defence (2003), Minutes of the 10th meeting of the MoD's Depleted Uranium Working Group.

52 ILC (2016) 68th session, Protection of the environment in relation to armed conflicts, Statement of the Chairman of the Drafting Committee, Mr. Pavel Šturma: http://legal.un.org/docs/?path=../ilc/documentation/english/statements/2016_dc_chairman_statement_peac_9august.pdf&lang=E; Draft Principle 16 Remnants of war: 1. After an armed conflict, parties to the conflict shall seek to remove or render harmless toxic and hazardous remnants of war under their jurisdiction or control that are causing or risk causing damage to the environment. Such measures shall be taken subject to the applicable rules of international law. 2. The parties shall also endeavour to reach agreement, among themselves and, where appropriate, with other States and with international organizations, on technical and material assistance, including, in appropriate circumstances, the undertaking of joint operations to remove or render harmless such toxic and hazardous remnants of war.

post-conflict assessment and remedial measures and on sharing and granting access to information relevant to environmental harm.

The need to enhance monitoring systems for toxic remnants of war has also been noted by the UN Human Rights Council's Special Rapporteur on Human Rights and Hazardous Substances and Wastes, as has the need for governments to provide: *"…an effective remedy for hazardous remnants of conflict and other military activities, including funding for full remediation, comprehensive medical treatment and compensation for individuals experiencing the effects of exposure to these materials*[53]*".*

The future development of formal obligations concerning the post-conflict management of DU contamination will require consideration of past and current state practice on data sharing and clearance, and US and UK policy towards the 2003 conflict in instructive in this regard.

8.2 Emerging state practice on DU data collection and sharing

Timely access to accurate DU targeting data is crucial for assessment, risk reduction and subsequent clearance efforts. In the case of the 2003 conflict, and in the conflicts in the Balkans, targeting data has been requested by UNEP, with varying degrees of success. Multiple approaches to NATO by the UN were necessary to encourage the release of data for the Balkans, whereas following 2003 the UK was far more forthcoming than the US, transferring data on its DU use in the Basrah region to UNEP. However the UK's use – amounting to 1,900kg[54] was only a fraction of that fired by the US. A joint radiological assessment published by the IAEA and UNEP in 2010 was therefore restricted to locations provided by the UK and potentially contaminated sites tentatively identified through media reports and the activities of the Iraqi environment ministry[55]. The absence of specific data from the US raised serious questions over how representative the sampling locations were and the utility of the study.

A lack of access to targeting data from the US also hampered the work of the IAEA in Kuwait in response to contamination from the 1991 Gulf War, with the IAEA reporting that: "…*US authorities have not released detailed information on the exact sites at which such munitions were fired during the Gulf War,"* forcing them to rely solely on information from the government of Kuwait's Radiation Protection Department to locate sites for survey, of which 11 were selected for research[56].

As discussed in Section 4, the US had noted that recording the locations of DU use by land platforms was problematic, although data had evidently been recorded and had been made

53 UNHRC (2016), A/HRC/33/41, Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes: http://ap.ohchr.org/documents/dpage_e.aspx?si=A/HRC/33/41&utm_content=buffer53496&utm_

54 UK Ministry of Defence (2003), Minutes of the 10th meeting of the MoD's Depleted Uranium Working Group.

55 IAEA (2010) Radiological conditions in selected areas of southern Iraq with residues of depleted uranium, Report by an international group of experts, pp 38: http://www.pub.iaea.org/MTCD/publications/PDF/Pub1434_web.pdf

56 IAEA (2003) Radiological conditions in areas of Kuwait with residues of depleted uranium, Report by an international group of experts: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1164_web.pdf

available to the Dutch MoD. The US clearly recognised the importance of data collection and sharing, as this 2003 directive from CENTCOM indicates: *"…the use and disposition of DU munitions and DU contaminated equipment has an immediate effect on the safety of our service members and international ramification* (sic) *with our coalition partners. It is imperative units provide accurate information regarding the disposition of this equipment and ammunition. These reports are important historical documents that will have long-term operations ramifications.* (sic) *The intent is to be able to release as much of this information to the public as possible*[57]*."*

US military environmental operating standards for 2003, which were also held by George Washington University, reveal that data pertaining to DU was to be recorded and doing so was the responsibility of "all components" of the mission and the Join Task Force. They were to be: *"Responsible for on-going monitoring/recording locations, types, and quantities where Depleted Uranium (DU) munitions have been fired, either during operations or for training, and where DU-destroyed equipment is collected or buried, and known or suspected locations of impacted expended DU munitions in order to ensure no improper disposal of DU munitions*[58]*."*

In addition specific policies were to be developed for dealing with *"Depleted Uranium expenditure known-site administrative record keeping"* and that all sites of known environmental contamination, including their *"…type, and scope"* were to be reported to each component's commander and CENTCOM's engineers. An additional memo, the full text of which has not been made public and which dates from late 2002, highlighted the importance of taking appropriate measures *"…to mitigate the uncertainty of post-contingency DU munitions locations*[59]*".*

The US's environmental policy also indicates that the data collected on DU use was to be made publicly available following the conflict, suggesting that a report be provided: *"…in suitable format including executive summary, discussion, maps, and supporting documentation. Provide digital and bound printed copy. Report to be unclassified. Data that cannot be declassified may be included in a small classified annex to the public report. However the intent is to maximise information available for public disclosure. Report is due 15 Sep 03*[60]*."* It was also suggested that records be maintained and collected as the operations continued.

Taken as a whole, the documents appear to suggest that the mechanisms for recording data on DU use, contaminated sites and the disposal of contaminated materials were in place for all components of the US forces in Iraq. As far as we are aware, the proposed public report on US DU use in the conflict – which contains the targeting data used in this report - was never made public until it emerged as a FOIA release in 2013. Nor is it clear whether the data were made available to the Iraqi authorities, for whom it could radically accelerate clearance measures.

It is unclear why the US elected not to share the data it had collected with UN agencies, Iraq

57 CENTCOM (2003) Declassified correspondence to Joint Staff, Washington DC, accounting for depleted uranium (DU) munitions and equipment destroyed by DU munitions.

58 US Department of Defense (2004) Declassified, Annex L to USCENTCOM OPORD11 (S/REL USA GBR AUSMCFI) Environmental Considerations, Feb 2004.

59 US Department of Defense (2004) Declassified, CCJ4-E Issue Paper Depleted Uranium (DU) in ITO.

60 CENTCOM (2003) Declassified correspondence to Joint Staff, Washington DC, accounting for depleted uranium (DU) munitions and equipment destroyed by DU munitions.

or the wider public as the UK did, but it may be likely that concerns over liabilities for the cost of clearance and the likely political backlash from the widespread use of DU may have been of concern. This is indicated in the assumptions that the mission's environmental policy was based on, including the recognition that: *"U.S. Forces will include environmental considerations in all aspects of operations to minimize actions which might expose U.S. Forces to unnecessary health risks, cause unnecessary harm to the environment, or subject the U.S. to unfavorable publicity and future claims for damages, and will assist coalition forces OPCON to USCENTCOM to do the same*[61]*."*

The pre-existing international stigmatisation of DU weapons poses a challenge to efforts to persuade those states that use them to be more transparent about where they are used and in what quantities. Yet this information is necessary to ensure DU's effective post-conflict management and measures to mitigate the risks its use poses to the civilian population. This dynamic is regrettable and, given the radioactive nature of the weapons, seems unlikely to be resolved without the development of formal obligations on transparency and data sharing.

8.3 Emerging state practice on the clearance of DU

In 2005, and as concern grew over the renewed use of DU during the conflict, UNEP held a training event for staff from Iraq's environment ministry in Amman, Jordan. During the workshop, UNEP argued that: *"…there is an urgent need to identify and assess DU contaminated areas. Risks to human health need to be clearly identified and alleviated. Urgent steps also need to be taken to raise awareness of the potential risks of DU and to introduce protection measures, including posting of warning signs and restricting access at contaminated locations and storage sites. There is also a need to develop a system for safe transport and storage of DU fragments and DU contaminated material. Systems also need to be established at border control points through which DU contaminated scrap is exported*[62]*."*

The WHO and IAEA, also present at the workshop, offered to contribute towards efforts to address the contamination and asses its potential impact. However representatives from the UK and US were more circumspect. The UK MoD's Defence Science and Technical Laboratory (DSTL), which had been interested in documenting the efficacy of the weapons in the conflict for research purposes, had been deployed and surveyed four tanks and one anti-aircraft gun, finding: *"Two possible DU impact locations…In addition, soil sampling has been conducted at 9 U.K. bases*[63]*."* Discussing their work later, they had been surprised that persons unknown had already marked tanks struck by DU[64]; it is unclear whether the marking had been done by the US, deminers or the Iraqi authorities. At the time of the study, and despite the UK and US having a common environmental policy, DSTL did not have access to US firing data and their work focused on targets struck by large calibre ammunition.

The environmental guidelines discussed in the previous section make clear that the US was

61 Ibid

62 UNEP (2005) report of seminar and workshop on Depleted Uranium (DU) field measurement techniques, reconnaissance and sampling, Amman, Jordan.

63 Ibid

64 DSTL (2004) MOD DU Environmental Monitoring in the Balkans & Iraq, presentation to the MoD's DU research programme, Tidworth.

DU contaminated scrap metal site near Al-Zubayr, Iraq 2012.

well aware of the potential health hazards and environmental risks associated with DU, and DU along with other forms of pollutants and hazardous waste were to be addressed within the overarching principle of taking: *"…all possible actions to protect human health and preserve the environment without regard to the location of operations*[65]*."* DU's use and contaminated sites were to be documented, records were to be kept but significant questions remain over what happened next.

The primary focus of US efforts appears to have been the management and removal of their own DU contaminated equipment - vehicles damaged by fires or in friendly fire incidents. This was undertaken by the Army Contaminated Equipment Retrograde Team (ACERT). Similarly, some clearance took place of contamination at locations in use by Coalition forces, such as Baghdad airport, with private contractors playing a role in these projects[66].

Work to identify and isolate contaminated armoured vehicles appears to have taken place in Basrah and elsewhere and the opportunistic removal of surface lying penetrators has been undertaken during the course ERW clearance projects. However it is unclear whether or not a concerted effort to meaningfully address contaminated sites was undertaken by the US or other Coalition partners during the occupation. Both the US and UK have consistently argued that responsibility for legacy contamination rests solely with the Iraqi authorities.

65 US Department of Defense (2004) Declassified, Annex L to USCENTCOM OPORD11 (S/REL USA GBR AUSMCFI) Environmental Considerations, Feb 2004.

66 See Zwijnenburg, W. (2014) pp 41-42; Zwijnenburg, W. (2013), pp 27-34.

Publicly, US and UK responsibility appears to extend only to contamination at military facilities, and is tempered by the need to ensure positive international relations with host nations. For example the US accepted 11,000m^3 of contaminated soil from the 1991 explosion and fire at Camp Doha in Kuwait for indefinite storage in the US[67], with the clean-up undertaken by private contractors MKM Engineers Ltd[68]. The US has also accepted the return of DU contaminated materiel from Saudi Arabia[69], in that case equipment from the 1991 Gulf War.

In 2003, US and UK tank forces used Range 8 at Kuwait's Udairi complex[70] for live fire training of DU prior to the invasion. The US Marines and Army fired 2,038 120mm rounds, contaminating the range and were obliged to remediate the facility. However cables released by Wikileaks reveal that the clean-up, which the Kuwaiti government felt did not go far enough, caused a diplomatic spat with the US government[71].

These examples are interesting because in both cases relations between the US and its hosts were dependent on remediation that went far beyond the opportunistic removal of surface lying DU or the collection and isolation of wreckage – the apparent policy in Iraq, instead also extending to the removal of contaminated soils. This can be a costly exercise, a fact not lost on the states that use DU. Hence the UK's internal DU policy in 2003: *"The MoD will not be undertaking any recovery of DU buried in the ground, except where required in small quantities for scientific purposes to support the MOD corporate research programme*[72]*."*

But is subsurface clearance necessary? The risks that DU in soils may pose are dependent on land use and whether human activities or natural processes – such as groundwater movements, or winds - are likely to lead to the dispersal of contamination. DU in soils can be mobilised over time. At one site assessed by the IAEA in Kuwait, researchers found that 30mm DU rounds had resurfaced 10 years after their use 1991 due to wind activity scouring away sand. These findings clearly raise concerns over the huge quantities of 30mm fired in or near populated areas in Iraq in 2003.

As a minimum, comprehensive records of sites and site assessments should be available to local authorities and, where necessary, DU users should be obliged to remove DU contamination where communities face exposure risks, or provide support to national authorities to do so. Even without subsurface clearance, such sites must be continually monitored to examine whether DU is being transported from the soil environment, something that often requires building technical capacity. Monitoring is still undertaken by national authorities at sites where DU was used in the Balkans, although with the exception of a box of spent PGU-14/B

67 Department of Defense (2003) DoD Memorandum for Records: CFLCC-C3-CHOPS. Department of the Army, Coalition Forces Land Component Command, United States Army Forces Central Command, Camp Doha, Kuwait, 15 September.

68 US NRC (2012) MKM Engineers Inc, depleted uranium (DU) contaminated material segregation, characterization and packaging process description: http://www.nrc.gov/docs/ML0720/ML072050109.pdf

69 TetraTech (online) Site Maintenance, Al Kharj, Kingdom of Saudi Arabia: http://www.tetratech.com/en/projects/site-maintenance-al-kharj-kingdom-of-saudi-arabia

70 Global Security (online) Udairi Training Range: http://www.globalsecurity.org/military/facility/udairi.htm

71 Wikileaks (online) Depleted uranium detection at range prompts convoking of ambassador, March 2009: https://wikileaks.org/plusd/cables/09KUWAIT180_a.html

72 Ministry of Defence (2003) Current policies and activities relating to clearance of unexploded ordnance (UXO) and depleted uranium (DU) in Iraq: http://www.iraqinquiry.org.uk/media/233440/2003-07-02-paper-mod-current-policies-and-activities-relating-to-clearance-of-unexploded-ordnance-and-depleted-uranium-in-iraq.pdf

ammunition[73], the US has not accepted the return of any DU or contaminated soils.

The precautionary recommendations from UNEP for the management of contaminated sites, and peacetime and military practice, could provide an initial framework for the development of obligations governing the management and disposal of DU, contaminated soils and materiel. Record keeping, site assessment and monitoring would all be critical elements in defining the specific activities at each site. Meanwhile established global norms on the management and movement of radioactive and hazardous wastes could help clarify the eventual fate of DU fragments and contaminated materials. At present, states that employ DU weapons are largely insulated from the true costs of their use, be they humanitarian, environmental or financial, and a reassessment of this calculation is long overdue.

73 ICBUW (2010) A Question of Responsibility: the legacy of depleted uranium use in the Balkans: http://www.bandepleteduranium.org/en/docs/134.pdf

9. Conclusion

Time and again, history teaches us that the true impact of weapons, whether humanitarian or environmental, is only understood after they have been used in conflict. This certainly holds true for the A-10, developed and promoted as a "tank killer": a perception built in large part on its 30mm cannon and its ability to fire PGU-14/B DU ammunition. In conflicts since the 1990s, the reality has proved rather different. The data in this report suggests that the A-10 could equally be marketed as a "car killer" or "building demolisher" – with just a third of the targets it attacked in the 2003 Iraq War tanks or armoured vehicles.

Ground forces hold the aircraft in great esteem, with it often praised for its role in close air support missions. But its utility in such roles does not justify the use of an inaccurate cannon capable of dispersing significant quantities of radioactive and chemically toxic DU, often in or near populated areas. The inability of A-10 pilots to select between high explosive and DU ammunition once in flight makes the aircraft disproportionate by design. It also ensures that when equipped with DU ammunition and utilised for the missions that contemporary conflicts require, it is incapable of being used without breaching the restrictions placed on it by its weapons review. The A-10 is a Cold War relic, its DU ammunition an artefact of outdated policies and scenarios.

This report reveals that the scope of DU contamination in Iraq is significantly larger than previously assumed; a result of the limited information made available by the US government. US A-10s used DU against 1,116 targets distributed across Iraq, the majority were targets of opportunity rather than armoured targets. A-10s used DU ammunition against unmounted troops, boats, cars, trucks, and buildings in densely populated areas – increasing the risk of civilian exposure.

Civilians in Iraq are still facing exposure to DU from the conflict, with little meaningful work done to identify and clear contaminated sites. Even where this work may have been done, the US appears unwilling to publicise such efforts to avoid establishing precedents that could strengthen norms governing the post-conflict management of DU. They and others enjoy the perceived benefits of the weapons, while apparently disowning any responsibility for their legacy.

Managing DU contaminated sites is expensive and technically challenging. Iraq's RPC puts the typical cost per site at US$100,000, multiply that by the 1,116 sites revealed in this report and the cost of their management may be in excess of US$100m. Factor in the as still largely undocumented use of DU by land platforms, such as the M1A1 Abrams and Bradley Fighting Vehicle, and that sum will increase further.

It seems clear that the US still retains data that would be of considerable assistance to the Iraqi authorities, international organisations and demining organisations as they seek to address DU contamination in Iraq. Sharing information on where the weapons have been used and detailing what historical work has been done to minimise the risks that contamination poses to civilians and their environment is critical for facilitating this process.

While much of the focus in the US and UK has been on the risks of DU exposure to their own military personnel, medical experts and communities across Iraq remain deeply concerned about the health risks from exposure to DU contamination. Greater transparency from the US and other Coalition partners would be a valuable contribution towards identifying locations where civilians may still be at risk of exposure, facilitating risk awareness programmes, health studies and, where necessary, ensuring medical assistance is provided, either to address the genuine risks or resolve unwarranted concerns about the perceived risks. The lamentable security situation in Iraq and the absence of transparency from DU users have been the two most significant barriers to determining the extent to which civilians have been exposed to DU and the prevalence of any health effects linked to those exposures.

As a platform, the A-10 is a particularly problematic and profligate user of DU, but the problems DU weapons create are not unique to this one aircraft or its PGU-14/B ammunition. However it does serve as a timely reminder of why we, and the majority of the international community, believe that DU has no place in conventional munitions.

As with anti-personnel land mines and cluster munitions, it seems apparent that the only lasting solution would be a global ban on the use of DU weapons, together with the development of formal obligations that ensure the provision of technical and financial assistance to the countries affected by their use. An aim supported by the Iraqi government, who have argued that*:*
"Efforts should be made to draft a binding and verifiable international treaty prohibiting the use, possession, transfer and trafficking of such armaments and ammunitions[74]*."*

74 UN General Assembly (2014), A/69/151, Effects of the use of armaments and ammunitions containing depleted uranium, Report of the Secretary-General.

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