
IKV PAX CHRISTI

# HAZARD AWARE

## Lessons learned from military field manuals on depleted uranium and how to move forward for civilian protection norms

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Cover: A member of Portuguese Technology and Nuclear Institute verifies the radiation levels in a residential area in the controlled region by Portuguese detachment of KFOR , on 08 January 2001 at Klina, Kosovo © ANP
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NORWEGIAN MINISTRY
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## Introduction

Over the past two decades, depleted uranium (DU) has been used in the Balkans (1994, 1995, 1999), in Kuwait (1991) and in Iraq (1991, 2003). Uncertainty still surrounds the use of DU in other regions such as Afghanistan, Georgia and Somalia.

After the first Gulf War in 1991, media reports documented apparent increases in the rate of health problems reported among US veterans and Iraqi civilians. The suite of health problems amongst veterans was coined 'Gulf War Syndrome'; a mixture of illnesses that could be ascribed to exposure to toxic materials such as chemical agents released from burning oil wells and destroyed chemical factories, medication prescribed in case of nerve gas attacks, Post Traumatic Stress Syndrome (PTSS), pesticides and exposure to DU. Medical reports and anecdotal evidence from Iraq both suggest a post-war spike in birth malformations and rare forms of cancer among Iraqi civilians.

While reliable data from the Saddam era between the two Gulf Wars is scarce, data collected after the 2003 Iraq War clearly points to an increasing problem with birth defects and rare types of cancer in southern Iraq, the root causes of which have not yet been fully identified. We do know that US forces have used large quantities of DU in Iraq. The US has published some quantitative data on the use of DU, which amounts to at least 400,000 kilograms over both the 1991 and 2003 conflicts, the bulk of which was fired in the southern part of Iraq[1].

Concern over the health and environmental impact of DU munitions has led to an international debate over their acceptability. It has also triggered scientific research by the military, academia and international agencies, including the United Nations Environment Programme (UNEP). This research has led many militaries to increase the number of precautionary measures in place for the protection of their own troops. These include measures to be taken during, and after, conflict. Such measures can be interpreted as an acknowledgment by militaries of the potential health hazards from DU exposure. While this paper mainly focuses on DU hazards, other toxic remnants of war should also be considered when discussing the protection of civilians during and after armed conflict.

**The aim of this paper is to review the precautionary measures taken by different armed forces, and assess whether they could provide a starting point for the development of civilian protection norms during and after armed conflict.**

The paper will consider guidelines from the United States' armed forces, the British Ministry of Defence, the Dutch armed forces, the German Bundeswehr, the Belgian armed forces and NATO guidelines[2]. Additional material dealing with civilian protection norms will be based on recommendations made by the United Nations Environment Program (UNEP), the World Health Organisation (WHO) and the International Atomic Energy Agency (IAEA), as well as the British Royal Society and others.

[1] Fahey, D. (2008) Depleted uranium and its use in weapons. In: Depleted Uranium Weapons and International Law, a precautionary approach. Mcdonald, A. et all. T.M.C Asser Press. The Hague.
[2] Other states also have military safety guidelines put in place but we were unable to obtain any copies from them

The paper will first briefly describe the discussion on DU's potential health effects and risk assessment. It will then analyse how military field manuals characterise DU, which offers an understanding of how the armed forces assess its potential dangers and the different scenarios where exposure to DU is likely. The paper then gives a short analysis of the precautionary measures currently in place for troops. It will conclude with recommendations based on these manuals for civilian protection norms, informed by recommendations from international organisations and institutes.

## Depleted uranium and health effects

The potential health effects of DU have long been debated within the international community. Numerous reports and studies have been produced by institutions such as the World Health Organisation (WHO), the British Royal Society, the International Atomic Energy Agency (IAEA) as well as the United States Armed Forces Radiobiological Research Institute (AFRRI)[3]. These have sought to include, to a varying extent, a wide range of peer reviewed papers in scientific journals[4]. Although most of these reports recognise the potential hazards of DU, they estimate that the risks to human health are generally low, and dependent on the level of exposure. Nonetheless, all of the aforementioned organisations outline safety procedures for protection against exposure to DU, thereby recognising the potential threat and underlining the need for precaution.

There are typically three main routes of DU intake for civilians and military personnel: ingestion, inhalation and embedded fragments or contaminated wounds caused by the impact of DU munitions. Once inside the body, the two health hazards of DU are its chemical toxicity and radioactivity.

DU primarily emits alpha particles, although beta and gamma radiation are also emitted from uranium 238's decay products. Inside the body, alpha radiation can disrupt cellular process and damage DNA strands, with a potential of causing different types of cancer, depending on the organ which is exposed. DU is also a heavy metal and therefore chemically toxic. Studies have shown that uranium can cause kidney damage and other studies have shown that it is also a neurotoxin, immunotoxin, mutagen, carcinogen and teratogen[5].

In a recent publication[6] by the European Union's Scientific Committee on Health and Environmental Risks (SCHER) it is stated that DU is unlikely to have an effect on the environment and human health as a result of low exposure levels, but this report was heavily criticized[7] for excluding relevant peer reviewed studies and extrapolating a small study on 24 civilians to a general statement on the likelihood and level of civilian exposure, thereby distorting the picture of the current state of understanding of the risk to civilians living in contaminated areas enduring chronic exposure to DU.

It is clear that the lack of studies on exposed civilians in affected areas currently makes it difficult to accurately determine the dynamics of exposure and health effects. As a result, the scientific debate revolves around the level of exposure and the dose-effect relationship. This uncertainty is further compounded by the lack of appropriate long term epidemiological studies on exposed civilians. In recent years therefore, a new discourse has emerged that seeks to analyse the nature of the risks from DU and assess the role of precaution.

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[3] Alexandra Miller, A Review of Depleted Uranium Biological Effects: *In vitro* studies can be found at http://www.bandepleteduranium.org/en/docs/183.pdf

[4] For an overview of peer reviewed studies, please see http://www.bandepleteduranium.org/en/docs/58.pdf

[5] See footnote 3

[6] SCHER, 2010: *Opinion on the Environmental and Health Risks Posed by Depleted Uranium*. Report accessed on 29 May 2012 at http://ec.europa.eu/health/scientific_committees/environmental_risks/docs/scher_o_123.pdf

[7] Both Dr. Keith Baverstock and the ICBUW have commented on SCHER's position, see http://www.bandepleteduranium.org/en/critique-of-the-european-commissions-scher-risk-as

## Risk assessment

The degree to which DU poses a risk to human health and the environment depends on a wide variety of factors. Undertaking accurate risk assessments for military DU use is therefore fraught with difficulties. For the purposes of this report, risk can be defined as the quantitative relationship between exposure and health consequence. In a presentation about risk assessment, Dr. Keith Baverstock, a former WHO expert, outlined the problematic nature of DU with regard to risk assessment as follows:

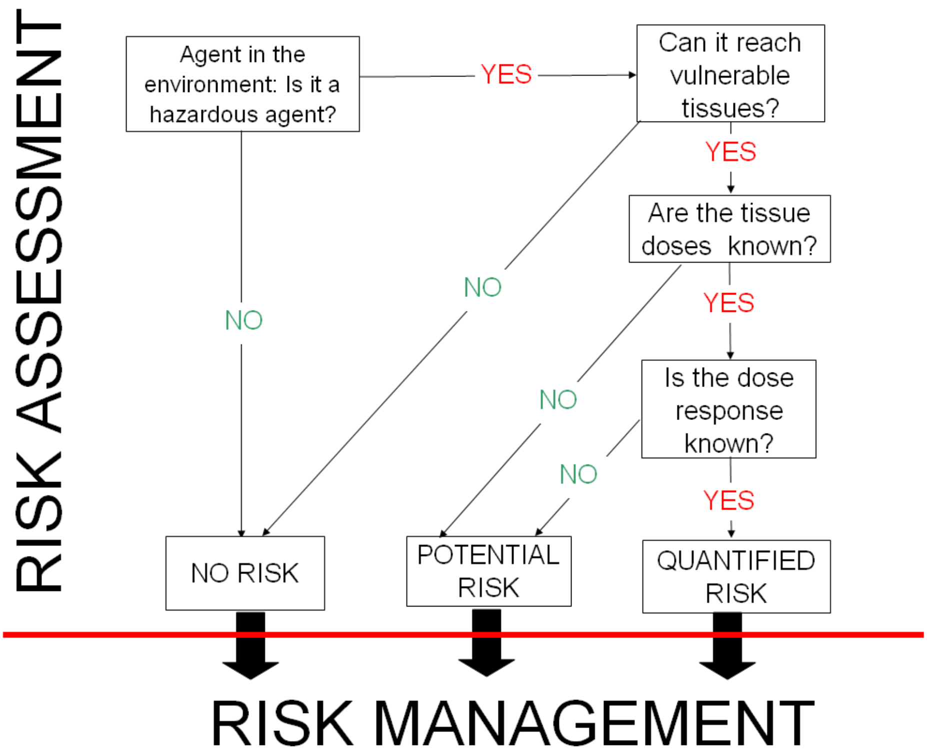
> *"By its nature this would depend upon assumptions about specific scenarios of exposure, not all of which could be predicted given the nature of the way in which DU is dispersed into the environment, where, for example, environmental conditions such as climate might influence the risk."*[8]

The amount of research on DU exposure on civilians is limited, and no large scale epidemiological studies have been conducted in contaminated areas; this therefore makes it difficult to accurately quantify the risks to civilians. However, we do know that DU is hazardous, that it can reach vulnerable tissues inside the body and that organs can be affected, thereby potentially resulting in different types of cancer. In risk assessment, the aim is to determine the quantitative or qualitative value of risk in relation to a concrete situation and from a known hazard. If this is applied to DU, this would imply that a quantitative risk threshold has to be established to make an assessment about the risk to human health.


**Scars from a DU strike on an Iraqi tank displaying high levels of residual radioactivity**
© Naomi Toyoda Image

[8] See footnote 7 for Keith Baverstock's paper.

As there is not sufficient experimental data to understand the dose-response relationship for all health outcomes, the relationship between dose and harm on civilians is not fully known. A risk assessment for DU cannot be made since there is no established safe threshold for the dose-effect relationship. Therefore, every exposure to DU should be considered a risk, and needs to be managed appropriately.




When coming to an understanding of the risks involved with military DU use, we can apply the flow chart above. DU is known to be a hazardous agent that can reach vulnerable tissues (long, kidney, brain, lymph nodes). However, substantial data on the tissue dose is unknown; therefore it should be labelled as a potential risk, and dealt with under risk management in an appropriate way, i.e. by preventing exposure.

To conclude, contamination from DU leaves a situation of uncertainty and unpredictability. We do not know for certain what a safe threshold for human exposure is, nor precisely how DU behaves in the human body. Further studies have shown that DU's environmental behaviour is also enormously variable, as are the locations and quantities it is used in during conflict. Because of these uncertainties, a precautionary approach should be taken, which would mean that every form of contamination needs to cleaned and decontaminated. This brings us to the main subject of this paper, namely the guidelines and procedures put in place by armed forces operating in conflict environments where DU has been used.

## Characterisation of DU in military field manuals

Armed forces have drawn up precautionary guidelines to limit DU exposure for their personnel. Each of the army manuals reviewed describes what DU is, how it is used and what the 'current' state of scientific understanding is when it comes to its potential health effects. Crucially, all the manuals label DU as potentially hazardous, although the risk from different exposures is evaluated differently. Some manuals suggest that exposure will not lead to significant health risks for most exposures in most scenarios. This is largely down to the short time periods during which troops are likely to be exposed. Although this is not reflected upon in the guidelines, it is worth noting that these acute exposures may well have a different risk profile to the chronic exposure that may be faced by civilians living, working or playing in or around contaminated sites.

The UK Ministry of Defence discusses the two main hazards associated with DU: its chemical toxicity and radioactivity. It perceives the radiation hazards to be of less concern than DU's chemical toxicity. In the same vein, the US Army's training manual states that: "the primary concern from a health perspective is uranium's chemical properties".

The table below summarises the definitions of DU present in the selected manuals:

**Table 1: Characterisation of depleted uranium**

| Country | Definition |
|---|---|
| United Kingdom[9] | 'DU is a low specific activity radioactive material and presents two hazards, radiological and toxic' |
| United States[10] | 'DU is a dense, slightly radioactive metal used by the US and other armed forces in munitions, armour and other applications'. 'The risks associated with DU in the body are both chemical and radio-logical' |
| Belgium [11] | 'DU is a dense heavy metal, the toxic dust spreads on the soil near the impact zone and further, depending on the weather ...DU munitions pose a radiological risk'. |
| The Netherlands [12] | No specific definition, but refers to reports written by the National Institute for Public Health and the Environment, who describe DU as 'limited chemically toxic' and a 'low level radiotoxic' material' |
| Germany[13] | 'DU is toxic and radioactive' |
| NATO[14] | DU is best described as a potentially toxic industrial material. Under specific combat conditions, DU can pose a risk of heavy metal toxicity. DU ...emits low levels of alpha, beta and gamma radiation'. |

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[9] Safety Instruction - Hazard Management of Depleted Uranium on Operations - version for open publication. February 2003

[10] Training Support Package TA-0310DUAT-001. Tier I: Depleted Uranium General Awareness. United States Chemical School Directorate of Training Development, Fort Leonard Wood. July 1999

[11] Mesures Provisoires Pour la Protection Du Personnel en Opération Contre les Risques Emanant de la Pollution par Uranium Appauvri. Date Unknown.

[12] CDS aanwijzing A-133. Handelingen bij blootstelling aan verarmd uranium. Ministerie van Defensie. Defensie staf Directie Operaties. December 2005

[13] Druckschrift Einsatz nr.02. Minen, Blindgänger, DU-munition und behlfsmäβige Sprengvorrichtungen. Einsatzfuhrungskommando der Bundeswehr. Juli 2006

[14] Stanag 2473 NBC (Edition2). Commander's guide to radiation exposures in non-article 5 crisis response operations. NATO Standardization Agency. Military committee Joint Standardization Board. October 2004

Each manual acknowledges the chemical and radioactive hazards of DU, and all recognise its potential health and environmental hazards. The chief area of dispute is the extent of the risk from DU exposure.

The risk assessments by different countries of the health risks from DU are summarised in the table below:

**Table 2: Risk assessment for DU**

| Country | Risk assessment |
|---|---|
| United Kingdom | Trials under worst case conditions indicate that there is no appreciable radiation health risk from DU', 'the toxic hazard is presented by inhalation or ingestion of DU dust, or by contamination of open wounds by DU dust' but the manual later states that 'DU does not present a significant health risk in most circumstances' (2003). In 2008, the MOD wrote: 'The present assessment is that the threat from DU munitions and any associated contamination equates to a low level radiological risk from environmental pollution' and 'the main hazard is inhalation of the dust formed during a fire or explosion involving DU munitions or when DU munitions hit an Armoured Fighting Vehicle (AFV)15. |
| United States | '...adverse health effects may only occur for intakes that greatly exceed the US safety standard'. It also states the following: 'Despite the misconception that uranium is highly toxic, it isn't'. In a FAQ in the same document, it is written that 'Even the largest amounts that could be internalized by personnel who are in, on, or near a vehicle at the time of impact by DU munitions are well below those that would affect your ability to have children, or your children's health'. |
| Belgium | 'Health risks are considered to be limited, but not zero, but are real'. |
| The Netherlands | Internal contamination can have negative health effects. |
| Germany | 'DU dust is dangerous during body contact or when ingested or inhaled'. |
| NATO | 'In combat, the primary hazard associated with DU is severe injury from shrapnel wounds ...cancer constitutes the long term health risk of greatest concern to personnel. Inhalation and ingestion of uranium particles has been studied extensively for decades. Such exposures to uranium have never been linked to any subsequent increase in human cancer incidence, including leukaemia. ...although not fully studied, the effects of DU introduced into the environment through military combat operations do not appear to pose any significant health risk to forces deployed to such areas or to indigenous populations.' |

Although some of the manuals claim that there is no danger from DU, they all acknowledge that it is a chemically and radiologically toxic heavy metal. Some manuals, particularly those from DU user states like the US, claim that there is no research that indicates that there are potential health effects. Interestingly, the Pentagon's own *Armed Forces Radiobiology Research Institute* has carried out a wide variety of *in vivo* and *in vitro* studies and demonstrated that DU is indeed a carcinogenic and genotoxic.[16]

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[15] Radiation Safety Handbook. Leaflet 30. *Depleted Uranium.* January 2008

[16] For more information see A Review of Depleted Uranium Biological Effects: *In Vivo* Studies and A Review of Depleted Uranium Biological Effects: *In Vitro* Studies, by Alexandra Miller, which can be accessed through http://www.bandepleteduranium.org/en/a-review-of-depleted-uranium-biological-effects-in-2

No large-scale and long-term epidemiological studies of civilians living in contaminated areas have ever been undertaken. Thus it is hard to make any scientifically meaningful claims about health risks to 'indigenous populations', as stated in NATO's assessment above. NATO also seeks to draw parallels with exposure studies in uranium mine and mill workers, an approach that has often been criticised for being of questionable merit[17].
The situation is complicated further as a result of the different health risks posed by radiation to different sections of the community. The US National Academies BEIR VII report[18] confirmed that women not only face a greater risk of developing cancer from the same radiation dose as men, but are also more likely to die from that cancer. Similarly children are widely accepted to be of greater risk from radiation due to the rate at which their cells are dividing as they grow, which leads to greater potential for disruption. This understanding of the relative risks from DU within a civilian population should be used to prioritise both awareness raising and environmental clean-up.

Civilian DU exposure scenarios vary widely. The two primary pathways are inhalation and ingestion. Upon impact with hard targets, a proportion of the DU burns into a fine dust that can be inhaled. Dusts can be re-suspended by the wind, and thus inhaled by individuals living or working around or near the target. Other routes include ingestion by eating or drinking contaminated soil, food or water. DU rounds that miss their target may remain on the ground and oxidize, gradually polluting soils and groundwater. The rates at which this occurs are highly variable[19].

Thus the risks of exposure are highly dependent on the specific characteristics of the attack and the target area. Key factors mediating the likelihood of exposure include the locality (e.g. urban vs. rural areas), land use, whether the target was a military or civilian object, environmental factors such as soil and climate and the type of ammunition, the quantity fired and its mode of delivery. DU use by different platforms, such as tanks, armoured vehicles and aircraft all result in different contamination footprints. This makes it difficult to generalise about the exposure risks from DU and sites must be assessed individually.

For combatants, acute inhalation exposures in struck vehicles may be considerable and embedded fragments of DU have the potential to cause illness.

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[17] An extended discussion on this subject can be found in Cullen, D (2011), ICBUW's commentary on the Scientific Committee on Health and Environmental Risks (SCHER) Opinion on the environmental and health risks posed by depleted uranium (DU). Accessed on 26-6-2012 on http://www.bandepleteduranium.org/en/docs/169.pdf

[18] Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2*. Washington, DC: The National Academies Press, 2006.

[19] See for example UNEPs recommendation to the United Nations Secretary General, A/65/129/Add. 1 where they state that "major scientific uncertainties persisted regarding the long-term environmental impacts of depleted uranium, particularly with respect to long-term groundwater contamination. Because of these scientific uncertainties, UNEP called for a precautionary approach to the use of depleted uranium, and recommended that action be taken to clean up and decontaminate the polluted sites. It also called for awareness-raising among local populations and future monitoring.

## Military field procedures

In order to protect soldiers from being contaminated by DU dust or shrapnel, a range of field procedures have been developed. These include guidelines to be followed when troops encounter DU on the battlefield, during clearance and decontamination operations, or during the transport and storage of DU munitions. The measures below are primarily based on field procedures during and after battle. The US and UK forces also have a wide variety of guidelines for handling accidents involving DU during storage and transportation, general handling procedures for DU munitions and guidance for shipping DU.

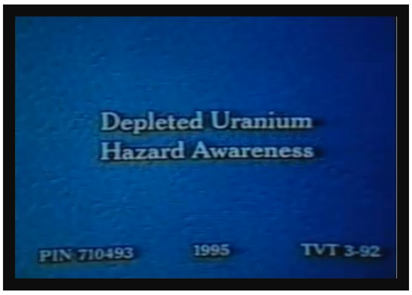
The main elements in the field manuals all focus on preventing exposure. As outlined above, the main routes of exposure are inhalation, ingestion and embedded DU shrapnel.

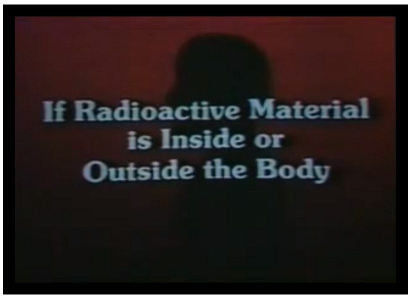
The following standard hygiene procedures can be found in all the manuals:

- Do not touch DU ammunition or contaminated vehicles.
- Cover exposed skin.
- Use a dust or NBC mask to protect the respiratory system when in a contaminated area.
- Do not eat, drink or smoke during activities in contaminated areas.
- Stay upwind from burning vehicles that are hit with DU munitions.
- Stay 50 metres away from contaminated vehicles (only if this does not jeopardise the mission).
- Wash hands thoroughly after the operation. Dust off shoes and uniform, and wash it after the operation.
- Limit your stay in contaminated areas as much as possible.

In addition, the following procedures feature in most of the manuals:

- Create a perimeter of 20 metres around the contaminated object.
- Alert NBC teams and report to the commander.
- Measure radiation levels with RADIAC meters, Thermo Luminescent Dosimeters (TLDs) or other measuring equipment.
- If exposed, troops must take a range of bio samples such as nose fluid, blood and urine that should be tested for DU exposure.




**Video stills of a US Army Depleted Uranium Radiation Awareness Training, 1995**

The key themes that emerge from these precautionary measures are visibility – DU contamination must be marked;  assessment – contamination levels and the pattern of contamination should be measured and recorded; protection – action must be taken to avoid or limit exposure; and monitoring – those likely to have been exposed should be monitored to assess their level of exposure.

Regrettably, no equivalent manual has been developed for civilians living or working in DU affected areas. But could these four precautionary themes, thus far only applied to military personnel, perhaps form the basis for post-conflict civilian protection norms?

**IRAQ, MAZHAM: Two US soldiers watch a plume of smoke rise in the horizon in Mazham, a village, 15 November 2003. According to US military authorities 2,700 warheads, 1,000 anti-tank shells and 2,400 depleted uranium rounds found in a bunker were destroyed** [20]
© ANP

[20] This photo demonstrates the lack of awareness amongst US soldiers.  DU is not supposed to be blown up, since this will lead to airborne DU particles and further environmental contamination. According to a source involved in mine clearance for the United Nations Development Program (UNDP), he immediately called the US Army when he heard about this practice and urged them to stop blowing up DU.

## Civilian protection norms – building a better case for precaution

It is clear from the recommendations in the previous section that the military now goes to some lengths to avoid exposing troops to the hazards from DU. These procedures underline the hazards associated with the use of DU. They can therefore form a useful starting point for further discussion on the acceptability of DU and the responsibility for clearance of DU remnants and contaminated hotspots following conflict.

In this section, I will briefly assess some of the guidance notes put in place by armed forces that possess DU and will also briefly look at civilian protection norms from national environmental institutes. The aim is to arrive at suggestions for clearance, decontamination and civilian protection norms in post-conflict areas contaminated with DU.

### *Clearance and decontamination*

At least 400,000 kilograms of DU have been fired in both Gulf Wars. A further 12,700 kilograms was used in the Balkans. Efforts by states to manage this legacy have met with varying degrees of success. The main factor in all cases has been the capacity of the states to manage contamination, with user transparency, financial and technical resources and political will also playing an important role.[21]

In 2010, the International Coalition to Ban Uranium Weapons (ICBUW) undertook fieldwork in the Balkans to assess whether UNEP's precautionary recommendations were implemented following its research on strike sites in 2002 and 2003 in Bosnia, Kosovo and Serbia and Montenegro. The results of ICBUW's research show that decontamination and clearance efforts are costly and time consuming. During NATO's Balkan campaign, DU was used by the A10 Warthog gunship as 30 mm PGU-14/B shells in the GAU-8 rotary cannon. Clean-up operations in Montenegro resulted in the clearance of 242 penetrators and 49 fragments of penetrators (in total, 3,000 DU rounds were fired), at a cost of US$ 280.000 and taking about 5,000 working person days to complete. As well as the penetrators, 200 kg of highly contaminated soil and 7,000 kg of low level radioactive material was removed and stored in a special bunker near the target sites. In Serbia, similar operations to decontaminate 11 sites led to the removal of 706 DU penetrators and 680 jackets, along with removing almost 10,000 kg of contaminated soil to safe storage bunkers. The amount of work spent on these operations was over 220 working days and cost US$ 1,479 million. However, the number of cleared DU penetrators was merely a fraction of what had been fired. The high costs of clearance place a strain on states recovering from armed conflict. As of today, only a small minority of the sites in Montenegro, Kosovo and Bosnia Herzegovina have been decontaminated, leaving most of the penetrators left in the soil.[22]

After the 2003 Iraq War, limited clean-up operations were undertaken by Coalition forces, mainly in Basra and to an unknown extent in Baghdad. However the true extent of these operations is unclear as neither the US, UK or Iraqi governments have been willing to publicise detailed information. Parliamentary statements in the UK suggest that work was restricted to the removal of penetrator fragments found during the course of general Explosive Ordnance Disposal (EOD) operations. The UK, which had publicly acknowledged a 'moral obligation' to the people of Iraq in

[21] ICBUW, 2010. A Question of Responsibility: depleted uranium weapons in the Balkans.
[22] Ibid. pg. 12-13.

relation to its use of DU in 2003[23], cooperated with UNEP and provided the Iraqi authorities with coordinates for the firing points of British DU rounds. British DU use in Iraq amounted to less than 1 tonne in the first Gulf War (1991) and 1.9 tonnes in the 2003 conflict.

The US however has consistently refused to release coordinates and specific details for the quantity of DU fired. This has hindered clean-up and awareness raising operations in affected areas and severely constrained UNEP's work. UNEP carried out a capacity-building programme in 2007, which aimed to improve skills and expertise amongst the Iraqi authorities in the detection and management of contaminated areas. The evaluation of this programme clearly demonstrated the need for further action in Iraq on clearance and decontamination in populated areas. The evaluation concluded:

"Local people were being exposed to DU and other heavy metals in uncontrolled scrap yards and scrap metal processing areas, with potential consequences for their health. Indeed, it should be noted that the toxic effects of DU may be more serious for human health than its radiological effects."

UNEP then provided the following recommendations:

1. The Iraqi Ministry of Environment should continue to receive support from the international community to maintain staff expertise and morale;
2. All tanks, armoured personnel carriers, and other military equipment hit by DU
3. ammunition should be identified and isolated to prevent access by the general population;
4. All metal scrap yards that have received scrap related to the conflict(s) should be assessed for the potential presence of DU;
5. Health and safety precautions in scrap yards and scrap processing plants should be improved to minimize long-term health impacts to people working there. With respect to human health, the radio toxicity or radiological effects of DU should be considered secondary to its chemical toxicity;
6. Education and awareness-raising efforts on DU-related issues should be scaled up throughout the country to avoid the population being accidentally exposed to DU residues and DU-impacted scraps; and
7. The issue of the storage and disposal of DU contaminated scrap metal should be taken into account as part of national efforts to decommission and store radioactive sources.[24]

Other recommendations on clearance, decontamination, monitoring and hazard awareness-raising have also been issued by the International Atomic Energy Agency (IAEA) in their reports on DU contamination in Kuwait (2003)[25] and southern Iraq (2010)[26]. These recommendations highlight the need for clearance and decontamination in civilian areas after armed conflict. However, in practice states recovering from conflict often lack the expertise and capacity to

[23] BBC News (2003) UK to aid Iraq DU removal. Accessed on 25-6-2003 on http://news.bbc.co.uk/1/hi/sci/tech/2970503.stm
[24] UNEP (2007) Capacity-building for the Assessment of Depleted Uranium in Iraq - Technical Report.
[25] IAEA (2003) Radiological Conditions in Areas of Kuwait with Residues of Depleted Uranium. Report by an international group of experts.
[26] IAEA (2010) Radiological Conditions in Selected Areas of Southern Iraq with Residues of Depleted Uranium. Report by an international group of experts.

implement these measures. Furthermore, even where funding has been available, a lack of transparency from users has hindered clean-up operations. The result is an increased risk of avoidable civilian exposure, a problem compounded by a lack of civilian hazard awareness work.

Having established that precautions are necessary, that DU is often poorly managed after conflict and that civilians are not currently party to the guidance felt necessary for reducing military exposure to DU hazards, the question remains over how these guidelines can be translated into civilian protection norms.

As outlined in the previous section, four key themes emerged from the analysis of the military's precautionary guidelines: **visibility, assessment, protection** and **monitoring.** For the purpose of the following proposals and given the poor history of information sharing in Bosnia and Iraq, visibility should perhaps become transparency and a fifth theme – **awareness-raising** – should be added.

### *Visibility*

If combatants are unwilling or unable to keep DU out of civilian areas, then civilian access to contaminated hotspots must be restricted in order to avoid exposure. This may prove particularly difficult when homes, agricultural land or work places are targeted, either directly or as a result of fighting taking place in these areas. Currently, the lack of DU user transparency constrains the ability of national authorities to mark and fence sites. It is therefore crucial that detailed targeting data is quickly made available to the relevant national authorities and international organisations following hostilities. Key stakeholders such as demining and humanitarian organisations should also be informed when DU is present in operational areas.

### *Assessment*

As discussed previously, the specific exposure risk at any given site will depend on a wide range of factors – this makes generalised statements about risk impossible to provide. It is therefore necessary to assess sites individually in order to prioritise clean-up and monitoring. The extent of contamination in a given area is dependent on a variety of factors. For instance, were the DU munitions fired by a tank (single rounds, 105-120 mm) or by an attack aircraft or armoured vehicle (multiple rounds 20-30 mm) with a narrower or wider dispersal? Is the contamination focused on a specific military object such as a tank or armoured vehicle and is the wreckage still present? Is the bulk of contamination in the soil or did it impact on a hard surface producing a greater fraction of fine or fragmentary residues? Were buildings struck and to what extent are they in use or accessible? Finally what quantity of DU was fired at each location?

All of these variables are crucial in assessing the nature and scale of contamination and the necessary follow up steps for decontamination and monitoring.

Another key question is who is responsible for the assessment of sites. This is likely to vary depending on the priorities and capacity of governmental and non-governmental actors in individual states. Historically this has often fallen to national regulatory, civil and military authorities as it is often not an area where demining NGOs and contractors have specific experience. We have learned that demining organisations often lack knowledge on how to recognise DU munitions and debris[27]. Although a technical note by the International Mine Action Standards (IMAS) does exist on DU, it is rarely implemented and limited in scope, despite DU

[27] Akerblom, G. (2008) Depleted Uranium - Experience of the United Nations Environmental Programme Missions

often occurring in areas with Explosive Remnants of War (ERW) contamination. Since DU munitions can be used in areas where landmines, cluster bombs and other Unexploded Ordnance (UXOs) may also be found, personnel dealing with battlefield clearance should be able to identify DU munitions. This will be addressed in more detail below.

### *Protection*

After thorough site assessment, and where justified by a risk of civilian exposure, action should be undertaken to clean up contaminated vehicles, soil and buildings or to mark and seal off areas. Protocols should be developed to safely deal with:

a) contaminated materials (scrap metal sites, destroyed tanks or buildings),
b) contaminated soil and debris,
c) DU munitions and remnants of munitions.

Particular consideration should be given to the removal and isolation of contaminated war wreckage, which may prove attractive to children. Additional problems have stemmed from the informal scrap metal trade, with DU contaminated materials joining waste streams and vehicle components being removed for domestic use. The authorities will also need to consider the potential for inadvertently spreading contamination through the in situ decontamination of sites and equipment.

Waste management protocols should extend to the long term storage and isolation of contaminated soils and fragments, with oversight of the entire process to avoid waste dumping. Suggestions have recently been put forward by researchers from Luleå University in Sweden on hazardous DU waste disposal, which could form the basis for further work on the storage of contaminated soil and debris [28].

In practice there are further considerations when conducting these types of clearance operations. First, if the quantity of DU used is relatively low and deeply buried in the ground, the immediate threat is correspondingly low, while decontamination costs can be high. Another problem could be that intensive clearance can have a deep psychological impact on the local population, although the risks might be limited if just a small quantity DU is deeply buried in the ground. However the public concern associated with the use of DU and the perception of its risks may leave administrations with a difficult choice when considering whether it is financially justifiable to undertake thorough remediation work; particularly where the process of removing, handling and storing the wastes may create a more significant health risk. Nevertheless, it is likely that in many cases exposure can occur and therefore contamination needs to be dealt with in an appropriate manner.

### *Monitoring*

To ensure that contamination does not spread beyond hotspots, through human or environmental mechanisms, and to contribute to a better understanding of how DU behaves in the environment, monitoring of the affected areas is necessary after localisation and removal of DU ammunition and waste. Long-term monitoring is recommended by UNEP, this includes record keeping of health claims, testing of groundwater, radioactivity monitoring and biomonitoring of vegetation.

[28] See for more information and papers on the work conducted by the Luleå university http://www.ltu.se/research/Avfallshantering-och-utarmat-uran-amnen-i-workshop-1.85911?l=en

### *Awareness-raising*

Civilians living in or near contaminated areas must be informed about the potential dangers from DU and advised about means of reducing exposure. The intensity and design of awareness programmes should be proportionate to the intensity of contamination and other site-specific considerations, such as land use. A certain amount of restraint may be desirable in order to avoid unnecessary fear amongst the population. Nonetheless, as a result of intense fighting or storage of DU contaminated vehicles, hotspots of contamination can pose a serious threat and therefore civilians need to be informed about these dangers on a precautionary basis.

Awareness-raising should include the following:

1. Recognition training on identifying DU penetrators, shrapnel and contaminated vehicles.
2. What to do if one encounters DU (alert relevant authorities).
3. Guidelines for reducing exposures in contaminated areas.
4. Hygiene measures: wash hands and clothes.
5. Regular health checks, which may include bio-samples to monitor exposure.

These measures aim to tackle both the concerns of the local population as well as reduce civilian exposure. Experience in Iraq and Serbia indicates that the presence or suspected presence of DU contamination causes considerable concern amongst local populations. Awareness-raising programmes must therefore be designed to be as transparent as possible and consider the best means to build trust and empower communities.

Should there be sufficient targeting data available to facilitate focused and effective hazard awareness programmes, these should not be seen as an alternative to decontamination and monitoring. Guidelines and procedures are already in place for the management of toxic and radioactive contamination, both from militaries and under domestic environmental protection norms. These may offer a useful starting point for designing post-conflict management programmes. One basic example is a briefing document produced by UNEP (2003)[29] for use by UN personnel working in affected areas:

- Do not enter known DU targeted sites prior to site decontamination.
- If entry is necessary, wear personal protective equipment (PPE) including rubber boots, gloves and as a minimum a dust mask.
- Additional caution should be taken as DU is frequently used in combination with cluster bombs during an attack. Not all cluster bombs detonate during an attack and a few may still be present on such sites.
- Attacks may have also taken place in mined areas.
- If DU munitions are found or suspected, do not touch or pick it up.
- Mark the exact location with a flag and/or a circle of paint and leave it on site.
- Contact and inform the relevant authority about the finding.
- Only authorized personnel with PPE are permitted to handle DU.
- Authorized personnel will take the necessary health and safety precautions before removal and proper storage of DU.
- Effects of DU can be long-term with the resuspension of particles and groundwater contamination. Therefore, local authorities should monitor the site on a regular basis.

[29] UNEP (2003 ) Depleted Uranium Awareness. Accessed on 26-06-2012 on http://postconflict.unep.ch/publications/DUflyer.pdf

Work on the five key themes outlined above, namely **visibility, assessment, protection, monitoring** and **awareness-raising**, could prove complex and a multi-agency approach is likely to be required, with expertise from the military, environmental and civil protection and health agencies. Coordinating this in a post conflict environment may prove challenging and international assistance is likely to be necessary.

Finally, it is necessary to reiterate the challenges likely to be encountered when designing hazard awareness programmes. As DU strikes are difficult to identify and dusts and radioactivity are, to all intents and purposes, invisible, uncertainty and doubt may lead to a prolonged state of fear among the population, even in cases where DU is removed. Furthermore, the limitations in risk modelling highlighted by recent risk assessments show that it is impossible for authorities to argue scientifically that there is no risk to health. This is demonstrated by the contamination of **the Hadžići** tank factory in Bosnia-Herzegovina and the fear of contamination amongst the staff after the war, as documented in ICBUW's *'A Question of Responsibility'* report (2010). A further example is the widespread fear amongst Iraqi citizens over DU due to increased birth deformations and cancers, even though conclusive evidence that links these increases with DU is lacking. The post-conflict management of sites therefore represents a difficult balancing act, particularly when the issue of DU becomes politicised.

While the psycho-social impact of the use of DU munitions on civilians has not been explored in detail, anecdotal reports from the Balkans and Iraq suggest that it can be significant. It should be noted that in the assessment of the legality of weapons under IHL, weapons that induce a long term or permanent alteration to the victims' psychology or physiology are viewed as causing superfluous injury or unnecessary suffering. Given the lack of data in the public sphere about the locations of DU weapon contamination and the weapons' high media profile, concern over their potential impact among Iraqi civilians is considerable.

The psychological burden of living with radioactive contamination has been documented in communities affected by nuclear accidents, such as Three Mile Island (1979), Chernobyl (1986) and Fukushima (2011). Together with civilian health and exposure studies, there are compelling arguments in favour of assessing the psycho-social impact of the use of DU in conventional weapons.

Based on the preceding analysis, we have drawn up the following approach that should be at the core of battlefield damage assessments after the use of DU. These steps are some of the basic elements that need adaption depending on the capacity and expertise of the national/local government, the presence of relevant (inter)national scientific and humanitarian organisations and the security situation in the affected areas.

## Civilian-centered strategies for post-conflict DU management

**Following the use of depleted uranium** contamination may be present in and around vehicles, buildings and infrastructure. Surface contamination may comprise of dusts, fragments and intact penetrators. Air launched DU rounds will lead to subsurface soil and groundwater contamination.

**Assessment:** users should rapidly transfer detailed quantitative and geographic firing data to key stakeholders including government entities, demining organisations and authorities and civil society. Affected areas should be rapidly assessed in order to ascertain the likelihood of civilian harm at each target location. Results should inform an action plan to prioritise clean-up.

**Clean up:** programmes should be developed in cooperation with experts for the safe removal and long-term storage or contaminated soils and materials. The international community should assist where necessary to ensure sufficient capacity and funding is in place to complete the work. Local communities should be engaged before, during and after projects

**Marking:** Areas where DU has been used should be marked and secured to reduce public exposure until remediation can take place.

**Monitoring:** Long term monitoring of soils, water and biological indicators such as vegetation and milk should be undertaken to gather data on the environmental behaviour of DU under different conditions. Civilians at high risk should be offered effective urine testing for DU.

**Awareness-raising:** Communities in areas with DU contamination should be informed about the potential risks from DU, with particular focus on high risk groups such as scrap metal collectors and children.

## Conclusion

It is becoming increasingly clear that the post-conflict health and psychological impact of DU on civilians demands closer scrutiny. More attention must also be focused on reducing the likelihood of civilian exposures for those living, working and playing in affected areas.

While the debate over DU's health impact is ongoing, it is clear from the approach to DU taken by militaries that the risks are real and that precautionary measures must be taken. Military guidelines can form a basis for designing a toolkit that can be drawn upon when follow-up action is required to protect civilian and environmental health.

This paper has identified a five step approach to civilian protection based on recurrent themes in military manuals. These five steps include transparency, assessment, protection, monitoring and awareness-raising. If developed and implemented, they have the potential to significantly reduce civilian exposure to DU contamination and help build trust and empower communities.

However, history has shown that states recovering from conflict often lack the capacity, financial resources and technical expertise to implement these measures. DU decontamination is costly and time consuming and requires a high degree of coordination, political interest and institutional capacity. These challenges have historically been compounded by the failure of states to share detailed quantitative and geographical data on DU use with affected governments. It is therefore incumbent on the international community to provide whatever support is required to help facilitate the effective management of DU wastes.

Many of the challenges discussed above are not unique to specific conflicts but are regularly encountered in post-conflict environments. IKV Pax Christi therefore believes that they serve to strengthen arguments in favour of a global ban on the use of DU munitions, both on the basis of their toxic legacy for civilians and military personnel and the burden their use places on states recovering from conflict.

## Recommendations

Based on the analysis of military guidelines for the handling of DU in conflict and other military operations we have drawn up the following recommendations:

1. Transparency from user states over location where DU has been used. This should include the type and quantity of ammunition and GPS coordinates. This information should be shared with relevant governmental bodies, international organisations active in the affected areas such as demining and humanitarian organisations and UN organisations such as the UNDP and UNEP.
2. Clear protocols on clearance, decontamination and safe storage of DU should be drawn up by experts on post conflict reconstruction and implemented in affected areas after armed conflict, be it by the national government or by international organisations.
3. Funding should be made available from the international community to clean up contaminated areas, implement awareness-raising programmes where appropriate, and monitor both the environment as well as the health of the local population.
4. States should share expertise and support capacity-building programs in affected areas, both on clearance, decontamination and research on health and the environment.
5. States should consider what the implications of DU's post conflict burden are for its acceptability in conventional weapons.

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