International Coalition to Ban Uranium Weapons

A Question of Responsibility: depleted uranium weapons in the Balkans

Preface

While this report deals with the legacy of war and the consequences of some of the weapons used, it does not seek to take a position on the conflicts in the former Yugoslavia. In highlighting the effects caused by some of the methods used in the conflicts by one party or another, some may interpret us as taking sides. We wish to explicitly reject this interpretation and to stress our humanitarian concern for the effects of uranium weapons on all people.

In conflict, and its aftermath, language itself is often used to privilege one perspective and exclude all others. We have tried in this report to choose language which does not do this, and to balance this need with writing clearly. If we have got the balance wrong in places, we hope it will be overlooked.

Preparing a report of this kind naturally involves a process of selection. In order to give the reader an overview, complex subjects have necessarily been dealt with briefly. In particular this report should not be taken as a full review of the literature pertaining to the health effects of uranium weapons, or their effect in the Balkans. The legal status of uranium weapons is also a complex matter that has only been briefly touched upon. More detailed treatment of these subjects can be found in many of the works cited in the endnotes.

It should be noted that the views expressed in this report are those of the authors. While every effort has been made to ensure that all the information in this report is correct, the authors welcome corrections and clarifications from all interested parties. All values expressed in US dollars have been calculated at current exchange rates at the time of writing.

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Cover: earth moving equipment in use during decontamination project near Borovac, southern Serbia, 2007. Photo by Naomi Toyoda.

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Acronyms

APC	Armoured Personnel Carrier
APM	Anti-Personnel Mines
BiH	Bosnia and Herzegovina
DfID	Department for International Development
DU	Depleted Uranium
EOD	Explosive Ordnance Disposal
ERW	Explosive Remnants of War
FBiH	Federation of Bosnia and Herzegovina
FRY	Federal Republic of Yugoslavia – at the time of the conflicts this comprised Serbia & Montenegro
IAEA	International Atomic Energy Agency
ICBUW	International Coalition to Ban Uranium Weapons
ICP-MS	Inductively Coupled Plasma – Mass Spectrometer
ICRC	International Committee of the Red Cross
IHL	International Humanitarian Law
KFOR	Kosovo Force – The NATO peacekeeping force in Kosovo
MAC	Mine Action Centre
MoD	Ministry of Defence
NATO	North Atlantic Treaty Organisation
NBC	Nuclear, Biological and Chemical
SAM	Surface to Air Missile
SFOR	The NATO peacekeeping force in BiH
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
US	United States (of America)
UXO	Un-Exploded Ordnance
WHO	World Health Organisation

Executive summary

Background

Depleted uranium (DU) is used in armour-piercing tank shells and bullets because of its extreme density, and because it burns upon impact. It is used in a dart or *slug* at the core of the weapon called the *penetrator*.

Uranium weapons were deployed in the Balkans by United States (US) aircraft operating under NATO auspices in Bosnia & Herzegovina (BiH) in 1994 and 1995, and in Serbia, Kosovo and Montenegro in 1999. The United Nations Environment Programme (UNEP) visited a representative sample of sites, and produced three reports between 2000 and 2002. These included lists of recommendations for dealing with contamination at the sites.

ICBUW visited the region in 2010 to investigate whether UNEP's recommendations had been carried out, as well as looking at the problems surrounding the assessment and decontamination of sites.

Transparency

Although NATO did release lists of strike coordinates in the Balkans, this information is still not complete, and there were delays in the release of information. In the case of BiH, information was not released until six years after the war ended. Without knowing everything that has happened at the sites, and what happened to the vehicles that were hit, complete assessment of the risks is not possible.

Environmental assessment

Without detailed information to work from, it is difficult to locate points of contamination within the landscape, and when fired by aircraft, penetrators are usually buried in the soil. Surveying contaminated sites requires expertise and equipment that is specialised and often very expensive. Neither may be available to countries emerging from conflict. Furthermore, such efforts need to be highly coordinated, yet the governance structures to organise such work are unlikely to be immediately in place after conflict, or in a newly formed state. Other administrative and environmental priorities may compete for resources and may result in recommendations like those of UNEP's not being fully implemented.

In BiH, uranium weapons contamination has been managed separately by the two parts of the country. This has historically created unnecessary duplication of function and impeded the sharing of expertise. In Kosovo, the Environment Ministry currently lacks the expertise and equipment to carry out soil testing and analysis, or decontamination.

Sites with detectable contamination in Serbia have been extensively decontaminated, as has the single site in Montenegro. There are also ongoing monitoring programmes. Decontamination has only been undertaken at one site in the Federation of Bosnia & Herzegovina (FBiH). No decontamination has been done at the site in Republika Srpska, though there has been monitoring there in the past. In Kosovo, where most of the contaminated sites are located and over 70% of the DU was fired, there has been no programme of monitoring since UNEP's study in 2001.

While many of the other problems faced by these countries are a product of their internal history, uranium weapons contamination is the result of the actions of others and adds to the burden on countries struggling to emerge from the legacy of war.

Health consequences

The health consequences of exposure to DU are not clear, but within the body it is a carcinogen. While several desk studies have been used to estimate the risks from contamination, these are not a substitute for real world studies of the effects.

There is concern in parts of the region about the use of uranium weapons. Media reports often link their use with reports of high rates of cancer. However, studies that could identify the cause have not been done to the extent required. Unfortunately, the circumstances typically found in post-conflict states may impede detailed scientific studies. As with environmental assessment, institutional capacity and resources will be in short supply. The public cancer registries in both BiH and Serbia broke down during the conflicts, and Kosovo is only now beginning to establish one.

While there have been some studies with interesting results, the constraints of funding and access to equipment are limiting. Again, because uranium weapons contamination was not caused by these countries, it should not be their sole responsibility to prove whether there are any health problems as a result of it. External funding and access to equipment could help facilitate these projects, but when international commentators call for more evidence on the effects of uranium weapons, they must understand the complexity of the work involved. Even in the most benign circumstances, conclusive results can be elusive, and the legacy of war is such that many potential studies are impeded by a lack of data.

Economic and social consequences

The case of the TRZ Hadžići site shows that economic damage and social problems can result from contamination, even when the full extent of the health consequences are unclear. The fear of contamination can have a major impact on communities and simply providing more information about the risks will not solve the problem. It would be scientifically unjustified to offer a clean bill of health to places where there are still elevated levels of uranium in the environment. Furthermore, there is too much distrust after conflict for authorities to easily reassure sceptical populations. In this context, the use of uranium weapons is a lightning rod down which old animosity and division can travel, a situation that is unlikely to change in the future.

Decontamination

Because of the dispersal of contamination, simple point coordinates are insufficient for site identification and more detailed information should be provided. The lack of information about whether any clean-up has previously been done at sites is also problematic. This is particularly a problem in Kosovo where the role of KFOR (The NATO Peacekeeping Force in Kosovo) is unclear. While Serbian sites with detectable contamination have been effectively decontaminated, only surface decontamination has been done on one site in FBiH, and none in Kosovo. Again Kosovo, where most of the contamination is concentrated, is in the worst position.

There are a number of reasons why Serbia has been able to carry out more extensive decontamination work than has been done elsewhere. Firstly it inherited many of the institutions that dealt with these matters in the former Yugoslavia, as they were based around Belgrade. Serbia is also much larger, so has more financial resources at its disposal and had relatively few sites to deal with. Also, although it suffered economic hardship and aerial attack during the conflicts of the 1990s, it has not had to deal with the legacy of a ground war.

Decontamination is difficult work, and it is impossible to fully remove all the contamination. It is also very costly: the Cape Arza site in Montenegro cost DM 400,000 (almost $280,000 US) and took about 5,000 working person days to decontaminate 480 rounds, which in total took around 12 seconds to fire.

Given that even after extensive decontamination many penetrators can remain in the ground, sites may require ongoing testing of groundwater. In some circumstances, estimates of how long this may need to be done run into centuries, and again the testing is very expensive. This is one of the reasons ICBUW advocates a precautionary approach to decontamination, and to the use of uranium weapons.

Explosive ordnance disposal & uranium weapons contamination

The presence of mines and unexploded ordnance (UXO) complicates dealing with DU and vice versa. While there are demining standards in place for DU, in practice the management of uranium weapons contamination was not a primary focus for the BiH or Kosovo Mine Action Centres. At the TRZ Hadžići site in BiH, a project that dealt with both was undertaken, and mines and UXO were detonated in situ because they represented the more immediate risk.

The presence of uranium weapons together with UXO meant that those planning demining activities had to weigh up the relative risks of losing a limb or developing cancer later in life.

International legal status

In contrast with explosive remnants of war (ERW), which are the subject of both international humanitarian law and specific treaty law, the norms governing the use of uranium weapons or other toxic remnants of war are derived solely from international humanitarian law. Several of these norms show that there is a clear legal case that states should observe precaution both in the use of uranium weapons, and in decontaminating affected areas. The moral case is boosted by the considerable barriers to effective decontamination.

Unfortunately, and despite these existing legal regimes, state users do not seem to have placed any restrictions on the use of the weapons, using the unresolved scientific issues surrounding the long-term impact of contamination as a justification. While the harm posed by ERW is more direct, and easy to understand, this cannot be allowed to justify inaction on uranium weapons.

Implications for Iraq and other conflicts

The use of A-10s in the two Balkan conflicts was actually very limited. If it had not been for specific conditions, the use of DU in the conflict would have been much greater. This was the case in Iraq, where more than 57 times as much DU was used. Although the environmental situation is very different, the challenges discussed in this report are likely to also be experienced by Iraq, but in much greater magnitude. Extensive fieldwork and risk reduction programmes with international assistance are urgently required.

Recommendations

The circumstances that always surround the use of DU (i.e. conflict) mean that we should never presume that affected states will be able to deal with assessment, monitoring or decontamination alone. In both the use of uranium weapons, and decontamination, a precautionary approach should prevail. There is a clear need for transparency over the use of uranium weapons, and for technical assistance with decontamination. International assistance should be targeted to increase capacity in the region and strengthen links between researchers.

There is still a need for further health studies in the region to assess the health consequences of uranium weapons use.

While the immediate need is for transparency and technical assistance, states should consider whether there is a case for specific international measures that address the particular characteristics of uranium weapons. Consideration should also be given to the best way to ensure that capacity exists to undertake marking, monitoring and clearance, including the creation of a semi-permanent capacity for such work to deal with both existing contamination and long-term monitoring.

1.0 Background

Depleted uranium is a by-product of the process used to enrich uranium to make nuclear weapons or fuel for power stations. Because of its extreme density, and because it burns upon impact, it is used in armour-piercing tank shells and bullets. The uranium is used in a dart or *slug* at the core of the weapon called the *penetrator*.

Depleted uranium may also be manufactured from reprocessed nuclear fuel, in which case it generally contains trace amounts of reactor waste, such as plutonium: the term *uranium weapons* is used to describe conventional weapons that contain uranium from any source. Unlike nuclear weapons, uranium weapons do not cause damage by using radioactive fission. Instead they rely on their high density, which allows them to penetrate armour when fired at high velocity.

Independent analysis has shown that samples of the uranium weapons stock used in the Balkan conflicts appear to have been manufactured from post-reactor material. Because of this, the terms *uranium weapons* and *depleted uranium* (DU) are both used to refer to material of this type in this report.

Uranium weapons were deployed in the Balkans by United States (US) aircraft operating under NATO auspices. In Bosnia & Herzegovina (BiH), they were deployed as part of Operation *Deny Flight* on two occasions in August and September 1994, and as part of Operation *Deliberate Force* on a further 17 occasions in August and September of 1995. At least 1,271kg of DU was fired during these 19 sorties. As part of Operation *Allied Force*, uranium weapons were fired on at least 112 occasions between 6th April and 11th June 1999 at targets in southern Serbia and Kosovo as well as one site in Montenegro. At least 5,723kg of DU ammunition was fired during this time.[1]

In all of these cases, the uranium-based round was the PGU-14/B, which is fired against targets on the ground by the large GAU-8 Gatling-type rotary cannon on the A-10 Thunderbolt II aircraft. Despite being used by only a single model of aircraft for a single military purpose, and in limited military operations, this still resulted in significant environmental contamination.

Nonetheless, the quantities involved are relatively small compared to those expended in Iraq. During the two conflicts in 1991 and from 2003 onwards, at least 404,000 kg was expended, more than 57 times as much. Although the environmental conditions and the type of warfare involved are not identical, the experience of the Balkan countries provides an invaluable insight into the effects of uranium weapons, with implications for their use in other conflicts. In particular, the issues surrounding environmental surveying, conducting health studies and decontamination procedures are likely to be common to all countries recovering from conflict.

Following growing concerns about its use in the 1991 Gulf War, the use of uranium weapons was already a controversial topic by the time of the 1999 Kosovo conflict. Researchers based in Serbia tested recovered NATO ammunition and confirmed that it contained uranium,[2] and significant media interest followed the Pentagon's public statement that they had used uranium weapons.[3] It was against this background that the recently launched Post-conflict Assessment Unit of the United Nations Environment Programme (UNEP) began to look into the matter. A desk study was produced in late 1999,[4] and it became apparent that for a proper assessment of contamination it would be necessary for NATO to produce details of targeted locations. Following a request by the UN Secretary-General, NATO provided some non-specific information and, following a second request, they produced a list of 112 strike sites. Subsequently NATO also confirmed the use of uranium weapons in BiH.

Using this information UNEP visited a representative sample of 11 sites in early 2000, and produced a report in early 2001. To some extent the report was reassuring – rather than the widespread contamination of the region that some had feared, contamination was localised. As the uranium in weapons is mostly comprised of the isotope uranium 238, it primarily emits alpha radiation. Alpha radiation cannot pass through the skin, which means that the major concern for human health is if it should find its way into the body. Uranium is also chemically toxic, a further reason to suspect it could be harmful to health. From UNEP's findings, it seems that the likely risks were that the uranium at the sites could find its way into drinking water sources, or that uranium dust at the sites could become resuspended and inhaled.

To reduce these risks, UNEP produced a list of recommendations for dealing with contamination at the sites, and for sites that it had not visited. A World Health Organisation (WHO) mission also visited several sites in Kosovo – although they did not carry out any sampling work in the field.[5] Subsequently, UNEP reports were produced looking at sites in Serbia and Montenegro in 2002, and BiH in 2003. A summary of the recommendations is produced in the appendix on pages 23 and 24 of this report.

In 2009, ICBUW secured funding from the Norwegian Ministry of Foreign Affairs to undertake a research trip to BiH, Kosovo and Serbia in order to examine whether UNEP's recommendations had been carried out. ICBUW also wanted to learn more about the effects of the contamination on people living nearby and to assess any research that had been done into possible health consequences. An international team from ICBUW visited the Balkans in March and April 2010. While our remit was not to undertake primary research, we were able to speak with many of the individuals and government agencies who have been involved in both research and remediation. We were also able to build up a picture of the current status of some sites, and look at the problems surrounding the assessment and decontamination of contaminated sites more generally.

The degree to which uranium weapons contamination had been monitored and dealt with varied greatly across the region. Extensive decontamination had been undertaken on the sites in Serbia where there was detectable contamination. In BiH, limited decontamination had been done at one of the worst affected sites, where there is also an ongoing monitoring programme. However, the capacity for such work is very limited in Kosovo and there is no organised ongoing programme, despite the fact that this is the location for most of the contamination in the region. This report explores some of the factors underlying this disparity, as well as the circumstances that impede health studies being undertaken to establish the health consequences of uranium weapons contamination.

2.0 Transparency

Release of information

Although NATO did release lists of strike coordinates after two interventions by the UN Secretary-General, this information is still not complete. For six of the sites in BiH, there is neither information about the number of rounds expended, nor the strike coordinates. The only information available is that the strikes were in the vicinity of the capital, Sarajevo.[6] In the list of strikes for the Kosovo conflict, a further 23 entries do not detail how many rounds were fired, and some coordinates appear to be invalid.[7] The data was compiled using mission reports to estimate coordinates, and records from each unit of the amount of ammunition expended.

Even where this information has been disclosed, there is considerable confusion about what proportion of bullets fired by the A-10s were PGU-14/B rounds with a DU penetrator, and what proportion were PGU-13/B high explosive rounds. Information held by the Kosovo Ministry of the Environment suggests that PGU-14/B made up 4/5 of the overall number,[8] the proportion that was used in the 1991 Gulf War.[9] Information provided by KFOR (the NATO peacekeeping force in Kosovo) to the WHO also cited the same ratio.[10] However, for the Kosovo conflict, the correct ratio is more likely to be that used by UNEP and the UK MoD (United Kingdom Ministry of Defence): DU ammunition made up 5/8 of the total.[11] In the earlier interventions in BiH, the situation is less clear. UNEP made the case that one should assume the same ratio was used in both conflicts,[12] but their calculations for the weight of DU expended at each site appear to assume that all rounds fired at sites in BiH were PGU-14/B.[13] Needless to say, knowing how many uranium rounds were likely to have been used at a site is of fundamental importance for the proper assessment of contamination, and NATO should clarify the situation as soon as possible.

Authorities in Serbia tasked with decontamination detected contamination at one location that was not on the list provided by NATO – on a hill at Pljačkovica near Vranje where a TV transmitter was based. Contamination at the site was later confirmed by UNEP.[14] This discrepancy, and the difficulty of recovering uranium penetrators in the field, has led to concerns that the NATO data is not correct, either in the locations listed, or the number of rounds fired at each location.[15] Concerns about the accuracy of the coordinates are not limited to the Serbian authorities. An investigation by the UK MoD into strike sites in the UK KFOR zone concluded that: *"the accuracy of the map coordinates for the locations where DU was used are only accurate to plus or minus one nautical mile."*[16]

The delay in the release of information was also problematic. In the case of BiH, confirmation that uranium weapons were fired did not come into the public domain until six years after the cessation of hostilities. In the case of one site visited by ICBUW, this delay meant that workers at the site cleared contaminated war debris by hand without any form of protection,[17] and that some demining of a contaminated site was undertaken by teams who had no knowledge of the contamination.[18] While this example is an extreme case, it is highly probable that at numerous sites throughout the region, civilians were unnecessarily exposed to hazards when the prompt disclosure of information could have allowed the local authorities to warn the populace and take remedial action.

Assessments by the Federal Republic of Yugoslavia Army

Although primary responsibility for the disclosure of strike sites naturally rests with the users of uranium weapons, some within the Federal Republic of Yugoslavia (FRY) Army during the years of conflict were aware that uranium weapons had been used, and did not release this information into the public domain. Possibly as early as 1994,[19] and certainly by 1996,[20] teams had visited the Han Pijesak site in BiH and confirmed the presence of DU contamination. However this information was not made available to the civil authorities until after NATO had confirmed its use several years later.

In the run-up to the Kosovo conflict, a project to identify the sites where uranium weapons had been used within Serbia was devised, and researchers were able to visit various strike sites during the conflict itself. This project identified several sites on NATO's list of strike sites in southern Serbia.[21] Although this information would have had little relevance for the other sites in BiH or those within Kosovo, it presented an opportunity to inform civil society and the international community of the use of uranium weapons. It was an opportunity that was unfortunately missed.

The fate of targeted vehicles

One issue that ICBUW pursued during its visit was that of vehicles that were hit with uranium weapons. Some studies have suggested that much of the contamination in this situation remains within the vehicle.[22] Therefore the lack of vehicles at most of the sites visited by UNEP suggests that significant sources of contamination remained unexamined.

These presumably posed a risk to anyone who came into contact with them. Aside from the case of the TRZ Hadžići site (dealt with in detail later in the report), we were not able to get a detailed answer to this question in BiH. It seems likely that at most of the other sites, any vehicles that were salvageable were removed by the Serbian forces, though none of our interviewees could say what was done with them.

Certainly in Kosovo, very few destroyed vehicles were left at strike sites when a US assessment team visited the area in the weeks and months after the conflict. However, it has been suggested this was simply due to NATO's lack of success in targeting Serbian forces on the ground.[23]

UNEP found wreckage at more than one site during their study, but none that tested positive for DU.[24] The wreckage that was left behind was apparently dealt with by KFOR,[25] but it has not been possible to ascertain precisely how.

For any vehicles within Serbia, the army's Nuclear, Biological and Chemical (NBC) Branch was responsible for decontamination, and the civilian authorities were not able to provide details.[26] Unfortunately we were unable to secure a meeting with the Serbian Army during our visit, and therefore were unable to establish what decontamination procedures had been undertaken.

During UNEP's study in Serbia and Montenegro they were able to examine an Armoured Personnel Carrier (APC) that had been hit with uranium weapons, and recommended that the vehicle be cleaned and the crew provided with medical care and health monitoring.[27]

3.0 Environmental assessment

Identifying contamination in the field

Without quite specific information to work from, it is difficult to locate points of contamination within the landscape. The radioactive signature of DU is mainly comprised of alpha particles, and this type of radiation is not easily detectable from a distance. Instead, equipment for detecting beta and gamma radiation is used in the field. DU only produces a small amount of this type of radiation, meaning that it is difficult to detect.

Penetrators are usually buried in the soil, where the radiation is not detectable from the surface, except for the soil immediately around the point of impact. While this uranium could in time come to pollute water sources, these factors make the task of environmental assessment extremely difficult. Teams investigating contamination have been forced to rely on local knowledge, or visual indicators of the attack in order to locate contamination.[28,29] It has been suggested that using metal detectors may help to locate buried penetrators,[30] but others found that the amount of shrapnel in the ground meant that they were of limited use.[31] Because of these limitations, there is no realistic possibility of locating the six sites *in the vicinity of Sarajevo* for which there are no target coordinates. Local residents and the authorities have no choice but to live with this situation.

Institutional capacity

Even in circumstances where contamination points can be located, countries that are emerging from conflict face significant impediments to performing environmental survey work. The expertise and equipment required to investigate uranium contamination are highly specialised, and may not be available. This is particularly true of the equipment that can reliably differentiate between natural and depleted uranium. Furthermore, such efforts need to be highly coordinated, well supported and funded. Without well developed governance structures, academic expertise in the relevant field, radiation and environmental protection legislation and political focus, they are unlikely to progress in a sufficiently sustained fashion.

While there can be no doubting the professionalism and dedication of those working in this field in the region, it is clear that many face significant impediments to their work. Before the breakup of Yugoslavia much of the work in this field, as well as many others, was done in or around Belgrade, which had been the capital of Yugoslavia, and where nuclear sciences research began as early as 1948.[32] One of our (non-Serbian) interviewees referred to it as the *real capital* of the region because of this legacy. To re-create all of these functions in a newly independent country is a huge task, and takes a considerable length of time. This is well illustrated by one national ministry in BiH, which began work with only four or five staff who had transferred over from the ministry in Belgrade – the rest of the staff began with no direct experience.

The compromises necessary for peace can also bequeath institutional frameworks that are ill-suited to smooth governance during peacetime. The Dayton Agreement split BiH into two distinct political entities where most governance functions were devolved, with few exercised at the state level. This means that for most of the time since uranium weapons were used, the issue of contamination has been managed separately by the two entities, creating unnecessary duplication of function and impeding the sharing of expertise. While a radiological protection agency has recently been formed at the state level, Republika Srpska has only had radiological protection legislation in place since 2007, and did not have any radioactive waste storage capacity.[33] The joint agency now has access to a central site that serves the whole country.[34]

As BiH had been a former republic of Yugoslavia, with considerable autonomy prior to the war, it was perhaps better placed in this regard than Kosovo, which had its autonomous status within Serbia rescinded at the end of the 1980s. While there has been an established Environment Ministry there since 2002, it still lacks the expertise and equipment to carry out soil testing and analysis or decontamination. The ministry is reliant on KFOR to notify them if DU contamination is a problem.[35]

Access to equipment

The lack of funds and the most precise equipment is not particular to Kosovo but is a shared problem throughout the region. Environmental testing in the entity of Republika Srpska relied upon equipment borrowed from the International Atomic Energy Agency (IAEA).[36] The testing of potentially exposed civilians in southern Serbia was restricted by cost.[37]

Lack of access to the most advanced equipment in BiH has also hampered detailed follow-up of some of UNEP's work. One of the major findings of UNEP's study in BiH was that DU could be detected in one or possibly two water samples taken at the TRZ Hadžići site. While the levels are below the WHO's 15 µg/litre provisional guideline value,[38] ongoing monitoring of the water at the site is essential to see whether there has been any change in the level of DU in the water source.

While the authorities in BiH have been taking both soil and water samples at the site, they have not found significantly increased levels of uranium contamination in the water. However, with the equipment available to them it is difficult to reliably distinguish between the isotopic signatures of natural and depleted uranium.[39] For such a test one would need to use an ICP-MS (Inductively Coupled Plasma Mass Spectrometer), rather than an Alpha Spectrometer. At the time of writing the cost of a new machine was in the region of £120,000 (US$180,000),[40] with independent laboratories charging hundreds of pounds to test individual samples. So, while it is possible to say that uranium contamination has not increased greatly since 2002, it is impossible for them currently to distinguish the presence of DU from natural uranium.

The current assessment picture

Because of the factors described above, knowledge about the status of contamination differs between the affected countries in the region. The sites with detectable contamination in Serbia have been extensively decontaminated,[41] as has the single site in Montenegro.[42] Some surface decontamination has been performed at the TRZ Hadžići site, and there is ongoing monitoring.[43] Other sites in the Federation of Bosnia & Herzegovina (FBiH) are not currently being monitored, nor is the site in Republika Srpska, although there has been monitoring there in the past.

In Kosovo, where most of the contaminated sites are located, there has been no visible programme of monitoring since UNEP's study in 2001, which looked at only 11 of 85 sites.[44] As the known environmental problems in Kosovo include the waste legacy from communist-era heavy industry, air pollution from lignite electricity generation, and untreated sewage in water courses,[45] it is unsurprising that the authorities are in no hurry to add further to this list.

Facing all of these impediments, it is clear that countries emerging from conflict cannot be expected to conduct environmental surveying work on uranium weapons without financial and technical support from the international community.

While many of the other problems faced by these countries are a product of their internal history, uranium weapons contamination was a result of specific military decisions, mandated by the UN in the case of BiH and by NATO member states in the case of Kosovo. Their use is an additional and unwelcome burden for countries struggling to emerge from the legacy of war: "*a new headache*", as one of our interviewees described it.

4.0 Health consequences of DU use in the Balkans

The current health picture

The most pressing and controversial question regarding the use of uranium weapons is whether they have any negative impact on human health. Since the issue came to prominence, there have been a number of desk studies that have sought to assess the risk from these weapons by compiling the existing research on the issue. However, with a lack of significantly sized studies on exposed civilians, there are ongoing uncertainties over the risks posed by the battlefield use of uranium weapons.

A full review of the evidence concerning the health risks of uranium weapons contamination is beyond the remit of this report. Nevertheless, while there is a spectrum of opinion on this question, there can be little doubt that within the body the alpha radiation produced by DU is a carcinogen.[46] This is a property, amongst others, that is also exhibited by uranium's heavy metal toxicity.[47]

Without a comprehensive picture of the extent of the contamination, it is very difficult to assess the risk to populations in the Balkans. Although many of those who have worked on measuring the contamination at sites were of the opinion that the general risks from the locations they had investigated are fairly low at the current time,[48] in some situations the risk could be significant.[49] However, studies to assess the effects on civilians of chronic long term exposure to battlefield residues of depleted uranium have not been undertaken.[50]

Health studies in post-conflict environments

There is considerable concern in some parts of the region that the use of uranium weapons has resulted in rising rates of cancer for some populations. Media reports often link the high rates of cancer in southern Serbia and northern Kosovo with the use of uranium weapons. Unfortunately these claims have not been subjected to detailed scientific analysis. There have also been reports that the population who moved from the Hadžići region to Bratunac in Republika Srpska have higher rates of cancer and greater cancer mortality than the local population.[51]

For greater scientific certainty, what is required are studies that can both show that individuals have been exposed to uranium weapons contamination, and that there is a statistically significant correlation between this exposure and a given health outcome. As with the question of environmental assessment, for a country recovering from conflict, conducting such studies presents a considerable challenge.

To carry out epidemiologic studies assessing all risk factors, including DU, a reliable registry of diseases in that area is needed, especially for cancer. Epidemiologic studies require the kind of uninterrupted and high quality healthcare provision which is practically unheard of in wartime. Large scale population movements are common in conflicts, as is the breakdown of governance structures, scarcity of funds and extreme stress on remaining healthcare systems. Keeping meticulous records of the type required for later scientific work is unlikely to be a priority.

The public cancer registries in both BiH,[52] and Serbia,[53] broke down during the conflicts, in spite of the fact that Serbia did not endure a ground war. The registry in BiH underwent a 12 year hiatus, only being re-established in 2004. Kosovo is currently undergoing a large scale reform of its health system. This covers cancer registration, public health laws, medical practice systems, and health insurance. The first stage of this process runs from 2010 to 2014, and as such a central cancer registry is yet to be established.[54]

Often the aftermath of war can bring further disruption. The Dayton Agreement in BiH, which divided the country into two entities along ethnic lines, presaged further population shifts.[55]

Another example is the hospital in North Mitrovica in Kosovo, which used to cater for all the inhabitants of the region but now finds itself within an ethnic Serb enclave in a divided city. Those in the south of the city (predominantly ethnic Albanians) travel to Prishtina for medical attention. Although the hospital is thought to also cater for Serbs from outside the immediate region, there is no official census and population figures are highly politicised. This has rendered it impossible to make authoritative statements on the incidence of disease in this population. Although the hospital's physicians have informal links with their medical colleagues in the rest of Kosovo, the fractured state of medical cover rules out any study which would seek to analyse medical records in order to look at rates of illness before and after the conflict.[56]

In one case, the disruption to medical records was the direct result of uranium weapons contamination. When the TRZ Hadžići site was discovered to be contaminated with DU, its post-war business collapsed and it was unable to continue paying taxes for a time. As a consequence, the workers, many of whom may have been exposed to DU contamination, lost their governmental health cover for this period.[57]

Evaluation of exposure

One major issue amongst the many which complicate epidemiological research is identifying those most likely to have been exposed. Using simple geographic proximity, such as living in the same town as a strike site, for example, is unlikely to be a sufficiently sophisticated method of identifying subjects.

Notwithstanding, those who have either lived or worked very close to an area which is contaminated are likely to be of interest to researchers. Questionnaires can then be used to refine this search further but self-reporting brings its own challenges. One unexpected problem mentioned by an interviewee was that the high profile of the DU issue and the subsequent notoriety from having been present at an attack can make self-reporting by subjects somewhat unreliable. It was suggested that recruiting a trusted local intermediary to help with subject identification was desirable in such cases.[58]

One of the standard tests to see whether an individual has been exposed to DU, is to test their urine to establish the level of uranium. The ratio of uranium isotopes then indicates whether it has a natural or man-made source. A study on workers and those living near to a uranium weapons manufacturing facility for DU products in New York State showed that exposure can leave a trace in urine for up to 20 years after the event.[59] However, even if a urine test is negative, it is not possible to rule out any exposure. Nonetheless, it remains the most common approach for detecting human DU exposure.

Research to date

The majority of urine testing to determine exposure in those who may have been in contact with uranium contamination in the region has been conducted by NATO member states on their peacekeepers. This testing was in response to media and military concerns that they may have been contaminated.[60] Unfortunately, while these studies achieve the objective of showing that the peacekeepers in question had no detectable contamination, they tell us little about whether civilians have been put at risk as a result of uranium weapons contamination.

One study of 12 residents of BiH and Kosovo appeared to show the presence of DU in the urine of all subjects.[61] However these

Anja and Sanin Haveric, researchers who have undertaken chromosomal aberration studies on exposed workers at the Hadžici facility, INGEB - Institute for Genetic Engineering and Biotechnology, Sarajevo BiH

findings were questioned by a later study that took several of the subjects as part of a cohort of 24 residents of Kosovo and Serbia, and found no detectable DU.[62] Unfortunately the costs associated with ICP-MS testing of samples means that large scale testing of subjects in this way is prohibitively expensive, and ICBUW knows of no studies that have involved large civilian cohorts.

In BiH, a major focus of research has been in the region of Hadžići, where three sites were targeted with uranium weapons. One study of interest looked at chromosome aberrations (a specific biomarker for radiation damage to DNA) in workers from the TRZ Hadžići site. The study included control groups from other regions, including one that had been exposed to some of the effects of the conflict, but not DU. The group of workers were found to have more aberrations, but the group size was not sufficient for statistically significant findings. In addition the groups were not evenly matched for lifestyle and other factors. Unfortunately funding for larger and more comprehensive studies was not forthcoming.[63]

The institute of Public Health in FBiH has also done a pilot study on 40 residents of Hadžići to see whether there were unusual rates of several diseases, including cancer. No significant findings were observed, but monitoring will continue.[64,65] A larger study was considered, comparing the municipality of Hadžići to another municipality, but it was ruled out on grounds of cost.[66]

Another study compared a number of possibly exposed groups, examining both chromosome aberrations and also the uranium content and isotope ratio in urine using alpha spectrometry. A number of subjects from contaminated areas in Serbia appeared to have an isotopic ratio consistent with DU contamination, and were part of the study group with a statistically significant increased risk of chromosome aberrations. While significant, this was lower than a control group who were occupationally exposed to X-rays as part of their work.[67] Again, the original study was limited in the funds and equipment that were available at the time, but the researchers would be willing to conduct more comprehensive work if funds became available.[68]

Implications and policy concerns

Notwithstanding the recognised limitations to these studies, it is clear that well designed studies with sufficient funding and equipment should be able to identify potentially exposed populations and assess their exposure. Unfortunately, researchers from these countries have been left to pursue these lines of inquiry with little help from other nations, who have in the main restricted their research to ascertaining whether peacekeeping troops have been contaminated.

ICBUW has long called for further research into the effects of battlefield uranium weapons contamination on civilians, but it is vital that when international commentators call for more evidence on the effects of uranium weapons in the field, they understand the complexity of the work required. External funding and access to equipment could help facilitate this work. Even with this kind of assistance, producing evidence sufficiently compelling to count at the international table is a tall order, and the legacy of war is such that many potential studies simply lack the data that would be required.

At present policy-makers in a country affected by uranium weapons contamination face an unappealing dilemma. Do they invest scarce public resources into studies that may yield inconclusive results or justify expensive decontamination work that may fail to calm worried populations? Or do they divert funds elsewhere in the hope that the contamination does not represent a major problem and risk being accused of covering up the issue?

In the absence of international assistance with research and post-conflict management of uranium weapons contamination, governments of contaminated countries are left with few other options.

5.0 Economic and social consequences

Case study: the TRZ Hadžici site

An instructive illustration of the problems caused by contamination is the case of the TRZ Hadžići site, BiH. Prior to the conflict the facility hosted a business repairing tanks. During the war, the business moved to Sarajevo and undertook maintenance work for vehicles belonging to the armed forces defending the city. The facility was occupied by the army of Republika Srpska, and the strategically important site with its vehicles and equipment came under sustained attack from NATO during September 1995.

Under the Dayton Agreement the site became part of the FBiH, and the Republika Srpska soldiers withdrew. When the workers returned to the site in March 1996 all equipment, fittings, machines and working vehicles had been taken by the retreating forces. Staff found a great deal of rubbish on the site, some of it contaminated with DU, and although all operable vehicles had been taken, the tanks that had been rendered immobile were left behind. However, the workers were unaware of the possibility of contamination, and from the Director down they cleaned up by hand using brooms. As they were not aware that the rubbish required special handling, it was simply dumped in landfill.[69]

Some time later, they became aware of rumours that some kind of unconventional weapon had been used. These centred upon reports of higher rates of cancer in the refugee population from Hadžići that had moved to Bratunac on the Serbian border. However, at the time it was dismissed as a rumour spread by the Serbians to cause fear and alarm. It wasn't until an international journalist came to the site in 2001 that they were made aware that DU had been used. This was confirmed by a German Commander from SFOR (the NATO peacekeeping force in BiH) who removed a box of spent penetrators, and warned them to stay away from any others that were found.[70] UNEP visited in 2002 and made a full assessment of the site, prior to issuing recommendations on how to reduce the risks of exposure (the site is named 'Hadzici Tank Repair Facility' in their report). The site was heavily mined during the conflict, but has since been demined, and periodic sampling of soil and water for DU has been undertaken by the FBiH authorities. Although the risks to the general population are not thought to be great, people performing work in the contaminated hot spots could be at risk of significant exposure.[71]

Zijad Fazlagic, Director of the TRZ facility

Economically, the damage has been significant. After repairing tanks in Sarajevo during the war, they returned to a factory that was stripped of equipment. In order to avoid laying off their staff, the business diversified into work that did not require specialised equipment. When news broke about the contamination, they were manufacturing military helmets. Because of the stigma associated with contamination, orders dried up. The company suffered badly, and at this time the workers lost their health insurance as the company was not able to pay its taxes. As one of the few profitable businesses in the area, with more than 100 employees, the effects would have been felt well beyond the factory walls. However they were able to keep paying wages by taking on work repairing roads and other activities that did not involve products that came into contact with people. At the time of our visit, they were manufacturing again but requested that we did not reveal the nature of their business for fear that the association with the site become known.[72]

Many of the workers have been with the company their whole lives. A number have died unusually young – the Director mentioned one who kept a penetrator as a souvenir because it released sparks when struck with a metallic object. He had died around 45 of lung cancer. While the Director knew that it was impossible to say for sure whether there was a connection, he said that the workers live with a constant sense of uncertainty. Many of them have to deal with concerns in their family about working at the site but are unwilling give up their income. It was described to us that any illness or ailment, whether it be asthma, kidney disease or a bad back, is accompanied by the thought in the back of their minds that it might be connected to the contamination. When they first heard about the contamination after the war, it did not seem to be too much of a threat as there were many other things to worry about, but as time has gone by, their concern has increased.[73]

Steel peg marking impact hot spot on the tarmac apron at the TRZ facility, gamma reading is 40x background, April 2010.

While we were informed by the Director that medical examinations have apparently been done by SFOR and by the Federal authorities on around 150 of the workers, no information had found its way back to them. This has been a further source of anxiety.[74] A similar issue was highlighted by another researcher concerning southern Serbia. There, residents have seen researchers come and go without being given feedback about whether their land was safe, what results have been found and what precautions they should take.[75]

Public perception of contamination

The lack of information for those living with contamination can be partially addressed by following up academic research with subjects, as well as risk education programmes (recommended by UNEP in all three reports).[76] However, without a larger body of research into the potential health consequences, and international assistance in order to ensure that sites are decontaminated, fear and exaggerated concern will continue to dominate. The Finance Director at the facility recounted a story about an experience she had shortly after the news about the contamination became well known. Visiting the bank to deposit some funds, there was a large queue of between 50 and 100 people, as banking facilities were still very scarce. However, when she was recognised a whisper went around the room: "*She's irradiated*", and everyone moved out of the way to avoid her.[77] While the anecdote is comic, the day-to-day effects of stigmatisation within the community would have been far from amusing.

The Director of the facility said that if they had money, they would consider a lawsuit against NATO. They were grateful to NATO, and believed that the intervention had helped to end the war, but found it hard to accept that NATO is also responsible for a threat to their survival.[78]

While it may be imagined that such issues can be easily countered by proper education about the risks, this fails to appreciate both the uncertainties over the long term health impact of uranium weapons and the nature of conflict. Although the authorities would like to reassure their populations, it would be scientifically unjustified to offer a clean bill of health to places where there are still elevated levels of uranium in the environment, so any assurances would be necessarily equivocal.[79]

Authorities in both Serbia and Kosovo complain about sensational coverage of the issue in the press, which had increased public fear.[80] While chemical toxicity may well be of greater concern medically speaking, fear of radioactivity is a natural human reaction to an invisible and deadly threat. At Radoniq/Radonjick Reservoir in Kosovo, visited by the ICBUW team as part of our research, leaching could occur from the area contaminated by DU close to the lake. UNEP assessments concluded that the sheer volume of water in the lake is sufficient to dilute any contamination to the extent that it does not pose a risk.[81] Nevertheless, the lake supplies drinking water for much of southern Kosovo, and whatever the actual dangers, the potential for such situations to cause public alarm is clear.

During our visit, it was abundantly clear that concern about the use of uranium weapons is more keenly felt in the Serbian parts of the region, with a clear distinction between those who supported the NATO interventions and those who did not. It is naïve to expect that in the future those who have been targeted with uranium weapons will accept that there is little risk - especially considering the ongoing uncertainty about the long term health impact. For this reason, the use of uranium weapons is always likely to be accompanied by situations such as those in Tuzla Canton in BiH, where SFOR representatives struggled to persuade a sceptical population that the destruction of weapons near the village of Seljublje was not connected with a local cluster of cancers.[82]

During our visit to Kosovo, we were told that even a vaccination campaign for Swine Flu had been perceived as a conspiracy against a particular ethnic group.[83] A distrust of authority and governments was common throughout the region, and is to be expected in the aftermath of conflict. In this context, the use of uranium weapons is a lightning rod down which old animosity and division can travel, and this is unlikely to change in the future. The irony of using such weapons under a humanitarian banner was noted by many of our interviewees.

6.0 Decontamination and monitoring

Strike site information in relation to decontamination

UNEP's recommendations for the sites that they visited involved the removal of penetrators and jackets (the casing for the penetrator within the projectile), as well as contaminated soil where feasible (the full recommendations are summarised on pages 23 & 24). They also recommended periodical sampling of groundwater for contamination, measures to inform those living near to contaminated sites of the risks, and investigations into claims of health problems. UNEP also recommended that the sites where they were unable to visit be surveyed and, if necessary, decontaminated.

Aside from the issues already raised regarding the early release of strike site information, the experiences of those involved in decontamination illustrate the limitations of the information provided by NATO. US Army information suggests that in a typical A-10 strafing run, 90% of the rounds will not hit their target. Instead they will be spread across an area of 500m^2.[84] This figure is heavily influenced by the flight path of the plane, as the GAU-8 cannon is mounted below the cockpit.

The practice of Serbian decontamination teams was to try to guess the plane's angle of approach, and locate the area with the highest radioactive signature. They would then explore a conical area from this point. However, they frequently found themselves moving the fence around their area of work as other points of contamination were identified.[85] Similarly, UNEP made use of military experts to identify the probable angle of attack in order to help them locate contamination.[86]

When providing information to the authorities dealing with unexploded ordnance (UXO), on the probable locations of cluster bomblets within Kosovo, NATO provided information with rectangular estimated strike footprints, with inner and outer areas marked. These rectangles related to *"probable dimensions of bomblet dispersal area around the desired location"* and probable dispersal *"including additional errors associated with weapon delivery from aircraft"*. Although the cluster strike information was more detailed, even this was described as inadequate by the former Programme Manager for the Mine Action Programme in Kosovo, who called for additional information, such as the direction of flight of the aircraft, to also be included.[87] This stands in contrast to the single point coordinates provided to UNEP for DU strikes.

Although NATO's information about sites in Kosovo, Serbia and Montenegro did not include the actual target (such as 'building', 'APC' etc.), this information was made available to the UK MoD and would certainly be of use in the field.[88] Interestingly, NATO's strike data for BiH did include this target information, as well as listing several coordinates for some targets. In the final analysis, any technical information related to the original firing of the weapons is likely to be of use in decontamination, and information provided should always be compiled in such a way as to maximise the possibility of effective decontamination.

Site histories

There are significant gaps in the information regarding what, if any, remediation activities have been undertaken at individual sites. In BiH, where information about the use of uranium weapons was not put into the public domain until six years after the conflict ended, it is very difficult to ascertain what occurred at the sites during this time. After the information became known, a German SFOR commander visited the TRZ Hadžići site and removed a box of penetrators.[89] During UNEP's visit they struggled to establish what had been done with the penetrators, and for a long time assumed that they had been destroyed at an ammunition detonation site. Subsequent requests to NATO resulted in internal enquiries and an assurance that they were removed to a US radioactive waste storage site.[90]

Sites in Serbia were identified early on, fenced off and marked with radiation signs and are likely to have remained undisturbed until UNEP's visit. However, one of our interviewees suggested that FRY military teams may have removed some penetrators during their investigatory work in 1999.[91] The number of penetrators removed from a site is significant: as most penetrators fired in an A-10 attack are thought to remain intact, most of the contamination at the Balkan strike sites is still present in the form of intact penetrators.[92] Without knowing how many are still present in the field, it is impossible to assess the success of decontamination work.

In Kosovo, as the Environment Ministry has been unable to undertake any work on contaminated sites, any activities at these sites are likely to have been done either by local people or KFOR. Unfortunately KFOR were not willing to meet with our team, though they did confirm subsequently through correspondence that a declaration was made in 2001 that KFOR would no longer be involved in: *"detecting, marking and removing spent Depleted Uranium (DU) in Kosovo."*[93] This was apparently in response to UNEP's report in March of that year, though it is hardly in line with UNEP's recommendations, indeed the recommendations for Kosovo specifically said that KFOR: *"should be fully involved in these tasks owing to the security risks posed by mines and unexploded ordnance."*[94]

Information passed from KFOR to the Kosovo Environment Ministry is that no systematic clean-up of sites was undertaken, although one KFOR brigade collected 36 penetrators at one location.[95] In fact investigative work was done on all the uranium weapon strike sites in the UK Zone of Kosovo and an Italian study team also investigated some target sites.[96] At the Gjakove/Djakovica garrison site, major demolition and clearance work was being carried out by Italian KFOR troops until penetrators were uncovered.[97] At the Rikavac site in Kosovo, UNEP recommended that penetrator impact holes be repaired.[98] When ICBUW visited the site in 2010 this had been done, possibly by KFOR, although we were informed the work had been done by local people. Unfortunately without comprehensive and detailed information about what interactions KFOR troops have had with individual sites, prioritisation of environmental survey work in Kosovo will be impossible, with long term implications for effective decontamination.

Unfortunately, our experience that KFOR was reluctant to engage with this issue is not unique. One of our interviewees approached KFOR troops regarding a site near to where he lived in northern Kosovo that was rumoured to be contaminated with uranium weapons. This was an issue of local concern, but he was rebuffed.[99] It is to be hoped that in the future KFOR will feel willing to publically state that it welcomes environmental survey and decontamination work and will provide information and logistical support to assist with this. This would enable the fulfilment of UNEP's recommendations, and ensure that the local population is not needlessly at risk from uranium weapons contamination.[100] The need for positive engagement by KFOR on the issue is particularly necessary as the Kosovo Environment Ministry has been reliant on them for information as to the appropriate action to take with regard to DU contamination.[101]

The decontamination procedure

Several sites in Serbia had been identified by a project undertaken during the Kosovo conflict itself. However remediation work on them did not begin until 2002, after the publication of UNEP's report. Decontamination work on the single site in Montenegro – at that time a republic within the Federal Republic of Yugoslavia alongside Serbia – began in 2001, and UNEP was able to observe the results of the first phase of operations. The work was financed by the Montenegrin government, and involved staff from the Centre for Ecotoxicological Research of Montenegro, the Faculty of Science at the University of Montenegro and the Vinča Institute of Nuclear Sciences in Belgrade. NBC officers from the FRY Army were also involved. Following the project, UNEP declared the site to be practically clean (meaning that there was no contamination that was detectable with field measurements). Consequently, they recommended that a final check should be carried out and signs placed in case penetrators were found at the site in the future.[102]

In six of the 10 coordinates in Serbia identified by NATO, the FRY authorities did not locate any contamination.[103] This was corroborated by UNEP at Bukurevac.[104] Two of the remaining four coordinates were very close together and were treated as a single site in the decontamination programme. The Pljačkovica site, which did not appear on the NATO coordinates, was also included. At the Borovac site, a second area of decontamination was located during the first stage of decontamination and was added to the programme.[105]

The first stage of work was a surface scan of the site with alpha radiation detectors, after which the soil was turned over to a depth of 1m using tractors. Dosimetric measurements were taken, and any solid pieces of penetrator and contaminated soil were removed. Throughout this time, air quality was measured with vacuum pumps to see if any DU was being disturbed. Teams would separate out metal and contaminated soil, which was then taken to the waste repository at the Vinča institute in Belgrade for indefinite storage. The process of measuring, finding contaminated soil and removing it was repeated, and the procedure was likened to fine archaeological research. Access to the site was limited, and workers were restricted to spending six hours a day on the site, and only working for two weeks at a time. They wore protective clothing and underwent health checks before and after the work. [106]

The structure of the soil at each site determined the paths of the penetrators in the ground, and how deep it was necessary to dig. At Pljačkovica, the ground was rocky and very hard to work with machines and they had to resort to manual tools. They found penetrators lodged in rocks at depths of up to 30cm. At Borovac 2, the penetrators were found up to a depth of 2.5m. In some cases the path of the penetrator under the soil was far from straight – it was described to us variously as a *corkscrew*,[107] or an *arabesque*.[108] Only when the penetrators had hit hard surfaces were they to be found above ground. The thoroughness of the Serbian decontamination projects work can be demonstrated by the fact that UNEP could not detect any surface contamination at Borovac,[109] even though the Serbian authorities subsequently removed 49 penetrators, 36 jackets and 1500 kg of contaminated soil.[110]

In total the work in Serbia involved surveying 29,724m^2 of land, and removing almost 10,000kg of soil to a radioactive waste repository.[111] Work ran in Bratoselce from September to November 2002 and the same months the following year; in Pljačkovica from July to November 2004; in Borovac from July to December 2005 and June to July 2007; and in Reljan from September to December 2006 and April to June 2007.[112]

At the site in Montenegro, the work involved surveying a total of 45,000m^2, of which 18,000m^2 was found to be contaminated. In total 242 whole penetrators and 49 fragments (equivalent to 16 whole penetrators) were removed. Around 200 kg of highly contaminated soil with activity between 10^4 and 3.5×10^6 Bq/kg was removed, and about 6m^3 of low radioactive material (about 7000kg) was removed and buried in a bunker near to the site. The work lasted 220 working days with a team of 10-15 professionals (seven civilian and eight military) and around 10 more in logistics.[113]

It was clear that even this detailed work was not sufficient to completely remove contamination from the sites. Many penetrators remain unaccounted for, many of them possibly more than 2m under the ground, and therefore undisturbed by the work. On average, across all sites where figures are available, only 6% of penetrators known to have been fired have been removed – although this average masks great variability. On sites in Serbia, BiH or Kosovo where only the removal of penetrators on the surface has been done, the number of penetrators removed is generally fewer than 10. However, where decontamination work has been done in Serbia and Montenegro, in some cases just over 50% of the penetrators have been removed – 328 penetrators in the case of Bratoselce.[114]

The Serbian authorities are clear that it is impossible to completely decontaminate the areas, and they work on the assumption that current efforts have not been sufficient.[115] With regards to the Cape Arza site in Montenegro, UNEP noted that most penetrators were probably intact somewhere on the site.[116]

As noted in a 2001 briefing on DU from Switzerland's Spiez Laboratory, which was involved in testing samples taken by UNEP, the use of uranium weapons: *"leaves behind a long-lasting contamination on the battlefields, which is not compatible with civil radiation protection norms. This argument holds independently whether or not - objectively - there is a danger to man and the environment."*[117]

Cost of decontamination

The total number of individual PGU-14/B DU projectiles fired at sites in Serbia was around 3,000. The GAU-8 gun on the A-10 fires at a speed of 3,900 rounds per minute, so mixed together with the high explosive rounds, this would represent 65 seconds of continuous firing.[118] In total, the decontamination work at these sites cost 116m Dinar[119] (equivalent to about $1.479 million US), and took approximately 41,000 working person-hours.[120]

The decontamination of the Cape Arza site in Montenegro cost DM 400,000 (almost $280,000 US) and took about 5,000 working person-days. This was to clean up 480 high explosive and DU rounds, which in total took less than eight seconds to fire. The site was situated in an important area for tourism, but at the time of UNEP's report, financial support was required to complete the decontamination programme.[121]

By comparison, the budget for the surface decontamination at the TRZ Hadžići site was 138,000 KM (about $96,000 US), to cover training in decontamination, printing information for the public, equipment, personnel and travel costs.[122]

Current status of sites

Following this work, the Serbian authorities have an active network of detectors that measure radiation in the air throughout the country. There are ongoing plans to monitor water, soil and air in order to ensure that there is minimal risk from the sites.[123]

The six sites in Serbia, such as Bukurevac, where no contamination has been found raise some interesting questions. It is possible that a small amount of contamination is present, but below the limit of detection; in which case there is little cause for concern. However, it is also possible that a significant number of penetrators are buried at the sites, but are not detectable from the surface. Another explanation is that the NATO coordinates are incorrect, and the contamination is elsewhere.

In BiH, no subsurface decontamination work has been done, but at the TRZ Hadžići site, removal of contaminated material and covering of impact hot spots has been undertaken. However, the ICBUW team was still able to detect the radioactive signature of uranium's decay products on the concourse using a handheld gamma detector – at one point above an impact hole this was more than 40 times the background radiation. Soil around the Hadžići TRZ is still known to be contaminated,[124] and there are thought to be more than 900 penetrators buried at the site.[125] Once the Hadžići Ammunition Storage Depot is cleared of mines and UXO, decontamination work may be required, as NATO figures suggest that between 1187 and 1900 DU rounds were fired at the site.[126] There is an ongoing monitoring programme for the groundwater in and around the TRZ Hadžići site but the authorities are less concerned about Rosca and Pjelugovici, because fewer rounds were fired there.[127]

In spite of extensive work, the six sites around Sarajevo have still not been identified,[128] and it is of great importance that NATO produces detailed information about these sites. The Han Pijesak site in Republika Srpska is still a military site, though it is not thought to currently be in use. Previous attempts to undertake decontamination there were frustrated by the lack of a radioactive waste storage facility.

As far as ICBUW is aware, no systematic decontamination has been undertaken on any sites in Kosovo, and as detailed above, there is very little capacity to study the current status of the sites. This is particularly problematic, as Kosovo accounts for


Serbian decontamination team sweeping soil for radioactive hotspots with the help of earth moving equipment at Borovac in 2007.


Serbian decontamination team removing the 'jacket' of a 30mm DU round at Borovac in 2007. Contaminated materials and soil from the site were removed to the Vinca Nuclear Institute near Belgrade for vacuum packing and indefinite storage in their low-level waste repository.

the vast majority of contaminated sites in the region: 85 sites (representing around 72% of the uranium weapons rounds fired in the Balkans), as opposed to 10 in Serbia (9% of the rounds), 11 in BiH (18%) and one in Montenegro (1%).[129]

During ICBUW's time in Kosovo we visited four sites, and did not locate any surface contamination – although we were not equipped for a proper survey, as this was not the purpose of our trip. We visited three sites that UNEP had previously visited: Gjakove/Djakovica garrison, Radoniq/Radonjick Lake and Rikavac. ICBUW also visited coordinate points that to the best of our knowledge had never been surveyed, in a field adjacent to the Rikavac site.

Although the Kosovo Environment Ministry assured us that they have taken steps to warn local people about the hazards of contamination, none of the people we spoke to on our visit to these sites seemed to have been warned. Neither were any of these sites marked (although marking sites where appropriate was one of UNEP's recommendations)[130] and a hazard sign that was visible in pictures of Radoniq/Radonjick Lake in UNEP's report was no longer there.[131] A field directly next to the coordinates beside Rikavac was being used to grow lettuces, and we were told that local people had filled in holes in the road where there were visible signs of the attack at Rikavac. Unfortunately, without proper environmental survey work, it is impossible to tell whether these activities put the local population at risk.

Long term consequences of contamination

In the long term, little is known about the consequences of uranium weapons contamination. Although at some sites the risk of resuspension of uranium is considered to be of greater concern in terms of human health, for most sites in the region the long term issue is likely to be groundwater contamination. Transport of DU in soils and groundwater is influenced by numerous environmental factors.[132]

The timescales involved can be extremely long – calculations by UNEP for sites in Kosovo for the time taken for uranium contamination to reach nearby wells give figures that range between one day at the lower band, and 312 years at the upper band. Given such uncertainties, it is clear that uranium weapon contamination saddles countries with a burden of environmental monitoring that could last several lifetimes.[133] This burden is increased by the cost of technology, such as ICP-MS, that can reliably differentiate between natural uranium and DU in the environment.

The standard practice is to try and estimate the possible consequences of contamination using computer models of uranium transport in soil, taking into account soil composition and other factors. In some cases where this has been done for actual strike sites, the results have suggested that significant contamination of groundwater could occur after some time has elapsed.[134] However, as the US Environmental Protection Agency notes, there is: *"much debate on the problems associated with existing models and little consensus on how chemical reactions and field parameters should be determined for field applications."*[135]

Even with ongoing monitoring, there are uncertainties regarding the safe levels of uranium in drinking water. The most recent WHO provisional guideline amount figure of 15 µg/litre is based on the calculation of a 60kg adult drinking two litres of water a day. However, as there is insufficient data on the carcinogenicity of uranium in either children or adults, this figure is based on a sub-chronic 91-day study done on rats, and is of questionable relevance to a human exposed to uranium in drinking water over a longer time period.[136]

When the uncertainty over the long term impact of contamination is coupled with its socioeconomic impact, it becomes clear that the best possible approach when implementing post-conflict management and decontamination procedures is a precautionary one. In practice, this means that decontamination work should aim to remove as much contamination from the environment as is feasible. Internationally, states should be transparent and open about the use of uranium weapons, as well as sharing expertise and providing technical assistance for decontamination.

7.0 Comparison with explosive ordnance disposal

At numerous sites, the presence of Anti-Personnel Mines (APM) and UXO is a complicating factor in the assessment of uranium weapons contamination. In 11 of the 26 sites visited in BiH, Kosovo and Serbia and Montenegro, UNEP was unable to make a full assessment due to the presence of mines and/or UXO.[137] During our visit we met with the national Mine Action Centres (MAC) in both BiH and Kosovo. While both were extremely helpful, it was clear that managing uranium weapons contamination was not a priority for either organisation, although it was recognised as being a complicating factor for some sites by the BiH MAC. In the Kosovo MAC, the issue was believed to have been dealt with by KFOR.

At least one of the contaminated sites in BiH, the Hadžići Ammunition Storage Depot, is still to be cleared of mines and UXO,[138] however the TRZ Hadžići site has undergone mine and UXO clearance. As previously mentioned, some work was done on the site prior to the release of information about the use of uranium weapons, which undoubtedly exposed the demining team to needless risk.

Where the presence of DU is known or suspected, a technical note is available, as part of the International Mine Action Standards, to guide demining teams and to help them to minimise risks.[139] However, this technical note is not binding, and is not clear how well versed actors in the demining world are in dealing with uranium weapons contamination. In the technical note, it makes it clear that in each country the National Mine Action Authority is responsible for warning all mine action agencies of any conflicts that have taken place and any history of the use of DU.[140] Without the users of uranium weapons making information available, it is hard to see how this could occur.

In the BiH Mine Action Standards – the procedure for mine and UXO clearance for the whole country, there is no mention of DU, and the document clearly states that all mines and UXO are to be destroyed in situ unless there are compelling reasons to do otherwise.[141] This clearly raises the possibility that contaminated material could become resuspended in the air. When the demining of the TRZ Hadžići site was being planned, this was a matter of some discussion, and it was decided that the more immediate risk was from moving mines or UXO.[142] ICBUW has no reason to query this judgement, but obliging deminers to face a choice between the risk of losing a limb and of increasing their risk of developing cancer later in life (as this quandary was characterised by one of our interviewees)[143] is far from ideal.

International legal status

In a legal context, a comparison between uranium weapons and Explosive Remnants of War (ERW) is instructive. While uranium weapons are not subject to any specific international regulations beyond the general obligations of international humanitarian law (IHL), ERW are the subject of various international norms, and obligations and procedures are well understood.

Although primary responsibility for providing information and coordinating demining activities falls to belligerents and those controlling territories containing explosive remnants of war, procedures exist for ensuring that the UN can establish mine action centres if necessary. There is also an established body of NGOs and private contractors with a wealth of experience and staff. Furthermore, many in the international community fund Explosive Ordnance Disposal (EOD) activities, whether or not they were involved in the original conflict. As such, there is an understanding that affected countries are not left to deal with this legacy of conflict themselves.

International treaty regimes apply to the use of APM, cluster bombs, and other explosive devices that may become post-conflict hazards. These include the Ottawa and Oslo treaties and Protocols II and V of the Convention on Certain Conventional Weapons.[144] Their use is also governed by IHL, as is the case with all weapons. While these norms are not sufficient to fully protect civilians from the effects of such weapons, they do serve to reduce the risks inherent in their use.

By contrast, the norms regarding the use of uranium weapons or other toxic remnants of war are those found within IHL, rather than treaties that cover them specifically. For example, the use of uranium weapons in areas where civilians may be at risk of exposure could breach the principle of distinguishing between combatants and civilians (codified in Article 51 of Additional Protocol I to the Geneva Conventions). Another relevant obligation is Article 57 of Additional Protocol I, under which parties are required to take all feasible steps to minimize the effects of military activities on civilians.

The International Committee of the Red Cross (ICRC) has identified one of the rules of customary IHL as being that all feasible precautions should be taken to minimise incidental damage to the environment, and that a lack of scientific certainty does not absolve a party from taking these precautions. Taken with Article 58 of Additional Protocol I, which obliges parties to take all necessary steps to protect the civilian population against the dangers resulting from military operations, there is a clear legal case that states should observe precaution both in the use of uranium weapons, and in decontaminating affected areas.[145] Considering the cost of decontamination, and the barriers to carrying it out effectively, the moral case is even stronger.

Unfortunately, despite these existing legal regimes, state users of uranium weapons do not seem to have placed any restrictions on their use, citing the unresolved scientific issues surrounding their long-term impact as justification. After conflict, as the experience of the Balkan states shows, there has been little international focus on assisting states to quantify the problem, study any effects and to remediate sites. Contamination has apparently been left to individual states to resolve, as one of many other competing priorities. There is an immediate need for transparency over the use of uranium weapons, and technical assistance with decontamination. In the medium term states should consider whether there is a case for focused international measures that address the specific characteristics of uranium weapons.

While some may contend that ERW constitute a greater risk than uranium weapons contamination, and this justifies the disparity between the two legal regimes, this position is hard to support, either scientifically or morally. From the experience of the Balkan countries it is quite clear that one cannot with any confidence estimate how many people have been exposed to uranium weapons contamination, or quantify the risk to these people. Whatever the relative risks, it is clear that all feasible steps to reduce harm and to protect civilians and the environment have not been taken.

While the threat posed by ERW is more direct, this should not prevent action on uranium weapons. The potential for harm, and the difficulties of decontamination, necessitate that the international community engage more fully with the issue. Countries affected by DU contamination can scarcely be expected to leave potentially hazardous contamination untreated because of a lack of scientific clarity.

8.0 Implications for Iraq and other conflicts

Had NATO forces been employed in greater numbers, or had they engaged in a ground war, the uranium weapons contamination in the Balkans would almost certainly have been far greater. As it was, the A-10's GAU-8 cannon was used on comparatively few occasions. The reasons for this are specific to these conflicts, and therefore no reason for complacency about the scope of contamination during future conflicts.

In the case of Kosovo, where the ostensible purpose of military action was to attack Serb units suspected of human rights violations in Kosovo, US Air Command favoured targeting infrastructure in the rest of Serbia instead. Efforts to locate Serb ground units within Kosovo – the type of engagement for which the A-10 was designed – were *"almost completely ineffective"*, and gave little opportunity for the GAU-8 to be used.[146]

Furthermore, due to an ongoing threat of Serbian surface to air missiles during the conflict and the perceived political unacceptability of NATO casualties, most NATO aircraft were restricted to altitudes of over 15,000 ft. For the few to which this restriction did not apply, the limit was 5,000 ft – but even at this height, with the angle towards the ground taken into account, targets were so far away it was almost impossible for pilots to see them.[147] As a result, in a conflict that saw 23,000 combat missions against 11,000 fixed and moving targets, with 28,000 munitions expended,[148] the A-10s fired their cannons a total of 156 times against 96 targets.[149] Without this specific military context, and the political decision not to use ground forces, the consequences described in this report could have been far more severe.

While the use of A-10s in the Balkan conflicts was extremely limited, this was not the case in Iraq. In the 1991 Gulf War, A-10s were thought to be responsible for destroying: 987 tanks, 926 artillery pieces, 501 Armoured Personnel Carriers and 1,106 trucks, as well as Scud missile and Surface to Air Missile (SAM) sites and two helicopters.[150] This can be compared to the Pentagon's figures of 93 tanks, 153 APCs, 339 other military vehicles and 339 artillery and mortars destroyed by all NATO forces in the Kosovo conflict.

As a result, and because of the other platforms firing uranium weapons, the estimated quantity of uranium weapons fired in Iraq in 1991 and 2003 is at least 57 times higher than the total expended in the Balkans.

Iraq has suffered three major wars since the 1980s, a decade of sanctions and a low intensity war since 2003 in which middle class professionals (such as doctors and scientists) have been specifically targeted for kidnappings or killings. It therefore follows that the challenges faced by Iraq in environmental surveying, conducting health studies and decontamination, are likely to be much greater than anywhere in the Balkans. By almost any measure, the situation of uranium weapon contamination in Iraq is many times worse than that of the Balkans, and the need for international assistance many times greater.

While the experience of the Balkans may be instructive when considering Iraq, it is worth bearing in mind that the contamination picture from tank based uranium weapons may be very different from A-10 fire. Instead of penetrators driven into the ground, much more contamination may be on the surface, or may become aerosolised. Similarly, the different soil types, land use and climate in Iraq could mean that the characteristics of contamination are very different. For that reason, extensive fieldwork, and risk reduction programmes with international assistance are urgently required. While the UK Department for International Development (DfID) funded a UNEP run programme to train Iraqi nationals to assess the extent of contamination, this was limited in scope, and UNEP has called for the international community to fund future projects by the Iraqi Environment Ministry.[151]

9.0 Recommendations

Because of the number of unanswered scientific questions relating to the potential impact of uranium weapons, ICBUW has long advocated a precautionary approach to their use. The findings of this report, which highlight the almost complete lack of regulations governing their use and post-conflict management, serve only to strengthen that call.

It is clear from the experience of the Balkan countries that, more than a decade on from the use of uranium weapons, much still needs to be done to address the legacy of contamination and reduce the potential risk to civilians. Again, precaution is the principle that should be applied in decontamination. The recommendations made by UNEP in their three reports remain the most authoritative standard for reducing risk. As far as ICBUW has been able ascertain, nowhere have they been implemented in full. It is to be hoped that a renewed focus on the issues identified in this report can help to remedy this situation.

Health studies

Comprehensive and well designed health studies are of paramount importance in order to establish the actual health consequences of uranium weapons use. The type of study recommended by UNEP in their report on BiH is one possible approach.[152] This report has mentioned some promising early studies that could be built upon, and also analysed some of the issues which need to be dealt with in the design of future studies. One major population in the region that has not been studied are soldiers who were present at the time of attacks using uranium weapons.

Any work with potentially exposed populations requires careful interaction to identify those individuals most at risk from contamination, and it is important to provide meaningful feedback to local populations afterwards.

Because of the difficulties of identifying the subjects most at risk of exposure, there is a clear need for health studies on the few people who are known to have been exposed. Although there are no populations within the Balkans where exposure has been confirmed, studies on exposed populations elsewhere in the world could serve this purpose.[153]

Capacity building

One major finding of this report is the differences in capacity across the region for environmental surveying, health studies and decontamination work. While those working on the issue in Serbia were quite willing to offer their expertise to assist with this work, the ongoing dispute over the status of Kosovo will make it difficult for this expertise to get to where it is most needed. Nonetheless, any assistance from the international community in these areas should be directed towards focused capacity building, and in strengthening links between researchers and institutions from different parts of the region.

Facilitating effective decontamination and reducing risk

In the immediate future, the problems surrounding effective monitoring and cleanup show that without a step change in international efforts on this issue, it will be impossible to either quantify or reduce the risks to civilians. An obvious first step is user transparency. Data on sites where DU has been used should be made available to affected countries and organisations as soon after the cessation of hostilities as is feasible. This places an onus on combatants to ensure the retention of accurate strike data. Given the challenges involved in identifying strike sites in the field, any information supplied should be as detailed as possible.

Related to this is the need for information about the history of sites after conflicts. All relevant authorities should review their records and release information about any activities undertaken at strike sites, particularly anything that may have removed or disturbed DU contamination. Studies specifically assessing the proportion of penetrators that remain intact after A-10 strikes on different surface, soil and vegetation types would also be helpful for post-conflict assessment.

States should also consider how best to ensure that capacity exists to undertake marking, monitoring and clearance work. Sharing of technical capacity and expertise is an obvious first step, as is integrating knowledge with existing post-conflict mechanisms for dealing with ERW. Thought should be given to where such activities are best located within current international frameworks – to some extent this depends upon how any measures to ameliorate the consequences of DU use are implemented.

While UNEP's work on this issue has added inestimably to the current understanding of the problem, it relied upon the participation of outside experts and funding for limited projects, so there is no guarantee that they would have the capacity for further work. Comprehensive cleanup work would need to be constituted quite differently, and while outside expertise would necessarily play a role, the creation of semi-permanent international capacity for such work should be seriously considered in order to deal with both existing contamination and long-term monitoring.

Interested parties should work together to develop standards for decontamination and monitoring, incorporating both scientific input and the experience of those who have had to live with the consequences of contamination. This should be coupled with rigorous procedures for hazard awareness, and providing information to local populations. Given the ongoing uncertainties over the long-term health impact and environmental behaviour of uranium weapons contamination, clearance should be guided by precaution and sites should be fully cleared of contamination wherever possible.

Conclusion

The status quo has been shown to be little more than a lottery, with outcomes seemingly dependent on the arbitrary decisions of users of the weapons and on the administrative structures in place following the conclusion of conflicts. From such a low starting point there is considerable opportunity to reduce the risk from these weapon systems and simultaneously increase our understanding of their long-term impact.

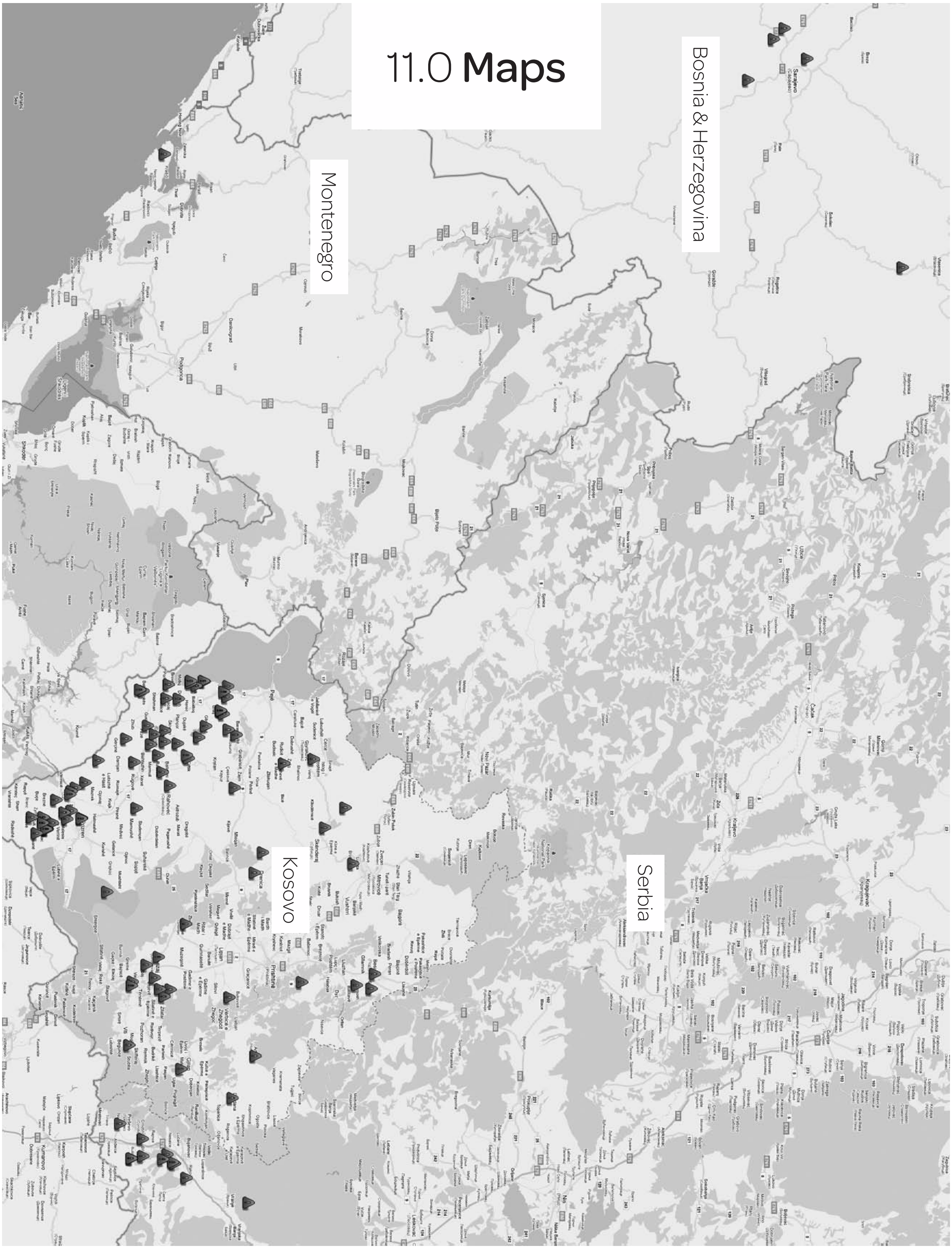
ICBUW believes that the concerns raised in this report add to the already compelling arguments in favour of implementing a specific legal mechanism restricting the use of uranium weapons.

10.0 Endnotes

1. See pages 24-27 for a list of NATO coordinates and figures for number of rounds fired. In BiH the number of rounds comes to 6,780. In Kosovo, Serbia and Montenegro, the number of rounds comes to 31,168. These figures were calculated using an assumed 5:8 DU ammunition mix in both conflicts, and a 300g penetrator weight. They do not include strikes where NATO has not provided figures for the number of rounds fired (a discussion of these issues can be found in the 'Transparency' section of this report).
2. Interview with Dr. Zora Žunić, Vinča Institute of Nuclear Sciences, Belgrade, 7th April 2010
3. See, for example, Alex Kirby, "Pentagon confirms depleted uranium use," BBC, May 7, 1999, sec. Sci/Tech, http://news.bbc.co.uk/1/hi/sci/tech/337855.stm.
4. UNEP/UNCHS Balkans Task Force (BTF), The potential effects on human health and the environment arising from possible use of depleted uranium during the 1999 Kosovo conflict: A preliminary assessment, 1999.
5. World Health Organization, Report of the World Health Organization Depleted Uranium Mission to Kosovo, 2001.
6. "Data concerning the locations of depleted uranium ordnance expended during Allied Operations Deny Flight-Deliberate Force, 1993-95 in Bosnia (grid co-ordinates)," January 24, 2001, http://www.nato.int/du/docu/d010124b.htm.
7. Strike no. 11 (4203N02030E) appears to be in a different format to the other coordinates and to refer to a location in Albania; strike no. 39 (34TEM209103) appears to indicate a site in Macedonia – a report by the UK MoD suggests that the correct coordinates are 34TEN209103; strike no. 59 (34TDM54938) appears to be invalid as it contains an odd number of digits. See "Data concerning the locations of depleted uranium ordnance expended during Operation Allied Force (grid co-ordinates)," January 24, 2001, http://www.nato.int/du/docu/d010124a.
8. Factsheet supplied to ICBUW team by Kosovo Environment Ministry
9. OSAGWI, HRA CONSULTATION No. 26-MF-7555-00D - APPENDIX R- Aerial Use of DU During the Gulf War, September 2000, http://www.gulflink.osd.mil/appendix_r.pdf. p2.
10. Report of the World Health Organization Depleted Uranium Mission to Kosovo. Op cit. p21
11. United Nations Environment Programme, Depleted Uranium in Serbia and Montenegro: Post-Conflict Environmental Assessment in the Federal Republic of Yugoslavia, 2002; Chief Environment and Safety Officer (MOD), Report of a Reconnaissance Visit to Develop an Enhanced Environmental Monitoring Programme in the British-led Sector in Kosovo (Ministry of Defence, June 2001), http://www.mod.uk/NR/rdonlyres/B59DB5F0-24FC-46EF-92B6-9AA7924406B5/0/eemp_rec_report.pdf.
12. United Nations Environment Programme, Depleted Uranium in Bosnia and Herzegovina: Post-Conflict Environmental Assessment, revised ed., 2003. pp266-267.
13. Ibid. pp72
14. Interview with Slaviša Simić, Head of Department for Ionizing and Non-Ionizing Radiation Protection, April 9, 2010.
15. Interview with Simić. Op cit.
16. Chief Environment and Safety Officer (MOD). Op cit. p9.
17. Interview with Zijad Fazlagić, General Manager, TRZ Hadžići, April 3, 2010.
18. Interview with Divna Sirko, Head of the Radiation Protection Center, Delveta Deljkic, physicist, Alfred Vidic, chemist, Institute of Public Health of Federation of Bosnia and Herzegovina and Dr Irena Jokic, Department for Social Medicine and Organization of Health Service, Sarajevo, March 29, 2010.
19. Interview with Dr Stevan Jović, Agency for Radiological Protection, Banja Luka, March 30, 2010.
20. Interview with Dr. Željmira Ilić, Coordinator for Health Surveillance, Snežana Pavlović, Coordinator for Radiation Security, Dr. Nataša Lazarevic, Coordinator for Decontamination of Work and Life Environment, Dr Milan Orlić and Dr Zora Žunić, Nuclear facilities of Serbia and Vinča Institute of Nuclear Sciences, April 7, 2010.
21. Ibid; See also Milan Zarić, Slobodan Petković, and Zoran Dević, "The use of depleted uranium ammunition during NATO aggression against the Federal Republic of Yugoslavia," Archive of Oncology 9, no. 4 (2001): 215-217.
22. David Smith and Ronald Brown, Radiological Assessment of Depleted Uranium Impact Locations in Iraq (Defence Science & Technology Laboratory Environmental Sciences Department, 2006), http://www.colloquium.fr/06IRPA/CDROM/docs/P-210.pdf
23. John Barry and Evan Thomas, "The Kosovo Cover-Up," NewsWeek, May 15, 2000, http://www.newsweek.com/2000/05/14/the-kosovo-cover-up.html.
24. These sites were Gjakove/Djakovica garrison and Iznic/Rznic barracks. See United Nations Environment Programme, Depleted Uranium in Kosovo: Post-Conflict Environmental Assessment, 2001. p40-49; p64-70
25. Muhamet Malsiu, Director of Environment Department, Ministry of Environment and Spatial Planning, Kosovo, April 5, 2010
26. Interview with Ilić, Pavolvic, Lazarevic, Orlić and Žunić. Op cit. Interview with Simić. Op cit.
27. Depleted Uranium in Serbia and Montenegro. Op cit. pp46-48.
28. Interview with Elizabet Paunović, Ministry of Health, Dr Aleksandar Milovanovic, Institute of Occupational and Radiological Health, Gordana Pantelić, Head of the Laboratory for Radioecology, Belgrade, April 9, 2010.
29. Chief Environment and Safety Officer (MOD). Op cit.
30. Interview with Paunović, Milovanovic, and Pantelić. Op cit.
31. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
32. Authors personal communication with Dr Radomir Kovacevic, Radiology Department, Belgrade
33. Interview with Jović. Op cit.
34. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
35. Interview with Malsiu. Op cit.
36. Interview with Jović. Op cit.
37. Interview with Dr Radomir Kovacevic, Head of Radiology Department. Dr Snežana Milacić, Medical Faculty of the University of Belgrade, Dr Bogoljub Pericic, Deputy Director of the Institute of Occupational and Radiological Health, Dr Aleksandar Milovanovic, Director of the Institute of Occupational and Radiological Health, Gordana Pantelić, Head of the Laboratory for Radioecology, Irena Tanasković, Milena Zdravkovic, Belgrade, April 8, 2010
38. Total U238 in the samples was measured at 2.68 and 0.749 µg/litre respectively. See United Nations Environment Programme, Depleted Uranium in Bosnia and Herzegovina: Post-Conflict Environmental Assessment, revised ed., 2003. p192.
39. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
40. Author's personal communication with PerkinElmer Inc.
41. Interview with Simić. Op cit.
42. See Depleted Uranium in Serbia and Montenegro. Op cit. pp 71-78.
43. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
44. See Depleted Uranium in Kosovo. Op cit.
45. Interview with Malsiu. Op cit.
46. In October 2009 the International Agency for Research on Cancer (IARC) reaffirmed that all materials emitting alpha radiation within the body are carcinogens. See F. El Ghissassi et al., "A review of human carcinogens–part D: radiation," The Lancet Oncology 10, no. 8 (2009): 751–752.
47. See Ian Fairlie, "The health hazards of depleted uranium," Disarmament Forum 2008, no. 3 (2008): 3-15.
48. Interview with Ilić, Pavolvic, Lazarevic, Orlić and Žunić. Op cit; Interview with Simić. Op Cit.
49. Alfred Vidic, Institute for Public Health of Federation of B&H, "Depleted Uranium Monitoring in Selected Sites of Bosnia Herzegovina" (Depleted Uranium Research: An Update, Rome, December 17, 2008), http://www.iss.it/binary/tesa/cont/Vidic_presetazione.pdf.
50. Wayne Briner, "The Toxicity of Depleted Uranium," International Journal of Environmental Research and Public Health 7, no. 1 (1, 2010): 303-313.
51. Interview with Jović. Op cit. See also Bosnia and Herzegovina: Report on the Consequences of Use of Weapons and Ammunition Containing Depleted Uranium - Report to the UN Secretary General [full report], 2008, Available at www.bandepleteduranium.org.
52. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
53. Interview with Paunović, Milovanovic, and Pantelić. Op cit.
54. Interview with Dr. Curr Gjocaj, Director of Health Services at the Kosovo Ministry of Health, April 6, 2010.
55. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
56. Interview with Dr. Zvonko Radosavljević, North Mitrovica Hospital, April 3, 2010.
57. Interview with Fazlagić. Op cit.
58. Interview with Ilić, Pavolvic, Lazarevic, Orlić and Žunić. Op cit.
59. Randall R. Parrish et al., "Depleted uranium contamination by inhalation exposure and its detection after ~ 20 years: Implications for human health assessment," Journal of Science of the Total Environment 390, no. 1 (2008): 58-68.
60. For example: UBA (2005). Uran und Human-Biomonitoring - Stellungnahme der Kommission Human-Biomonitoring des Umweltbundesamtes. Bundesgesundheitsbl-Gesundheitsforsch-Gesundheitsschutz 7, p822-827; Galletti, M., D'Annibale, L., Pinto, V., and Cremisini, C. (2003). Uranium daily intake and urinary excretion: a preliminary study in Italy. Health Phys 85, 228-235; Oeh, U., Li, W. B., Hollriegl, V., Giussani, A., Schramel, P., Roth, P., and Paretzke, H. G. (2007a). Daily uranium excretion in German peacekeeping personnel serving on the Balkans compared to ICRP model prediction. Radiat Prot Dosimetry 127, 329-332.
61. Nick D. Priest and M. Thirlwall, "Early results of studies on the levels of depleted uranium excreted by Balkan residents," Archive of Oncology 9, no. 4 (2001): 237-240.
62. U. Oeh et al., "Measurements of daily urinary uranium excretion in German peacekeeping personnel and residents of the Kosovo region to assess potential intakes of depleted uranium (DU)," Science of The Total Environment 381, no. 1 (August 1, 2007): 77-87.
63. Interview with Anja and Sanin Haverić, Institute for Genetic Engineering and Biotechnology, Sarajevo, March 31, 2010. See also Anja Krunić, Sanin Haverić, and Slavka Ibrulj, "Micronuclei frequencies in peripheral blood lymphocytes of individuals exposed to depleted uranium," Arhiv Za Higijenu Rada I Toksikologiju 56, no. 3 (September 2005): 227-232.
64. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
65. Author's personal communication with Dr Irena Jokić, Institute of Public Health of the Federation of Bosnia and Herzegovina
66. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
67. Snezana Milacić et al., "Examination of the health status of populations from depleted-uranium-contaminated regions," Environmental Research 95, no. 1 (May 2004): 2-10.
68. Interview with Kovacevic, Milacić, Pericic, Milovanovic, Pantelić, Tanasković and Zdravkovic. Op cit.

69. Interview with Fazlagić. Op cit.
70. Interview with Fazlagić. Op cit. See also Depleted Uranium in Bosnia and Herzegovina. Op cit p123; David Taylor, "SFOR takes the scientific approach to DU ammunition," NATO/SFOR Informer, January 24, 2001, http://www.nato.int/sfor/indexinf/105/s105p03a/t0101243a.htm
71. Vidic 2008. Op cit.
72. Interview with Fazlagić. Op cit.
73. Interview with Fazlagić. Op cit.
74. Interview with Fazlagić. Op cit.
75. Interview with Žunić. Op cit.
76. See pages 23-24 for a summary of UNEP's recommendations
77. Interview with Fazlagić. Op cit.
78. Interview with Fazlagić. Op cit.
79. Interview with Simić. Op cit.
80. Interview with Malsiu. Op cit.; Interview with Paunović, Milovanovic, and Pantelić. Op cit.
81. Depleted Uranium in Kosovo. Op cit. pp55-64
82. "SFOR and Tuzla Cantonal Government on Seljublje case: Destruction of weapons is not related to cancer cases," SFOR - Main News Summary, September 11, 2003, http://www.nato.int/sfor/media/2003/ms030911t.htm.
83. Interview with Radosavljević. Op cit.
84. HRA CONSULTATION Appendix R. Op cit. p1.p1.
85. Interview with Simić. Op cit.
86. Depleted Uranium in Bosnia and Herzegovina. Op cit. p25.
87. Richard Moyes and Landmine Action., Cluster munitions in Kosovo: analysis of use, contamination and casualties. (London: Landmine Action, 2007). p34
88. See Chief Environment and Safety Officer (MOD). Op cit.
89. Interview with Fazlagić. Op cit; See also 'SFOR takes the scientific approach to DU ammunition'. Op cit.
90. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.; See also United Nations Environment Programme., Depleted Uranium in Bosnia and Herzegovina. Op cit. p123
91. Interview with Kovacevic, Milacić, Pericic, Milovanovic, Pantelić, Tanasković and Zdravkovic. Op cit.
92. Depleted Uranium in Serbia and Montenegro. Op cit. p33; Depleted Uranium in Kosovo. Op cit. p35; Depleted Uranium in Bosnia and Herzegovina. Op cit. p49
93. Markus Bentler, "Letter from Headquarters Kosovo Force to ICBUW Coordinator Doug Weir," July 12, 2010.
94. Depleted Uranium in Kosovo. Op cit. p37
95. Factsheet supplied to ICBUW team by Kosovo Environment Ministry
96. A.Benedetti, "Presentation by A.Benedetti, CISAM-Pisa (English translation)," February 5, 2001, http://www.nato.int/du/docu/d010205-it/start.htm; Chief Environment and Safety Officer (MOD). Op cit.
97. See Depleted Uranium in Kosovo. Op cit. p40.
98. Depleted Uranium in Kosovo. Op cit. p79.
99. Interview with Radosavljević. Op cit.
100. UNEP's recommendations are summarised on pages 23-24
101. Interview with Malsiu. Op cit.
102. See Depleted Uranium in Serbia and Montenegro. Op cit. pp71-78.
103. The Republic Of Serbia: Positions On The Effects Of The Use Of Armaments And Ammunitions Containing Depleted Uranium – Report to the UN Secretary General [full report], 2008. Available at www.bandepleteduranium.org
104. Depleted Uranium in Serbia and Montenegro. Op cit. pp61-64.
105. Interview with Simić. Op cit.
106. Interview with Simić. Op cit; Authors personal communication with Slaviša Simić
107. Interview with Simić. Op cit.
108. Interview with Žunić. Op cit.
109. Depleted Uranium in Serbia and Montenegro. Op cit. p51.
110. о резултатима санације локација контаминираних осиромашеним ураном [Results of the rehabilitation of sites contaminated with depleted uranium]' (Department for Ionizing and Nonionizing Radiation Protection, Serbia, n.d).
111. Ibid.
112. Ibid.
113. Zora S. Žunić and Nada R.Miljevic, Environmental and health impact assessment of ammunition containing transuranic elements (Vinča Institute of Nuclear Sciences, n.d). p20.
114. All figures are available in the tables on pages 24-27.
115. Interview with Simić. Op cit.
116. See Depleted Uranium in Serbia and Montenegro. Op cit. p75; It should be noted that after later phases of decontamination, just over 50% of the penetrators were recovered. See tables on pages 24-27.
117. E. Schmid and Ch. Wirz, "Depleted Uranium - Background Information on a Current Topic," AC-Laboratorium Spiez, May 2000, http://www.nato.int/du/docu/d000500e.htm.
118. NATO data for strikes at these sites gives a total of 3,270 rounds (see table on pages 24-27). Using the average figure from these strikes (251 rounds) for strikes with unknown numbers of rounds, including Pljackovica, this gives a total of 4,274 rounds fired at these sites. Assuming a mix of 5:8 DU rounds, that gives a figure of 2,671 DU projectiles fired over the four sites. As the rate of the GAU-8 is 3,900 rounds per minute, 4,274 rounds represents 1 minute and 5 seconds of continuous firing
119. о резултатима санације локација контаминираних осиромашеним ураном [Results of the rehabilitation of sites contaminated with depleted uranium.] Op Cit.
120. Calculated by author following personal communication with Slaviša Simić
121. See Depleted Uranium in Serbia and Montenegro. Op cit. pp70-73.
122. See "The removal of depleted uranium fragments will take one year," SFOR Main News Summary Sunday, 31 August 2003, 2003, http://www.nato.int/sfor/media/2003/ms030831t.htm.
123. Interview with Simić. Op cit.
124. "Depleted Uranium Monitoring In Selected Sites Of Bosnia Herzegovina". Op cit.
125. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
126. NATO figures state that 1900 rounds were fired at the site. It is not known what proportion of these rounds were PGU-14/B with a DU penetrator. A discussion of the uncertainties can be found in the 'Transparency' section of this report.
127. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
128. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
129. Of the strikes where NATO gives figures for the number of rounds, Kosovo sites total 27,418 rounds; Serbian sites total 3,270 rounds; the site in Montenegro totals 480 rounds and the sites in BiH total 6,780 rounds. Together these numbers total 37,948. Treating these numbers as comparable assumes that in BiH the ratio of PGU-14/B and PGU-13 used was the same as in the Kosovo conflict. The six sites in BiH where the number of rounds fired is unknown have a distorting effect on these figures.
130. UNEP's recommendations are summarised on pages 23-24
131. Depleted Uranium in Kosovo. Op cit. p38.
132. United States Environmental Protection Agency, Depleted Uranium Technical Brief, December 2006. p5.
133. Depleted Uranium in Kosovo. Op cit. p152-154
134. See Marco Durante and Mariagabriella Pugliese, "Depleted uranium residual radiological risk assessment for Kosovo sites," Journal of Environmental Radioactivity 64, no. 2 (2003): 237-245; Cristina Giannardi and Daniele Dominici, "Military use of depleted uranium: assessment of prolonged population exposure," Journal of Environmental Radioactivity 64, no. 2 (2003): 227-236.
135. Depleted Uranium Technical Brief. Op cit.p8
136. World Health Organization, Uranium in Drinking-water Background Document for Development of WHO Guidelines for Drinking-water Quality, 2005, http://www.who.int/water_sanitation_health/dwq/chemicals/uranium290605.pdf.
137. In BiH the sites were – former Hadžići Tank Repair Facility, Hadžići Ammunition Storage Depot, Rosca, and the Vogosca Ammunition Production Facility. In Kosovo they were Bandera & Pozhare/Pozar, Rikavac, Ceja mountain, Kuke/Kokovce and Buzesh/Buzec. See relevant UNEP reports for more information.
138. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
139. Geneva International Centre for Humanitarian Demining, Clearance of Depleted Uranium (DU) hazards, V2, 2001.
140. ibid. p10
141. Bosnia And Herzegovina Mine Action Centre, Standard For Mine Clearance And EOD Operations In Bosnia And Herzegovina, March 15, 2004, http://www.mineactionstandards.org/standards/BosniaHerzegovina-NMAS-MineAndEodClearance-2004.pdf.
142. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
143. Interview with Sirko, Deljkic, Vidic, and Jokic. Op cit.
144. See International Committee of the Red Cross, Weapon contamination manual: Reducing the impact of explosive remnants of war and landmines through field activities, 3 vols. (Geneva, 2007). pp91-99
145. A longer discussion of these matters can be found in the ICBUW legal briefing - http://www.bandepleteduranium.org/en/i/63.html and also in Avril McDonald, "Depleted uranium weapons: the next target for disarmament?," Disarmament Forum 2008, no. 3 (2008): 17-24. Available at http://www.bandepleteduranium.org/en/docs/74.pdf
146. Benjamin Lambeth and United States; Project Air Force (U.S.), NATO's air war for Kosovo: a strategic and operational assessment (Santa Monica CA: Rand, 2001), http://www.rand.org/pubs/monograph_reports/MR1365/index.html. p xvi.
147. ibid. p52
148. ibid. pp61-64
149. Locations of depleted uranium ordnance expended during Operation Allied Force. Op cit.
150. David R. Jacques and Dennis D. Strouble, A-10 Thunderbolt II (Warthog) Systems Engineering Case Study (Air Force Center for Systems Engineering, n.d), http://www.afit.edu/cse/csdl.cfm?case=21&p=0&file=A%2D10%20Case%20Study%20Final%20Med%20Quality%20for%20Posting2%2Epdf
151. United Nations Environment Programme, Technical Report on Capacity-building for the Assessment of Depleted Uranium in Iraq (Geneva, August 2007).
152. Depleted Uranium in Bosnia and Herzegovina. Op cit. p60
153. One promising example is a group who lived close to a factory involved in the manufacture of uranium weapons in Colonie, New York State. See Parrish (2008) Op cit. Unfortunately, studies done under the auspices of the US Department of Veterans Affairs on another exposed group - US soldiers involved in friendly fire incidents - are not as useful as they may at first appear. A Congressionally-mandated committee on Gulf War Illness found that, in these studies occurrence of tumours in subjects had failed to be reported, significant findings were not followed up and overall the studies have failed to answer important questions about the health effects of DU exposure. See Research Advisory Committee on Gulf War Veterans' Illnesses, Gulf War Illness and the Health of Gulf War Veterans: Scientific Findings and Recommendations (Washington, D.C: U.S. Government Printing Office, November 2008). pp96-99

11.0 Maps



Map of Bosnia Herzegovina, Montenegro, southern Serbia and Kosovo

(Above) regional map showing DU strike sites based on coordinates supplied by NATO. Incorrect coordinates have been excluded from the map and some locations were struck repeatedly. A more detailed map of the southern Serbia/Kosovo area is shown on the opposite page. Please note that coordinates have been translated using online tools. Every effort has been made to accurately place markers, but these maps should be used as a guide only. Data also reproduced as Google Maps of known uranium weapons strike sites in the Balkans: http://goo.gl/9XjF


Prishtinë
Prizren
Ferizaj
Pejë
Gjilan
Kumanovo
Vranje
Dranica

11.0 Appendix

The recommendations below are summarised. For the full detailed recommendations, please refer to the relevant UNEP report. These spreadsheets are available online at: http://goo.gl/DCGs

UNEP general recommendations for all Kosovo sites	**Site name**										
1. All sites to be examined & assessed for cleanup. KFOR & NATO to be involved because of mines & UXO											
2. Sites should be marked where appropriate											
3. Penetrators & jackets should be collected and disposed of											
4. Decontamination of contamination points where feasible & justifiable											
5. Ongoing testing of groundwater											
6. Consider presence of transuranic elements in DU during analysis											
7. Inform local population, possibly integrated with mine awareness programmes											
8. Implement site-specific recommendations (see below)											
9. Further scientific work should be carried out to reduce scientific uncertainties											
10. Scientific work should be done in BiH											
Site specific recommendations for sites in Kosovo	**Gjakove/Djakovica garrison**	**Vranoc/Vranovac hill**	**Radoniq/Radonjick lake**	**Irzniq/Rznic barracks**	**Bandera and Pozhare/Pozar**	**Rikavac**	**Ceja mountain**	**Planeje/Planeja village**	**Bellobrade/Belobrod**	**Kuke/Kokovce**	**Buzesh/Buzec**
Inform local people about risk from penetrators & jackets	•	•	•	•	•	•	•	•	•		•
Sample local wells	•	•		•	•	•		•	•		•
Clean platform or cover with concrete	•										
Study site properly once cleared of UXO & APM					•	•	•	•	•	•	•
Repair road to cover contaminated holes						•					

UNEP recommendations for all Serbia and Montenegro sites	**Site name**						
1. All sites to be examined & assessed for cleanup							
2. Authorities to consider removing the fences at sites where this is recommended (see below)							
3. All penetrators and jackets should be collected and disposed of							
4. Decontamination where feasible & justifiable							
5. Groundwater should be tested periodically							
6. Inform local population, possibly integrated with mine awareness programmes							
7. Documentation kept at sites including how many penetrators are thought to be buried							
8. Decontamination to be considered on the basis of resuspension risk vs. risk of continued contamination							
9. Contingency plans should be place before disturbing soil at the sites							
10. Implement changes for radioactive waste storage in Vinca							
11. Information about strike sites should be released quickly							
12. Check transuranic content of uranium weapons during future testing							
13. Biomonitoring of bark and lichen can be used to check airborne DU content over time							
14. Medical attention should be provided to personnel exposed to high levels of DU							
15. All claims of health effects of DU should be investigated by health authorities							
16. Implement site-specific recommendations (see below)							
17. Further scientific work should be carried out to reduce uncertainties							
18. Scientific work should be carried out in other affected areas							
Site specific recommendations for sites in Serbia & Montenegro	**Pljackovica**	**Vranje garrison – DU-targeted military vehicle**	**Borovac**	**Bratoselce**	**Bukurevac**	**Reljan**	**Cape Arza**
Once site is decontaminated, fence can be taken down	•						
Fence should be kept up				•			
Fence can be removed			•			•	
Re-survey the area up to 100m away from the fence as a precaution	•		•			•	
Neither the area inside or outside the fence requires general decontamination	•						
Information signs should be put up at the site	•		•	•		•	•
Annual water sampling	•		•				
Clearing up fragments & wet cleaning is sufficient decontamination		•					
Crew should get health monitoring and medical care		•					
No part of site needs general decontamination, except any localised contamination found during re-survey			•	•		•	
Densely vegetated area within fence, and up to 100m outside should be re-surveyed				•			
Nearest well is over 700m away, but regular sampling should be considered				•			
Whole area should be searched more thoroughly after UXO clearance, if possible check coordinates					•		
Information should be passed on to local population					•		
Consider further action if contamination found in the future					•		
Already decontaminated area is practically clean, but final survey should be done							•
After final check decontaminated area is fit for public access							•
Survey and decontaminate unsurveyed part of the site							•
Out of scientific interest, it is worth measuring the uranium content of the air when no people present							•

UNEP recommendations for all Bosnia & Herzegovina sites	Site name				
	Hadzici Tank Repair Facility	Hadzici Ammunition Storage Depot	Rosca	Pjelugovici - T55 Tank	Han Pijesak artillery storage and barracks
1. Measure contamination and detect possible DU at sites					
2. Decontaminate contamination points					
3. Handle and dispose of DU properly					
4. Keep records of everything known about the DU sites					
5. Appropriate planning should be undertaken prior to any soil disturbance					
6. Clean the contaminated buildings					
7. Test drinking water annually					
8. Avoid contaminated water					
9. Do not transport DU to ammunition destruction sites					
10. Implement site-specific recommendations (see below)					
11. NATO should release the missing DU coordinates					
12. Further scientific work should be carried out to reduce uncertainties					
13. Inform the civilian population and military and mine clearing personnel					
14. Train experts for DU decontamination					
15. Investigate all health claims					
16. Develop descriptive and analytical epidemiological studies					
17. Develop health cooperation between Federation of BiH and Republika Srpska					
18. Strengthen the radiation safety authorities					
19. Improve radiation safety cooperation between FBiH and Republika Srpska					
20. Build facilities for radioactive waste treatment and storage					
21. Mitigation of all radioactive waste					
22. Monitor the targeted sites for radioactivity					
23. Use proper measures to avoid heavy metal contamination					
24. Investigate other regions where DU has been used					
Site specific recommendations for sites in Bosnia & Herzegovina					
All penetrators and fragments on the surface to be removed	•	•			
All contamination points should be cleaned of loose contamination and contaminated soil	•				•
Holes of buried penetrators should be covered by asphalt, concrete or clean soil	•				
All buildings on sites should be searched for loose contamination	•				
Mend damaged water pipeline & check drinking water annually	•				
Clean contaminated buildings	•				•
Consider presence of penetrators during mine clearance	•	•			
Radioactive lightning rods (not DU) might be a risk. Remove & dispose	•				
Information to be provided to civilian, military and demining personnel	•	•	•		•
When the area is clear of mines & UXO, it should be searched thoroughly for DU	•	•	•		
Any loose contamination should be picked up by authorized personnel			•		
Risk information for people living in the area. All penetrators found should be handed to the authorities				•	
Annual sampling of drinking water as a precaution				•	•
A full search of the forest area					•
Investigate any remaining military vehicles					•

Detail of strike sites in Montenegro, southern Serbia and Kosovo

Full descriptions of sites can be found in the relevant UNEP report for that country. See endnotes 11 and 24 for full publication details. In the figures given for penetrators removed from Serbian sites, it is presumed that figures for the number recovered during decontamination did not include penetrators previously removed by FRY authorities and UNEP. This spreadsheet is available online at http://goo.gl/DCGs

#	Date of attack	NATO Coordinatess	Total rounds (API & HE)	WHO site name	UNEP site name	Penetrators removed	Further information/Comments
1	06/04/1999	34TDM717863	Unknown				Same coordinates as #15.
2	07/04/1999	34TDM551901	110				
3	08/04/1999	34TDN665117	150				
4	08/04/1999	34TDN834190	Unknown				Visited by UK MOD. Target listed as APC.
5	15/04/1999	34TEM580880	250		Bukurevac (Serbia)	0	FRY Authorities did not find any contamination. UNEP could not find any contamination.
6	15/04/1999	34TEM680995	Unknown				Site in Serbia. FRY Authorities did not find any contamination.
7	16/04/1999	34TEM643964	Unknown				Site in Serbia. FRY Authorities did not find any contamination.
8	17/04/1999	34TEM1885	200				
9	27/04/1999	34TDM433974	Unknown				
10	27/04/1999	34TDM680690	Unknown	Zhur/Zur			Visited by WHO - close to the village of Zhur/Zur.
11	30/04/1999	4203N02030E	Unknown				Coordinates unclear - not shown on ICBUW map.
12	30/04/1999	34TEM208935	Unknown				
13	30/04/1999	34TDN402102	Unknown				
14	05/05/1999	34TDM515938	210				
15	06/05/1999	34TDM717863	Unknown				Same coordinates as #1.
16	07/05/1999	34TDM503893	400	Zhub/Zub			Former police station. Visited by WHO - access to presumed strike site not possible due to presence of mines. Same coordinates as #70 & #74.
17	07/05/1999	34TDN387039	500				Same coordinates as #71.
18	07/05/1999	34TDM771627	100				Same coordinates as #72.

#	Date of attack	NATO Coordinatess	Total rounds (API & HE)	WHO site name	UNEP site name	Penetrators removed	Further information/Comments
19	09/05/1999	34TDN416092	200				
20	10/05/1999	34TEN148478	200				Visited by UK MoD. Target listed as a vehicle. Area under cultivation, and road where attack probably happened had been resurfaced.
21	11/05/1999	34TEN187470	700			3	Visited by UK MoD. Former barracks. Target listed as buildings. Nearest house is 150m away. Localised contamination found.
22	11/05/1999	34TEM019990	150				Visited by UK MoD. Target listed as APC. Area hazardous due to mines and UXO.
23	11/05/1999	34TDN505044	65				Same coordinates as #24.
24	12/05/1999	34TDN505044	110				Same coordinates as #23.
25	13/05/1999	34TDN7735	570				
26	14/05/1999	34TDM723693	170				
27	14/05/1999	34TEM105920	Unknown				
28	14/05/1999	34TDM525911	300	Gjakovë/ Djakova	Gjakove/Djakovica	1.5	Site was Serb garrison for vehicles and ammo depot. Visited by both UNEP and WHO. WHO noted proximity of site to populated area. Italian KFOR soldiers carried out demolition work at site before discovering penetrators. At time of UNEP visit a number of destroyed vehicles were present at the site. Site also surveyed by Italian army. ICBUW visited in 2010.
29	14/05/1999	34TEM126888	90				
30	15/05/1999	34TDM7462	210		Bellobrade/Belobrod	0	Target thought to be heavy artillery and armoured vehicles. Visited by UNEP - treated with #35 as a single site. No penetrators found but lichen and moss indicated DU had previously been present in the air.
31	15/05/1999	34TDN514102	320				
32	15/05/1999	34TEM1995	200				
33	15/05/1999	34TEM6496	130				Site in Serbia. FRY Authorities did not find any contamination.
34	15/05/1999	34TDN719403	Unknown				
35	15/05/1999	34TDM741622	Unknown		Bellobrade/Belobrod	See above	Treated with #35 as a single site. See comments above.
36	16/05/1999	34TDM745682	90				
37	17/05/1999	34TDM755619	170		Buzesh/Buzec	0	Targets probably vehicles. Visited by UNEP - only able to access roads and buildings as surrounding fields mined, near village and agricultural area.
38	17/05/1999	34TEM540821	120				Site in Serbia. FRY Authorities did not find any contamination.
39	22/05/1999	34TEM209103	Unknown				Coordinates not thought to be correct - UK MoD information suggests that correct coordinates are 34TEN209103. Target listed as artillery. Area was only partially clear of mines and UXO.
40	25/05/1999	34TDM624931	120				
41	25/05/1999	34TEM620945	300		Borovac (Serbia)	154	Site 1.5km from village. Target thought to have been artillery position. Second area of contamination located during decontamination. Decontamination of both sites carried out by the Serbian authorities between 8th August and 5th December 2005.
42	25/05/1999	34TEM632934	150				Site in Serbia. FRY Authorities did not find any contamination.
43	26/05/1999	34TDM588998	Unknown				
44	26/05/1999	34TDM5597	170				
45	28/05/1999	34TEN472112	100				
46	28/05/1999	34TEM625882	200		Bratoselce (Serbia)	328	Target thought to be shelters for armoured vehicles. Visited by UNEP. Site 700m from village of Bratoselce. Same coordinates as #65 & #106. Most heavily targeted site in Serbia - more than 400kg of DU fired during three strikes. Decontamination carried out by Serbian authorities between September and November in 2002 and 2003.
47	28/05/1999	34TDM43159425	300				
48	28/05/1999	34TDM659950	50				Same coordinates as #54.
49	28/05/1999	34TEM189923	90				
50	29/05/1999	34TEN178432	350				Target listed as APC, thought to have been a decoy. Visited by UK MoD survey team - at that time the site was being used as a UK KFOR base after soil removal and the area having been concreted over.
51	29/05/1999	34TDM695654	190				
52	29/05/1999	34TEM335844	Unknown				Same coordinates as #56.
53	29/05/1999	34TDM580994	Unknown				
54	29/05/1999	34TDM659950	50				Same coordinates as #48.
55	29/05/1999	34TCM01479634	230		Cape Arza (Montenegro)	242	Decontaminated by the Montenegrin authorities. UNEP observed the results of the first phase. An ongoing monitoring programme is thought to be in place. Same coordinates as #58.
56	29/05/1999	34TEM335844	80				Same coordinates as #52.
57	30/05/1999	34TEM1691	480				
58	30/05/1999	34TCM01479634	250		Cape Arza (Montenegro)	See above	Same coordinates as #55. See comments above.
59	31/05/1999	34TDM54938	200				Coordinates not thought to be correct - not shown on ICBUW map.
60	31/05/1999	34TDM6573	970		Planeje/Planeja	2	Visted by UNEP. Target was a village held by Serbs, mostly destroyed at the time of the report. Few measurements were taken due to security concerns, but elevated radiation in some areas.
61	01/06/1999	422550N0202630E	200				
62	01/06/1999	34TDM663705	540				
63	01/06/1999	34TDM597858	400				
64	01/06/1999	34TDM782603	500		Kuke/Kukovce	1	Target was probably an artillery position on the slopes of a mountain above the village of Kuke/Kukovce. Visited by UNEP, but presence of cluster bombs and mines hampered access. Turkish EOD team had previously found a penetrator at the site.
65	01/06/1999	34TEM625882	970		Bratoselce (Serbia)	See above	Same coordinates as strikes #46 & #106. See comments above.
66	02/06/1999	34TDM728675	80				Same coordinates as #67.
67	02/06/1999	34TDM728675	70				Same coordinates as #66.

#	Date of attack	NATO Coordinatess	Total rounds (API & HE)	WHO site name	UNEP site name	Penetrators removed	Further information/Comments
68	02/06/1999	34TDM5892	600				
69	02/06/1999	34TDM743720	400		Rikavac	0	Visited by UNEP. At time only road and one ploughed field were considered safe from mines. No penetrators found but DU dust and contamination detected on the road. Visited by ICBUW in 2010, where local people seemed unaware of possible contamination. Impact holes in the road had apparently been filled in without their knowing about possible contamination.
70	02/06/1999	34TDM503893	400	Zhub/Zub			Same coordinates as #16 & 74. See comments above.
71	02/06/1999	34TDN387039	500				Same coordinates as #17.
72	02/06/1999	34TDM771627	100				Same coordinates as #18.
73	03/06/1999	34TEN362171	150				
74	03/06/1999	34TDM503893	470	Zhub/Zub			Same coordinates as #16 & 70. See comments above.
75	03/06/1999	34TDM740590	370				
76	03/06/1999	34TDN59223216	700				
77	05/06/1999	34TDN393005	280	"Batushë/ Batusa"			Site is near a small mountain village near Albanian border. Surrounding area is hilly with grassland and woods. Same coordinates as #80.
78	05/06/1999	34TDN4002	120				Same coordinates as #86.
79	05/06/1999	34TDN389042	400				
80	05/06/1999	34TDN393005	200				Same coordinates as #77. See comments above.
81	05/06/1999	34TDN387005	560				
82	05/06/1999	34TDN603245	320				
83	05/06/1999	34TDM67256935	286	Zhur/Zur	Ceja Mountain	2	Visited by UNEP and WHO (who treated it as a single site with #10). Not clear of mines at time of UNEP visit. Highest density of penetrators found of all UNEP Kosovo sites, and localised pockets of heavy contamination.
84	06/06/1999	34TDM409873	Unknown				
85	06/06/1999	34TDM412883	907				
86	06/06/1999	34TDN4002	120				Same coordinates as #78.
87	06/06/1999	34TDM936785	970				
88	06/06/1999	34TDN474090	745	Irzniq/Rznic	Bandera and Pozhare/Pozar	0	Visited by both WHO (treated it as a single site with #92) and UNEP. Site consists of two small villages. Area had been attacked by cluster munitions. Presence of mines and UXO hampered survey. Same coordinates as #91
89	06/06/1999	34TDM396948	100				Same coordinates as #90.
90	06/06/1999	34TDM396948	100				Same coordinates as #89.
91	06/06/1999	34TDN474090	200	Irzniq/Rznic	Bandera and Pozhare/Pozar	See above	Same coordinates as #89. See comments above.
92	06/06/1999	34TDN464082	440	Irzniq/Rznic			Although coordinates not identical, target thought to be same as #97, see above. Visited by UNEP and WHO (who treated it as a single site with strikes #88 and #91).
93	07/06/1999	34TDM7439471956	140				Visited by ICUBW in 2010. Land under cultivation, and local people seemed unaware of the possibility of contamination.
94	07/06/1999	34TDM545937	225				
95	07/06/1999	34TDN886168	370				Visited by UK MoD. Target listed as artillery. Farm adjacent to target, and area cultivated. Farmer thought to grow his own food and drink from own well, borehole or rainwater.
96	07/06/1999	34TDM592764	610				
97	07/06/1999	34TDN465083	530		Iznic/Rznic barracks	1	Visited by UNEP and WHO. Former Yugoslavia Army barracks surrounded by agricultural land. Localised contamination & lichen samples show that DU had been present in the air. No penetrators found, although one had previously been retrieved by an Italian EOD unit. Although the coordinates are not identical, target is thought to be the same as #92, see below.
98	07/06/1999	34TDN534026	655	"Radoniq/ Radonjic Lake"	Radoniq/Radonjic Lake	1	Targets thought to be artillery or tank positions dug into ridge, or possibly nearby radio transmitter. Site is next to reservoir providing water for most of southern Kosovo – covering a population of 200,000. Penetrators had previously been found by Italian EOD teams. Significant contamination found near a bunker. Contamination of reservoir not thought to be a risk because of large volume of water. ICBUW visited the site in 2010.
99	07/06/1999	34TDN4310	560	"Llukë e Epërme/ Gornja Luka"			Visited by WHO. Site is about 200 to 300 metres south of a village, in agricultural land. Some isolated houses near to the coordinates but the precise location of the strike is difficult to identify.
100	08/06/1999	34TDN528123	1320		Vranoc/Vranovac	0	Visited by UNEP. Target thought to be anti-aircraft and tank positions found by UNEP. No penetrators found, despite over 2000 rounds fired. Lichen sample showed DU had been present in the air. Same coordinates as #103.
101	08/06/1999	34TDM771631-DM762600	400				
102	08/06/1999	34TDN863422	670				
103	08/06/1999	34TDN528123	1000		Vranoc/Vranovac	See above	Same coordinates as #100. See comments above.
104	09/06/1999	34TDM755645	200				
105	11/06/1999	34TDM772630	500				
106	11/06/1999	34TEM625882	970		Bratoselce (Serbia)	See above	Same coordinates as #46 and 65. See comments above.
107	17/04/1999	34TEM170852	Unknown				
108	Unknown	34TEM6308785128	Unknown		Reljan (Serbia)	197	Visited by UNEP. Targets probably armoured vehicles. Site 3km from village of Reljan. Decontaminated by Serbian authorities between September and December 2006, and April and August 2007. Treated by Serbian authorities and UNEP as single site with #112.
109	Unknown	34TEN17012908	Unknown				UK MoD wished to visit, but could not as site was inaccessible by road.
110	Unknown	34TDM5359283702	Unknown				
111	27/05/1999	34TEM397979	Unknown				
112	Unknown	34TEM631852	180		Reljan (Serbia)	See above	Treated by Serbian authorities and UNEP as single site with #108. See comments above.
	29/05/1999	Not on NATO coords	Unknown		Pljackovica (Serbia)	54	Target thought to be communications mast. Decontamination carried out by Serbian authorities between 25th July and 8th November 2004.

Detail of strike sites in Bosnia and Herzegovina

Full descriptions of site findings can be found in: 'Depleted Uranium in Bosnia and Herzegovina: Post-Conflict Environmental Assessment'. This spreadsheet is available online at http://goo.gl/DCGs

NATO #	UNEP site name	Date of attack	NATO target	No. rounds	NATO coordinates	Penetrators removed (max estimate)	Rounds accounted for by contamina-tion points	Further information/comments
1	Rosca Site (76 mm AT Self-Prop Gun)	05-Aug-94	76mm AT Self Propelling Gun	860	43443.2N 18210.9E	0	0	UNEP could not access this site due to the presence of mines.
2	Hill at Pjelugovici (site of T55 tank)	22-Sep-94	T-55 Tank	120	43523.7N 18170.2E	0	0	Hill overlooking Sarajevo in a civilian area. Fruit trees growing and animals grazing. Tank no longer present at time of UNEP's visit but a local directed them to its location at the time of attack. No significant contamination found.
3	N/A	30-Aug-95	Warehouse	Unknown	Vicinity of Sarajevo			UNEP could not visit this site due to the lack of firm coordinates.
4	N/A	30-Aug-95	Artillery/Bunker	Unknown	Vicinity of Sarajevo			UNEP could not visit this site due to the lack of firm coordinates.
5	N/A	30-Aug-95	120mm artillery	Unknown	Vicinity of Sarajevo			UNEP could not visit this site due to the lack of firm coordinates.
6	N/A	30-Aug-95	AAA (Anti-Aircraft Artillery)	Unknown	Vicinity of Sarajevo			UNEP could not visit this site due to the lack of firm coordinates.
7	N/A	30-Aug-95	Mortar Position	Unknown	Vicinity of Sarajevo			UNEP could not visit this site due to the lack of firm coordinates.
8	N/A	30-Aug-95	Mortar Position	Unknown	Vicinity of Sarajevo			UNEP could not visit this site due to the lack of firm coordinates.
9	Hadzici Tank Repair Facility	05-Sep-95	Hadzici Military Repair Facility	800	434932.7N 181122.9E	10	233	Target covered two large concrete yards where a large number of tanks and vehicles were located, plus large buildings where repairs were carried out. Site designed for rainwater to run off into nearby stream. UNEP only looked at hard surfaced areas due to mines/UXO, and a few cleared spaces. 233 contamination points identified and radiation readings up to 100 times background. History of site covered in detail in report. Since UNEP visited EOD programmes and surface decontamination has occurred. FBiH authorities continue to monitor site. There was still noticable surface contamination at the time of ICBUW's visit in 2010.
10	Han Pijesak Artillery Storage and Barracks	07-Sep-95	Han Pijesak Army Storage	700	440522.0N 185655.7E 440525.1N 185653.7E 440527.2N 185653.5E 440539.6N 185649.7E 440540.0N 185645.0E	20	49	Targets included tanks, vehicles, artillery and potentially an anti-aircraft gun. In the 1990s, a team from Serbia visited the site and confirmed the use of uranium weapons but this information was not made public. A stream runs through the site and into a sinkhole. Site is still in use by the military. Contamination was found both inside and outside the buildings. At least two buildings were assumed to have been hit but were not accessed by the team. Republika Srpska authorities are thought to have done some sampling work there but no decontamination work was undertaken due to the lack of radioactive storage facilities in Republika Srpska. Significant contamination found - one sample contained DU levels 1000 times higher than the natural uranium content of the local soil.
11	Han Pijesak Artillery Storage and Barracks	07-Sep-95	Han Pijesak Army Storage	700	440522.0N 185655.7E 440525.1N 185653.7E 440527.2N 185653.5E 440539.6N 185649.7E 440540.0N 185645.0E			
12	Han Pijesak Artillery Storage and Barracks	07-Sep-95	Han Pijesak Army Storage	500	440539.6N 185649.7E 440540.0N 185645.0E 440540.3N 185642.5E			
13	Han Pijesak Artillery Storage and Barracks	07-Sep-95	Han Pijesak Army Storage	500	440539.6N 185649.7E 440540.0N 185645.0E 440540.3N 185642.5E			
14	Hadzici Tank Repair Facility	09-Sep-95	Hadzici Military Repair Facility	350	434939.1N 181117.3E	See above	See above	See above.
15		09-Sep-95	Hadzici Military Repair Facility	350	434939.1N 181117.3E			See above.
16	Hadzici Ammunition Storage Depot	11-Sep-95	Hadzici Ammo Storage Depot	400	4348N 1812E	1	6	Targets were ammunition storage bunkers containing a large volume and variety of live ammunition and possibly anti-aircraft guns. Area so heavily mined that UNEP team could only walk on roads. Penetrators found at road crossing near bunker in eastern part of the site. Contamination found.
17	Hadzici Ammunition Storage Depot	11-Sep-95	Hadzici Ammo Storage Depot	400	4348N 1812E			
18	Hadzici Ammunition Storage Depot	11-Sep-95	Hadzici Ammo Storage Depot	550	4348N 1812E			
19	Hadzici Ammunition Storage Depot	11-Sep-95	Hadzici Ammo Storage Depot	550	4348N 1812E			

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