frontiers | Frontiers in Political Science

TYPE Brief Research Report
PUBLISHED 04 September 2024
DOI 10.3389/fpos.2024.1387183

Depleted uranium munitions and the Ukraine war: a warning against DU renaissance

Mohammad Eslami[1]*, Alena Vieira[1] and Ibrahim Al-Marashi[2]

[1]Department of Political Science and International Relations, Research Center in Political Science, University of Minho, Braga, Portugal, [2]Department of History, California State University San Marcos, San Marcos, CA, United States

Check for updates

OPEN ACCESS

EDITED BY
Aaron Specht,
Purdue University, United States

REVIEWED BY
Jon M. Schwantes,
The Pennsylvania State University, United States
Yu Zhang,
Nankai University, China

*CORRESPONDENCE
Mohammad Eslami
✉ id7418@alunos.uminho.pt;
✉ mamad.eslami.1390@gmail.com

RECEIVED 16 February 2024
ACCEPTED 09 August 2024
PUBLISHED 04 September 2024

CITATION
Eslami M, Vieira A and Al-Marashi I (2024) Depleted uranium munitions and the Ukraine war: a warning against DU renaissance. *Front. Polit. Sci.* 6:1387183.
doi: 10.3389/fpos.2024.1387183

Contrary to the contested use of depleted uranium (DU) weapons following the Iraq war in 2003, which led some nations to seek a ban on DU use and even eliminate their existing arsenals, there is now a growing tendency both toward the use and production of DU weapons, rendering such weapons as "normal" and "acceptable." There is a risk of a DU renaissance as a consequence of the war in Ukraine. We argue that more attention is needed to the strategies to deal with the DU renaissance, including further research on the health and environmental effects and the associated clean-up efforts, particularly concerning chemical toxicity and exposure to DU-linked radiation, to the alternatives military strategies, as well as alternative munitions, such as tungsten.

KEYWORDS

depleted uranium (DU), Ukraine war, international security, radiation, toxicity, human security, environment security

1 Introduction

Since 2022, a devastating,[1] fully-fledged conventional war with pitched battles employing ground forces, consisting of artillery, tanks, and armored vehicles, has been waged on the European continent, involving a nuclear state. Implications of the Ukraine war are yet to be fully assessed (Eslami, 2022), but the increase in military spending represents its clear result; the market of armored vehicles has grown significantly since the beginning of the Ukraine war and will reach $40 billion by 2028 (SWR, 2024). Military spending and efficiency have become a cornerstone of international politics, bringing the issue of Depleted Uranium (DU) weapons to the international agenda.

In early 2023, the US and several European states decided to transfer advanced tanks to Ukraine (Walsh, 2023), protected by DU armor plates and capable of deploying DU rounds (See Table 1). On 22 March 2023, the UK's Ministry of Defense stated that it would dispatch DU armor-piercing rounds alongside the Challenger-2 main battle tank. While UK Foreign Secretary James Cleverly affirmed no nuclear escalation was intended with the decision, Russia's President

1 This study was conducted in a close yet unofficial dialog with the academic, political, and military experts in the field of DU munitions. We would like to thank our colleagues who are or were previously working at the International Atomic Energy Agency (IAEA), North Atlantic Treaty Organization (NATO) and Pentagon as well as military experts from Russia, Ukraine and Iraq who interacted with us, allowing for triangulation of the information.

TABLE 1 Western main battle tanks delivered to Ukraine as of June 2024.

Tank	Countries	Number	Armor	DU Rounds
Abrams M1A	The United States	31	DU	M829A1/2/3
Leopard-2	Germany, Poland, Portugal, Norway, Canada, Denmark, Netherlands	152	DU, Composite	DM-53 Rheinmetall
Challenger 2	The United Kingdom	14	DU	Charm-3 L-27 L29A1 C3TR
Stridsvagn 122	Sweden, Spain	22	DU, Composite	M-53 Rheinmetall

Ukraine has also received around 270 Leopard-1 that are capable of using DU rounds from Germany, Denmark, and Netherland; however, over 100 of them could not function due to missing parts.
Source: European Parliament (https://www.europarl.europa.eu/RegData/etudes/ATAG/2023/739316/EPRS_ATA(2023)739316_EN.pdf).

TABLE 2 DU munitions in service of US' and Russia's (Airforce and Navy).

Organization	DU Ammunition	Deployed by
USAF	30 mm PGU-14/B	GAU-8 Avenger Cannon of A-10 Thunderbolt II Aircraft
USMC	25 mm M919	Bradley Fighting Vehicle (LAV-25)
USMC	25 mm PGU-20	GAU-12 Equalizer Cannon of the AV-8B Harrier
USMC	20 mm M197	AH-1 Cobra Helicopter Gunship
USMC	20 mm M197	Navy's Phalanx CIWS's M61 Vulcan Gatling Gun
RAF	30 mm APHE/AP	GSh-6-30 cannon mounted on the Su-25 and MIG-27
RAF	30x165mm DUP	Shipunov 2A42 deployed on the Mil Mi-28 N helicopter
RN	30x165mm DUP	AK-630 naval cannons deployed on most of the warships

Source: The National Interest (2020, 2021).

Vladimir Putin stated that Russia would be 'forced to react' if shells made with DU were sent (Wilkins, 2023). Russia also accused the West of deploying weapons containing a 'nuclear component' (Gozzi, 2023), and Foreign Minister Sergei Lavrov said sending DU ammunition to Ukraine would mean the UK was "ready to violate international humanitarian law as in 1999 in Yugoslavia" (Gozzi, 2023).

In response to the possible delivery of DU weapons, Russia declared that it would deploy tactical nuclear weapons on the territory of Belarus (Putin, 2023). However, Russia has its own significant DU arsenal, and has deployed to the Ukraine battlefield hundreds of T-80 and T-90 tanks covered by Kontakt-5 plates (explosive reactive armor) that are capable of employing 3BM29-Nadphil-2 and 3BM59 "Svinets-2" DU munitions.

High-density DU alloys, the world's most widely used nuclear-based weapons, have a proven military efficiency due the capacity of increased armor penetration. DU has been employed in anti-armor rockets, several types of cruise and ballistic missiles, hypersonic munitions, artillery shells, and even regular bullets (Fetter and von Hippel, 2000). DU ammunition was used in the Gulf War (against Iraq), Bosnia, Kosovo, Afghanistan, Syria and Sudan. Deployment of such weapons has subsequently raised concerns regarding adverse health (including cancer) and environmental effects, particularly in relation to chemical toxicity and to a lesser extent, exposure to DU-linked radiation (Sutton and Novkov, 2008; Briner, 2010; Carpenter, 2011, 2016), even though a clear mechanistic connection between the use of DU munitions and health effects has not been established. The debate on impact of DU effects has triggered the discussion on whether DU weapons should be considered "conventional" (Katz, 2014; Shaki et al., 2019), even though there is no treaty or binding resolution prohibiting them (Table 2).

In light of the Ukraine war, and contrary to their contested use following the Iraq war, there is now a tendency toward viewing DU weapons as "acceptable" weapons, despite the previous trend of some nations seeking to ban the use of DU or even eliminate their existing arsenals. The academic literature about the role and place of DU weapons in international security remains limited (Carpenter, 2016; Bruess et al., 2020), and studies tackling DU weapons employment in the Ukraine war remain an exception (Fuller, 2024).

2 Employment of DU-based munitions: a brief overview

DU was initially produced as a "waste" by-product of uranium enrichment during the Manhattan Project (Motron, 1960; Nelson and Carmichael, 1960; Gosling, 1999). The Project's scientists discovered that DU could be used to create weapons with increased armor penetration, without the need for highly enriched uranium, which is expensive and difficult to obtain (Mizokami, 2021). In the 1970s, the Pentagon reported that the Soviet military had developed armor plating for Warsaw Pact's T-72 tanks that NATO ammunition could not penetrate. The Pentagon began searching for a material to make denser armor-piercing projectiles. After testing various metals, ordnance researchers settled on DU (Mizokami, 2020).

DU has two military advantages. First, DU is very dense, and its original use was restricted to armored plates protecting military vehicles. For the same reason, it is used in armor-penetrating ordnance. When a DU projectile strikes an armored target, it does not flatten on contact but instead penetrates and 'self sharpens' as it passes through the armor (Fetter and von Hippel, 2000). This happens because as the DU projectile is penetrating its target, its outer layer catches fire, creating some radioactive dust, essentially lubricating the remaining projectile, helping it to penetrate further. Second, DU materials are provided to military industries at a very low price (sometimes for free) by stockpilers, because it absolves them of the responsibility of storage (White, 2008). To this end, the invention of DU was a revolution in the military industry.

DU has been used in various types of armaments including high-explosive anti-tank (HEAT) munitions, tank armor, and anti-tank shells, as well as some types of missiles and aircraft counterweights. Modern battlefields are, in other words, loaded with DU.

Artillery rounds and projectiles are the most used munitions, especially by the US, Russia, and the UK (ICBUW, 2024). The US employs various types of armor-piercing DU projectiles, including tank rounds and anti-tank munitions. US military employs the M829A1, M829A2, M829A3, and M829E4 tank rounds and the 105 mm kinetic energy rounds consisting of three models, M774, M833, and M900, all made from DU and in use since the 1970s; however, these munitions were upgraded to a more efficient model of the 105-mm M735E1 since the 1980s. The British Army's DU (tank rounds) arsenal includes Charm-3 L-27 armor-piercing fin-stabilized discarding sabot (APFSDS) and L29A1 C3TR developed in the 1990s and used in the Middle East in 2003. Other European states also possess DU munitions, such as France which owns OFL 105F2 APFSDS-T tank rounds. The German, Swiss, and army of the Netherlands have another DU tank round, DM-53 (Rheinmetall) currently in service (Global Security, n.d.). Russia also has several models of DU munitions and tank rounds including 3VBM10, 3BM29/30 (3BM29-Nadphil-2), 3VBM13/3BM32/33 (3BM32 "Vant"), 3VBM22/3BM59 (3BM59 "Svinets-2") as well as 3BK21B and 3BM42 in service since the 1980s; with over a million of DU bullets in service. Soviet DU munitions and more specifically 3BM-46 "Svinets" have been exported to India and are currently in service. As for the types of tanks using DU rounds, these include the American *M1 Abrams*, the British *Challenger 2*, the German *Leopard 2*, the Israeli *Merkava IV*, the Russian *T-72* and *T-90*, the Japanese *Type 90*, and the Chinese *Type 99*. Both Russian tanks and DU rounds have been exported to several states and are currently in service in India, Pakistan, Israel, Ukraine, the United Arab Emirates, Jordan, Saudi Arabia, Bahrain, Turkey, Taiwan, South Korea, Thailand, Oman, and Kuwait (ICBUW, 2022).

Apart from the artillery rounds deployed by different countries' ground forces, the US Air Forces (USAF) and US Marine Corps (USMC) as well as the Russian Air Force (RAF) and Russian Navy (RN) also possess several types of other DU-based munitions.

DU munitions also include missiles. The Tomahawk cruise missile version used by the US in both Balkan wars employs 400 kg of DU in its airframe to increase its penetration and survivability (Pirot, 2018). Other DU munitions are the air-to-ground missiles (AGM), including the AGM-114 Hellfire missile, the AGM-88 HARM anti-radar missile, the BGM-71 TOW anti-tank missile, the AIM-120B air-to-air missile, and aerial bombs such as GBU-24 Paveway III (2000 lb), 25846d GBU-28 or 37, all used by numerous militaries around the world including the United States, Saudi Arabia, Israel, Turkey, Jordan, Bahrain, Kuwait, Qatar, Afghanistan, Iraq, Egypt, and some European countries (Center for Defense Information, CDI, 2001).

Since DU penetrators are very powerful, the only way to defend against these modern penetrators is DU armor-plates, covering all of the major battle tanks such as Abrams 1, Leopard 2, Challenger 2, Merkava, T-90, and the Indian Arjun MBT. DU armor is also used in a wide range of armored vehicles, such as armored personnel carriers, infantry fighting vehicles, self-propelled artillery, and combat engineering vehicles.

DU munitions have been used in various conflicts since the 1990s (White, 2008), starting with the US using armor-piercing shells and bullets fired from American tanks and planes during the 1991 Gulf War. DU munitions were also used by the US in the Balkans in the 1990s (Young, 2021): NATO forces used DU munitions in Bosnia in 1994, during Operation Deny Flight, and during the 1999 NATO bombing campaign in Kosovo. In 2001, the US and its allies used DU munitions during the invasion of Afghanistan (Global Security, n.d.; Fahey, 2003), reportedly fired from aircraft to destroy Taliban tanks and fortifications. In 2003, the US and its allies again used DU munitions during the invasion of Iraq (Mizokami, 2021), including its extensive use in urban areas such as Baghdad and Basra. DU munitions have also been used by other countries, including the UK and Israel. The UK used DU in the Gulf War and in the Balkans, while Israel reportedly used DU munitions during its conflict with Hezbollah in Lebanon in 2006. Finally, the US Army used thousands of DU rounds during attacks on ISIS militants in Syria in 2015 (Bruess et al., 2020; ICBUW, 2022).

3 Stigmatization of the DU weapons

Although DU weapons are not classified as unconventional weapons, their use has been increasingly associated with a certain stigma, due to potential health hazards and environmental damage (Al-Ansari et al., 2014; Besic et al., 2017; Bjørklund et al., 2020), in spite of the ongoing research on their exact effects.

In 2001, a decade after the massive use of DU weapons in the first Gulf War, their effect came to international attention, first and foremost, in connection with the NATO 1999 military operation in the Federal Republic of Yugoslavia. 2001 European Parliament (EP) resolution called for a moratorium, eventually producing a restrictive effect on the use of DU weapons within NATO, in parallel to instances of reverting from DU to tungsten in both US and UK (Gibbons, 2004). In the same year, Iraq sponsored a resolution in the UN General Assembly to document the impact of DU use in armed conflict, but the initiative failed to win a majority. The study, undertaken by World Health Organization (WHO), flagged potential long-term repercussions of DU use on human health and the environment (WHO, 2001). However, other studies pointing at more serious health and environmental consequences (including cancer, birth defects, and other illnesses reported by the Government of Iraq, associating them with the Gulf War in 1991) have led to the institution, in October 2003, of the International Campaign to Ban Uranium Weapons (ICBUW) and "call for a halt to the production, testing, sale, stockpiling, transport and export of these weapons and a decommissioning of all existing stockpiles" (CADU, 2003), coinciding with the US military invasion and occupation of Iraq in March the same year (Eslami and Vieira, 2023a, 2023b).

The years 2007–2008 constituted a milestone period in the international stigmatization of DU weapons, mainly with the adoption of the resolution A/RES/62/30 by the UN General Assembly (UNGA) 'Effects of the use of armaments and ammunitions containing depleted uranium" of 5 December 2007', followed by another nine resolutions, the last one adopted in December 2022 (77/49, 13 December).[2] The

2 Resolutions 63/54 of 2 December 2008, 65/55 of 8 December 2010, 67/36 of 3 December 2012, 69/57 of 2 December 2014, 71/70 of 5 December 2016 and 73/38 of 5 December 2018 and 75/42 of 7 December 2020.

UNGA, while "taking into consideration the potential harmful effects of the use of armaments and ammunitions containing depleted uranium on human health and the environment" asked "the Secretary-General to seek the views of the Member States and relevant international organizations on the effects of the use of armaments and ammunitions containing depleted uranium, and to submit a report on this subject" (A/RES/62/30). Since 2008, the matter has been addressed by the UNGA on a biennial basis. ICBUW campaigning efforts contributed to the 2008 EP Resolution 'Global treaty to ban uranium weapons', also asking to "support for projects that could assist victims and their relatives as well as for clean-up operations in the affected areas, should a negative effect on human health and the environment be confirmed." [P6_TA (2008) 0233] Belgium was the first country to declare a ban on weapons in 2007, followed by Costa Rica in 2011.

Against this background, one could argue that a certain stigmatization of DU armaments has been emerging, even though it failed to acquire the scale of an international moratorium (Carpenter et al., 2014). The regular adoption of the UNGA resolutions and other documents, even though non-binding, had led to the categorization of DU weapons as causing undue suffering due to their potential indiscriminate, lingering impact on the environment and humans, well beyond the duration of the conflict. Eventually, despite the opposition by some UN member states, there was a tendency of seeking less hazardous materials and trying to replace DU in tank ammunition with alternatives. Indeed, as an instance of this tendency was South Korea transferring, in April 2022, 1.3 million rounds of armor-piercing ammunition made of DU to the US, following the debate over their "conventional" status (Stars and Stripes, 2022). A gradual progress in stigmatization of the DU has been thus taking place, which is very possibly at risk with the war in Ukraine.

4 The war in Ukraine: a warning against DU renaissance

DU weapons have reportedly been employed in Ukraine war by both warring parties (ICBUW, 2024), in spite of its environmental and health consequences for civilians and military personnel, its status in international law and treaties and conventions aimed at protecting civilians during armed conflicts, and the existing alternatives. This is contrary to the contested use of DU weapons following the Iraq war in 2003, which led some nations to seek a ban on the use of DU and even eliminate their existing arsenals. The Ukraine war thus potentially sets off a tendency both toward a growing use of DU, paving the way to the consideration of DU weapons as "normal" and "acceptable." While in December 2020, the vote in the UNGA (A7RES/77/49) registered the record high number of 159 countries in favor and only the US, Israel, and France against (UNGA, 2020), in the December 2022, the number of states voting against the resolution (A/RES/75/42) dropped to 147, with the UK, Liberia, the US, Israel, and France voting against and 23 European and NATO states and NATO abstaining (UNGAV, 2023).

The use of DU munitions by warring parties in Ukraine can result in the further de-stigmatization of these arms and therefore encourage different states to develop, purchase and employ such munitions. The implication of de-stigmatization and normalization of DU munitions will affect the policy of three groups of actors toward DU-based armaments. Firstly, there is a group of countries that have been both producing and using DU munitions, composed most notably by the United States (but also the UK, even though employed to in a more limited manner). These countries are now more reassured in the importance of both having and using these weapons. To this end, the US officials demonstrated DU munitions as "normal" weapons and reinforced the idea that "If Russia is deeply concerned about the welfare of their tanks and tank soldiers, the safest thing for them to do is move them across the border, get them out of Ukraine" (Kirby, 2023). As it is clear from the quote, the fact that they can be employed is not connected to any kind of restrictive effect of the DU as a weapon itself.

Secondly, there is a group of states that have been producing, or in possession of DU munitions, however never actually using them. These states would now tend to view the elimination of their DU arsenal, as already undertaken by some states like Belgium or Costa Rica in the past, as an irrational option, in both defense economic and strategic terms. Thus, the tendency toward employment of DU armaments in the Ukraine war is dissuading countries from eliminating their existing DU munitions. Countries that have stopped or restricted the use of DU munitions could consider their reintroduction into the arsenals.

Thirdly, there is a group of states that have never employed nor produced DU munitions but are considering producing them. Two representatives of this group are Poland and Iran. In April 2023, Poland's then Prime Minister Mateusz Morawiecki officially announced that the country was considering becoming independent in the production of DU rounds and is planning to produce its local DU munitions and armored plates (Morawiecki, 2023). As for Iran, an emerging military power, which has never produced or imported DU munitions, it has been revising its strategic capabilities, and currently making operational its local Karrar tanks, based on the Russian T90 platform, capable of employing DU munitions.

Ultimately, the war in Ukraine appears to be reversing the stigma of DU weapons, which can encourage other states to produce, acquire and use them and thus significantly complicate the efforts toward its prohibition. Eventually, such an effect might not be restricted to DU weapons, but extend to other kinds of munitions, including landmines or cluster munitions, already used since 2022, or blinding lasers. In light of this proliferation trend, it is important to identify risks associated with the employment of DU munitions and the ways to mitigate them, based on previous lessons (Storm et al., 2006; Faa et al., 2018). The use of DU munitions in Iraq affected military and civilians, and all neighboring countries in the Middle East, as documented by several studies demonstrating the pollution of air, soil, and water sources in Iran, Saudi Arabia, and Kuwait (Shaki et al., 2019). Both combatants during the conflict in Ukraine have deployed DU munitions. The health and environmental concerns are significant, especially given that Ukraine is one of the most important agricultural producers in the world, and that the pollution of Ukraine's soil and water will result in the pollution of agricultural products for long decades, with implications for health and environmental security in European countries. Ukraine, however, has been excused for potentially considering to use DU weapons as a result of being invaded by a much larger and better equipped (in terms of sheer numbers of vehicles and munitions) army that possesses armor-plated tanks and DU munitions itself.

From a normative perspective, offensive weapons in their entirety are ultimately detrimental to humanity and ideally would be prohibited. Yet most military planners operate in the realist school, seeking an advantage over adversaries due to the security dilemma. Thus, there will always be advocates of DU deployment. Yet there are existing alternatives where military objectives can be achieved with conventional weapons. In response to DU advocates, there are conventional munitions, while not as effective as DU for armored piercing missions, that range from "kamikaze" drones and quadcopters, top-attack missiles, man-portable anti-tank rockets, and steel projectiles can be used against targets, ranging from the advanced main battle tanks, including the Abrams, Leopard, Russian T90 and T80 to artillery cannons such as Howitzers, multiple rocket launchers such as HIMARS, Tosochka, Tornado, personnel carriers, and other armored vehicles. As of June 2024, close to 900 Ukrainian tanks (including 77 Leopard-2 and 9 Abrams-1) as well as over 3,000 Russian tanks (including 273 T80 and 145 T90) were destroyed, without the use of DU projectiles. This is not to mention tungsten (armor-piercing rounds), is an important DU alternative due to its penetration capacity. While DU still outperforms tungsten shells in terms of penetrating power, tungsten, which is denser than DU, still represents a viable armor-piercing alternative. Though tungsten may be more expensive than DU, the cost difference is not significant enough to outweigh the benefits of using a cleaner and more environmentally friendly alternative, since it does not pose similar risks to human health and the environment as DU. Tungsten is, however, not as abundant in nature as uranium and is found only in China, Vietnam, Russia, North Korea, Rwanda, Australia, Pakistan, Iran, and Bolivia, as well as in Spain, Austria, and Portugal. More attention needs to be paid to the alternative military application of tungsten and a possible transition from DU munitions to tungsten projectiles by leveraging the latter's unique properties. Ultimately, this alternative is part of the avenues for future research, along with the human health and environmental debate on DU contamination, and counter-proliferation strategies to deal with the acceptance and increased use of DU munitions.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

ME: Writing – original draft, Writing – review & editing. AV: Writing – original draft, Writing – review & editing. IA-M: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This research has been financed by Research Center in Political Science (UIDB/CPO/00758/2020), University of Minho/University of Évora and supported by the Portuguese Foundation for Science and Technology (FCT) and the Portuguese Ministry of Education and Science through national funds.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Al-Ansari, N. A., Knutsson, S., and Pusch, R. (2014). Environmental implications of depleted uranium in Iraq and principles of isolating it. *Waste Manag.* 5, 367–376.

Besic, L., Muhovic, I., Asic, A., and Kurtovic-Kozaric, A. (2017). Meta-analysis of depleted uranium levels in the Balkan region. *J. Environ. Radioact.* 172, 207–217. doi: 10.1016/j.jenvrad.2017.03.013

Bjørklund, G., Pivina, L., Dadar, M., Semenova, Y., Rahman, M. M., Chirumbolo, S., et al. (2020). Depleted uranium and gulf war illness: updates and comments on possible mechanisms behind the syndrome. *Environ. Res.* 181:108927. doi: 10.1016/j.envres.2019.108927

Briner, W. (2010). The toxicity of depleted uranium. *Int. J. Environ. Res. Public Health* 7, 303–313. doi: 10.3390/ijerph7010303

Bruess, E., Snell, J., and Goswami, M. (2020). War and the environment: the disturbing and under-researched legacy of depleted uranium weapons. *Bull. At. Sci.*

CADU. (2003). Formation of the International Coalition for a Ban on Uranium Weapons. Available at: https://www.cadu.org.uk/info/campaign/16_1.htm (Accessed June 19, 2024).

Carpenter, R. C. (2011). Vetting the advocacy agenda: network centrality and the paradox of weapons norms. *Int. Organ.* 65, 69–102. doi: 10.1017/S0020818310000329

Carpenter, C. (2016). Rethinking the political/−science−/fiction nexus: global policy making and the campaign to stop killer robots. *Perspect. Polit.* 14, 53–69. doi: 10.1017/S1537592715003229

Carpenter, C., Duygulu, S., Montgomery, A. H., and Rapp, A. (2014). Explaining the advocacy agenda: insights from the human security network. *Int. Organ.* 68, 449–470. doi: 10.1017/S0020818313000453

CDI. (2001). Known & suspected DU weapon systems hellfire brimstone shaped charge warheads. Center for Defense Information. Available at: http://eoslifework.co.uk/pdfs/DU2102A3b.pdf (Accessed June 18, 2024).

Eslami, M. (2022). Iran's drone supply to Russia and changing dynamics of the Ukraine war. *J. Peace Nuclear Disarmament* 5, 507–518. doi: 10.1080/25751654.2022.2149077

Eslami, M., and Vieira, A. V. G. (2023a). The arms race in the Middle East: Contemporary security dynamics. Cham, Switzerland: Springer Nature.

Eslami, M., and Vieira, A. V. G. (2023b). "Introducing the arms race in the Middle East in the twenty-first century: a "powder keg" in the digital era?" in *The arms race in the Middle East: Contemporary security dynamics*. Eds. Eslami and Vieira (Cham: Springer International Publishing), 3–13.

European Parliament. (2008). Motion for Resolution about the Hazards of Depleted Uranium. Available at: https://www.europarl.europa.eu/doceo/document/B-6-2008-0230_EN.html (Accessed June 14, 2024).

Faa, A., Gerosa, C., Fanni, D., Floris, G., Eyken, P. V., Lachowicz, J. I., et al. (2018). Depleted uranium and human health. *Curr. Med. Chem.* 25, 49–64. doi: 10.2174/0929867324666170426102343

Fahey, D. (2003). Science or science fiction: facts, myths and propaganda in the debate over depleted uranium weapons. Available at: https://web.mit.edu/pugwash/du/resources.html (Accessed June 16, 2024).

Fetter, S., and von Hippel, F. (1999). After the dust settles. *Bull. At. Sci.* 55, 42–45. doi: 10.1080/00963402.1999.11460391

Fetter, S., and von Hippel, F. N. (2000). The hazard posed by depleted uranium munitions. *Sci. Glob. Secur.* 8, 125–161. doi: 10.1080/08929880008426473

Fuller, M. (2024). Depleted uranium in Ukraine: lessons from the Balkans and Iraq. *Peace Rev.* 36, 53–62. doi: 10.1080/10402659.2023.2296085

Gibbons, O. T. (2004). Uses and effects of depleted uranium munitions: towards a moratorium on use. *Yearbook Int. Humanit. Law* 7, 191–232. doi: 10.1017/S1389135904001916

Global Security. (n.d.) M829 120mm, APFSDS-T. Available at: https://www.globalsecurity.org/military/systems/munitions/m829a1.htm (Accessed June 15, 2024).

Gosling, F. G. (1999). The Manhattan project: Making the atomic bomb. Whashington D.C, US: Diane Publishing.

Gozzi, L. (2023). Ukraine war: UK defends sending depleted uranium shells after Putin warning. The BBC. Available at: https://www.bbc.com/news/world-europe-65032671 (Accessed June 20, 2024).

ICBUW. (2022). Depleted uranium weapons – State of affairs 2022. Berlin, Germany: International Coalition to Ban Uranium Weapons. Available at: https://www.icbuw.eu/depleted-uranium-weapons-state-of-affairs-2022/ (Accessed June 24, 2024).

ICBUW. (2024). Made with nuclear industry waste: Depleted uranium weapons. International Coalition to Ban Uranium Weapons. Available at: https://www.icbuw.eu/made-with-nuclear-industry-waste-depleted-uranium-weapons/ (Accessed June 14, 2024).

Katz, S. A. (2014). The chemistry and toxicology of depleted uranium. *Toxics* 2, 50–78. doi: 10.3390/toxics2010050

Kirby, J. (2023). About the ammunition transferred to Ukraine. RealClear Politics. Available at: https://www.realclearpolitics.com/video/2023/03/22/kirby_depleted_uranium_is_commonplace_munition_if_russia_is_worried_about_their_tanks_move_them_out_of_ukraine.html (Accessed June 11, 2024).

Mizokami, K. (2020). The brutal reason American tanks shoot depleted uranium shells. The National Interest. Available at: https://nationalinterest.org/blog/buzz/brutal-reason-american-tanks-shoot-depleted-uranium-shells-115571 (Accessed June 14, 2024).

Mizokami, K. (2021). Why depleted uranium rounds are the ultimate anti-tank weapon. The National Interest. Available at: https://translate.google.pt/?hl=pt-PT&sl=en&tl=fa&text=Mizokami%2C%20K.%20%20%20Why%20Depleted%20Uranium%20Rounds%20are%20the%20Ultimate%20Anti-Tank%20Weapon.%20The%20National%20Interest.%20Available%20at%3A%20&op=translate (Accessed June 19, 2024).

Morawiecki, M. (2023). Poland seeks to produce depleted uranium ammo for Abrams tanks. The First News. Available at: https://www.thefirstnews.com/article/poland-seeks-to-produce-depleted-uranium-ammo-for-abrams-tanks-37801#:~:text=%22We%20have%20been%20making%20efforts%20to%20locate%20in,can%20have%20a%20devastating%20effect%20on%20armoured%20vehicles (Accessed June 12, 2024).

Nelson, H. W., and Carmichael, R. L. (1960). Potential Nonnuclear Uses for Depleted Uranium. Washington DC, US: Batelle Memorial Institute.

Pirot, F. (2018). Uranium is a Genocide Giant. Available at: https://uraniumisagenocidegiant.com/2018/04/25/depleted-uranium-ram-of-the-tomahawk-pictured-after-us-missiles-shot-down-in-syria-le-belier-en-uranium-appauvri-du-tomahawk-photographie-apres-que-des-missiles-us-ont-ete-abattus-en-syrie/#:~:text=You%20can%20clearly%20see%20that%20the%20metal%20is,of%20depleted%20uranium%20in%20each%20Tomahawk%20cruise%20missile (Accessed June 14, 2024).

Putin, V. (2023) Russia to deploy tactical nuclear weapons in Belarus, Putin Says. The BBC. Available at: https://www.bbc.com/russian/news-65077823humans (Accessed June 14, 2024).

Shaki, F., Zamani, E., Arjmand, A., and Pourahmad, J. (2019). A review on toxicodynamics of depleted uranium. *Iran. J. Pharmaceut. Res.* 18, 90–100. doi: 10.22037/ijpr.2020.113045.14085

Stars and Stripes. (2022). The US Air Force removes stockpiles of depleted uranium rounds from South Korea. Available at: https://www.stripes.com/theaters/asia_pacific/2022-04-14/us-air-force-depleted-uranium-rounds-south-korea-5684066.html#:~:text=CAMP%20HUMPHREYS%2C%20South%20Korea%20%E2%80%94%20South%20Korea%20recently,welcomed%20departure%2C%20according%20to%20a%20South%20Korean%20legislator (Accessed June 12, 2024).

Storm, H. H., Jørgensen, H. O., Kejs, A. M. T., and Engholm, G. (2006). Depleted uranium and cancer in Danish Balkan veterans deployed 1992–2001. *Eur. J. Cancer* 42, 2355–2358. doi: 10.1016/j.ejca.2006.01.064

Sutton, B., and Novkov, J. (2008). Rethinking security, confronting inequality. Security disarmed: Critical perspectives on gender, race, and militarization, Eds. Morgen, Sutton and Novkov (New Jersey: Rutgers University Press). 3–29.

SWR. (2024). The market of armored vehicles has grown. Startview Research. Available at: https://www.stratviewresearch.com/2921/armored-vehicle-market.html (Accessed June 12, 2024).

UNGA. (2020). Resolution of General Assembly on the effects of the use of armaments and ammunition containing depleted uranium. Available at: https://digitallibrary.un.org/record/3893809?ln=en (Accessed June 19, 2024).

UNGAV. (2023). Resolution of General Assembly on the effects of the use of armaments and ammunition containing depleted uranium. Available at: https://cdn.who.int/media/docs/default-source/radiation/2022-un-ga-res-77-49-on-effects-of-du-n2273723.pdf (Accessed June 19, 2024).

UNGAV. (2020). Effects of the use of armaments and ammunitions containing depleted uranium. Available at: https://reachingcriticalwill.org/images/documents/Disarmament-fora/1com/1com22/votes-ga/385DRVI.pdf (Accessed June 19, 2024).

Walsh, N.P. (2023). Why sending Ukraine tanks represents a fierce new step by the west. Atalanta, US: The CNN. Available at: https://edition.cnn.com/2023/01/25/europe/western-tanks-ukraine-russia-intl-cmd/index.html (Accessed June 12, 2024).

White, R. (2008). Depleted uranium, state crime and the politics of knowing. *Theor. Criminol.* 12, 31–54. doi: 10.1177/1362480607085793

Wilkins, B. (2023). Russia warns US delivery of depleted uranium arms to Ukraine would be akin to use of nukes. Common Dreams. Available at: https://www.commondreams.org/news/depleted-uranium (Accessed June 13, 2024).

WHO (2001). Depleted uranium: Sources, exposure, and health effects (No. WHO/SDE/PHE/01.1). Geneva, Switzerland: World Health Organization.

Young, S. (2021). Depleted uranium, devastated health: military operations and environmental injustice in the Middle East. *Harv. Int. Rev.* https://hir.harvard.edu/depleted-uranium-devastated-health-military-operations-and-environmental-injustice-in-the-middle-east/