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Addressing the Impact of Chemical, Biological and Radiological Warfare Internationally

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Introduction

The large-scale use of chemical weapons during World War I marked a turning point in warfare, as it revealed the unprecedented humanitarian consequences of industrialized weapons and prompted early efforts to impose moral and legal constraints on armed conflict.The widespread suffering caused by poison gases demonstrated that certain weapons posed unacceptable humanitarian risks. These events directly influenced early international prohibitions and established the idea that warfare must be constrained by moral and legal norms. [1]Biological weapons research during the twentieth century further highlighted the dangers of invisible, highly contagious agents. Even limited experimentation revealed that biological threats could spread uncontrollably, reinforcing the need for strict international oversight. Not all CBR harm has resulted from warfare. Radiological accidents and chemical plant disasters exposed civilians to long-term environmental and health risks.[2] These events demonstrated that hazardous materials used for peaceful purposes could still produce mass harm if mismanaged. Such incidents expanded the international understanding of security to include industrial safety, environmental protection, and emergency preparedness, shaping modern international regulatory approaches.

The development of global norms regarding chemical, biological, and radiological (CBR) warfare has been largely shaped by historical experiences of mass harm and humanitarian suffering. Early uses of chemical weapons and subsequent industrial and radiological disasters demonstrated that these threats posed risks not only to combatants but also to civilian populations and the environment. In response, the international community gradually established norms emphasizing prohibition, prevention, and accountability.[3] Over time, these norms expanded beyond the battlefield to address accidental releases, dual-use technologies, and long-term environmental contamination. The evolution of global standards reflects a growing consensus that CBR threats undermine international peace, public health, and sustainable development, and therefore require collective restraint and cooperation rather than unilateral action.[4]

History of Chemical Weapons

Chemical and biological warfare existed in limited form prior to World War 1. Ancient warfare saw the use of irritating and poisonous chemicals in small scales, as well the use of corpses as a vector of disease. It wasn't until the first industrial revolution that chemical weapons developed into its recognizable form. The arrival of modern chemistry increased the number of proposals for the use of poisonous gases and materials in warfare. For example, British chemist Lyon Playfair proposed the use of cacodyl cyanide artillery shells for the Crimean War (1853 - 1856). Because of the increased interest in chemical weapons, the 1899 and 1907 Hague conventions outlawed "the use of poison and of material causing unnecessary suffering".

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[1] Martínez, Francisco Javier. 2025. "Hidden in Plain Sight: The Beginnings of French Chemical Warfare in Morocco's Rif War (April–July 1925)." *Frontiers in Political Science* 7 (October). https://doi.org/10.3389/fpos.2025.1634144.

[2] Gawlik-Kobylińska, Małgorzata. 2022. "Current Issues in Combating Chemical, Biological, Radiological, and Nuclear Threats to Empower Sustainability: A Systematic Review." *Applied Sciences* 12 (16): 8315. https://doi.org/10.3390/app12168315.

[3] Ramil Akhundov, and Elshan Hashimov. 2025. "MİLİTARY ACTİVİTY and the ENVİRONMENT: THE NEED for a SYSTEMİC APPROACH to RADİOLOGİCAL and CHEMİCAL SAFETY." *Archives*, May, 187–97. https://doi.org/10.62731/mcnd-16.05.2025.004.

[4] "Mission." n.d. OPCW. https://www.opcw.org/about-us/mission.

Despite existing treaties, World War 1 saw the industrial production and use of chemical weapons. Much of the industrial production of chemical weapons in World War 1 originates with the production of artificial fertilizer. The process to make artificial fertilizer, the Haber Process, was also used to create large amounts of chlorine gas. Thus, the innovation that goes into the consumer use of chemicals is now intertwined with the production of chemical weapons. The humanitarian devastation caused by poison gases prompted the creation of several humanitarian treaties. Most important was the 1925 Geneva Protocol[5], which outlawed the use of all gasses and bacterial methods of warfare. However, some countries were able to addendum their acceptance of the treaty. For example, the United States, though a party and signatory, has reserved the right to use chemical weapons against a nation who is not a signatory. The convention also did not outlaw the domestic use of chemical weapons, such as for riot control.

Throughout the mid-twentieth century, particularly during the Cold War, fears expanded beyond chemical agents to include biological pathogens and radiological materials. The targets of chemical weapons also expanded during this era. Many countries began testing defoliants, chemical targeting plants and agriculture, with the famous case being the use of defoliants by the United States during the Vietnam War. Additionally, the domestic use of chemical weapons expanded heavily. For example, in an effort to combat anti - government protests, the Assad regime in Syria used nerve gasses to attack the town of Khan Sheikhoun in 2017.[6] Although large-scale use was limited, extensive research programs and weapons stockpiles revealed the catastrophic potential of these technologies. Simultaneously, rapid industrialization and technological expansion increased the civilian production, storage, and transportation of hazardous chemical and radiological materials, often without commensurate regulatory oversight or emergency preparedness. Industrial facilities, medical institutions, and agricultural operations came to rely on substances originally developed or refined for military purposes, creating vulnerabilities to accidental releases through equipment failure, improper disposal, or human error. These incidents revealed that large-scale humanitarian and environmental harm could occur even in the absence of warfare, underscoring how CBR risks increasingly transcended traditional distinctions between civilian and military domains and necessitated broader international approaches to regulation and safety.[7]

In the late twentieth and early twenty-first centuries, attention shifted toward the long-term consequences of both deliberate and accidental CBR incidents. Industrial chemical disasters, radiological accidents, and cases of biological contamination highlighted persistent environmental damage and public health risks extending far beyond the initial event. These experiences reinforced the need for comprehensive international regulation, emergency preparedness, and global cooperation. Today, CBR threats are increasingly understood not solely as instruments of warfare, but as multidimensional risks that intersect with sustainable development, public health systems, and environmental governance. Modern international

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[5] "Geneva Protocol." 2002. U.S. Department of State. September 25, 2002. https://2009-2017.state.gov/t/isn/4784.htm.

[6] Human Rights Watch. 2017. "Death by Chemicals | the Syrian Government's Widespread and Systematic Use of Chemical Weapons." Human Rights Watch. May 1, 2017. https://www.hrw.org/report/2017/05/01/death-chemicals/syrian-governments-widespread-and-systematic-use-chemical-weapons.

[7] "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction. Opened for Signature at London." n.d. https://www.un.org/en/genocideprevention/documents/atrocity-crimes/Doc.37_conv%20biological%20weapons.pdf.

frameworks—shaped by the cumulative lessons of industrial disasters, accidental releases, and regulatory failures—prioritize preventive risk management, scientific innovation, and cross-border coordination, reflecting a shift from reactive response toward long-term resilience. This evolution demonstrates how historical experiences have transformed global security strategies, embedding CBR risk reduction within broader efforts to protect human well-being, ecological stability, and institutional capacity in an interconnected world.[8]

Background: Contextualizing Regulations

Despite extensive international efforts to regulate and prohibit chemical, biological, and radiological (CBR) weapons, significant challenges persist in the modern era. Rapid scientific and technological advancements have increased the availability of dual-use materials, which are essential for medicine, agriculture, and industry but may be misused for harmful purposes. At the same time, global inequality in preparedness and response capacity leaves many states vulnerable to accidental releases or deliberate attacks, particularly in regions lacking adequate detection systems and emergency infrastructure. Environmental contamination from past incidents continues to threaten public health, food security, and access to clean water, demonstrating that the consequences of CBR hazards often extend across generations. Additionally, the involvement of non-state actors and the complexity of enforcing international agreements further complicate global prevention efforts.[9] Together, these challenges underscore the need for sustained international cooperation, innovation, and alignment with sustainable development goals to effectively address CBR threats in the present day.

The United Nations has played a central role in advancing international efforts to prevent and mitigate the impact of chemical, biological, and radiological threats. Through its agencies, treaties, and coordinating bodies, the UN has supported the implementation of international prohibitions, promoted information-sharing among states, and assisted in capacity-building for detection, preparedness, and emergency response. The organization has also emphasized the connection between CBR risk management and broader goals such as public health, environmental protection, and sustainable development.[10] By facilitating international dialogue, monitoring compliance, and supporting affected states, the United Nations has worked to transform historical lessons into practical mechanisms for prevention and response, though challenges related to enforcement and unequal state capacity remain.[11]

The history of chemical, biological, and radiological warfare demonstrates a consistent truth: policy advances follow tragedy.[12] By studying the past, the international community has developed stronger legal norms, better preparedness strategies, and a growing emphasis on sustainability.

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[8] Wexler, Philip, Steven G Gilbert, Pertti J Hakkinen, and Asish Mohapatra. 2009. *Information Resources in Toxicology*. Amsterdam: Academic/Elsevier.

[9] "Treaty on the Prohibition of Nuclear Weapons | United Nations Office for Disarmament Affairs." 2025.Unoda.org. 2025.http://disarmament.unoda.org/en/our-work/weapons-mass-destruction/nuclear-weapons/treaty-prohibition-nuclear-weapons.

[10] "Countering Chemical, Biological, Radiological and Nuclear Terrorism." n.d. United Nations : Office on Drugs andCrime.https://www.unodc.org/unodc/en/terrorism/expertise/countering-chemical-biological-radiological-and-nuclear-terrorism.html.

[11] "Part IX Subsidiary Organs of the Security Council: Committees, Tribunals and Other Bodies." 1295. https://main.un.org/securitycouncil/sites/default/files/part_ix_2016-2017.pdf#page=21.

[12] "Biological Weapons | United Nations Office for Disarmament Affairs." 2025. Unoda.org. 2025. https://disarmament.unoda.org/en/our-work/weapons-mass-destruction/biological-weapons.

Strengths and Weaknesses in Enforcement

The Syrian chemical weapons crisis illustrates both the strengths and limitations of international CBR enforcement mechanisms. Following confirmed chemical weapons attacks in Ghouta in 2013, including the use of the nerve agent sarin against civilian populations, Syria acceded to the Chemical Weapons Convention under international pressure. A joint UN–OPCW, a collaboration between the United Nations and the Organization for the Prohibition of Chemical Weapons, mission successfully verified and oversaw the removal and destruction of approximately 1,300 metric tons of declared chemical agents and precursors by 2014. However, subsequent investigations by the UN-OPCW Joint Investigative Mechanism documented repeated chemical attacks involving chlorine and sarin between 2014 and 2018, demonstrating the existence of undeclared stockpiles and the limits of compliance verification during active conflict. Restricted access to contested areas, reliance on state declarations, and political divisions within the UN Security Council hindered accountability, allowing chemical weapons use to persist despite formal disarmament. The Syrian case underscores how enforcement mechanisms can succeed technically yet fail politically when state cooperation erodes and geopolitical interests obstruct collective action.

The Syrian case also exposed structural weaknesses in the Chemical Weapons Convention's verification regime when applied to noncompliant states during active conflict. The CWC's verification system, administered by the Organisation for the Prohibition of Chemical Weapons[13], is designed primarily for peacetime compliance and relies heavily on the accuracy and completeness of state declarations. In Syria, inspectors were tasked with verifying declared stockpiles while facing restricted access, ongoing hostilities, and intelligence asymmetries that limited independent assessment of undeclared facilities. The removal of declared materials, while technically successful, did not account for the continued production or weaponization of industrial chemicals such as chlorine, which fall under less stringent monitoring regimes due to their widespread civilian use. This revealed a critical enforcement gap in addressing dual-use substances and underscored the limitations of a treaty framework that assumes baseline state cooperation.

Efforts to address accountability led to the creation of the UN-OPCW Joint Investigative Mechanism[14], which was mandated to attribute responsibility for confirmed chemical weapons attacks in Syria. Between 2015 and 2017, the Mechanism produced reports linking the Syrian government to multiple chlorine attacks and the use of sarin in Khan Shaykhun, as well as identifying non-state actor involvement in limited cases. However, despite evidentiary findings meeting international investigative standards, enforcement stalled due to repeated vetoes within the United Nations Security Council, preventing the renewal of the Mechanism's mandate and blocking punitive measures. This outcome demonstrated that attribution alone is insufficient without political consensus, reinforcing the reality that international CBR enforcement is constrained not by technical capacity, but by geopolitical dynamics. Syria thus serves as a defining example of how international law can establish norms and document violations, yet remain ineffective in deterring repeated use when accountability mechanisms are politically undermined.

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[13] Organisation for the Prohibition of Chemical Weapons. 2019. "Organisation for the Prohibition of Chemical Weapons." OPCW. October 22, 2019. https://www.opcw.org/.

[14] "OPCW-UN Joint Investigative Mechanism (JIM)." 2025. OPCW. 2025. https://www.opcw.org/taxonomy/term/72.

Radiological risk is exemplified by the 1987 Goiânia incident in Brazil, one of the most severe radiological accidents involving civilian radioactive sources. After a radiotherapy machine containing cesium-137 chloride was abandoned in a derelict medical facility, individuals scavenged and dismantled the equipment, unknowingly dispersing radioactive material throughout residential areas. The glowing blue powder was handled, shared, and spread across multiple neighborhoods, resulting in four confirmed deaths, hundreds of contamination cases, and the long-term displacement of affected communities. Cleanup efforts required the demolition of homes, the removal of thousands of tons of contaminated waste, and long-term health monitoring of exposed populations. The incident revealed critical failures in regulatory oversight, public awareness, and secure disposal of radiological materials, particularly in developing urban contexts. Goiânia demonstrates how radiological threats need not stem from hostile intent to produce catastrophic humanitarian and environmental consequences, reinforcing the importance of lifecycle management and international standards for radioactive sources.[15]

The Goiânia incident exposed critical gaps in the regulation, tracking, and disposal of radioactive sources outside military or nuclear power contexts. In response to incidents of this nature, the international community strengthened radiological safety governance through the International Atomic Energy Agency, including the development of the Code of Conduct on the Safety and Security of Radioactive Sources and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. These frameworks emphasize lifecycle control, secure storage, regulatory oversight, and international cooperation to prevent the loss, theft, or improper disposal of radioactive materials. The Goiânia case thus demonstrates how radiological disasters have directly informed the evolution of international norms aimed at mitigating long-term humanitarian and environmental harm.[16]

Taken together, the cases of Syria and Brazil illustrate the cyclical relationship between catastrophe, regulation, and reform in the governance of chemical and radiological hazards. In Syria, repeated chemical weapons use despite formal accession to the Chemical Weapons Convention revealed the limits of treaty enforcement in the absence of political consensus and sustained state cooperation, demonstrating how even robust verification systems can be undermined during active conflict. In contrast, the 1987 Goiânia radiological accident in Brazil—absent malicious intent—exposed systemic failures in the control and disposal of civilian radioactive sources, prompting the strengthening of international safety frameworks under the International Atomic Energy Agency, including the Code of Conduct on the Safety and Security of Radioactive Sources. While Syria highlights the political fragility of enforcement mechanisms, Brazil underscores the regulatory consequences of institutional neglect and uneven capacity. Together, these cases show that effective CBR governance requires not only technical expertise and legal norms, but also continuous oversight, equitable capacity-building, and political will to translate lessons from past failures into durable preventive frameworks.

Case Study: Vietnam

The most famed case of the use of chemical weapons was Operation Ranch Hand, the United States' defoliant project during the Vietnam War. The project originated from a desire by U.S forces to combat the use of dense jungles by Vietnamese guerillas. Ranch Hand itself was

[15] Backhouse, Fid. n.d. "Goiania Accident | Description & Facts | Britannica." Www.britannica.com. https://www.britannica.com/topic/Goiania-accident.
[16] "IAEA Code of Conduct on the Safety and Security of Radioactive Sources." 2026. Nucleus. 2026. https://nucleus.iaea.org/sites/ns/code-of-conduct-radioactive-sources/Pages/default.aspx.

the aerial component of the larger Operation Trail Dust, which involved the testing of multiple different types of defoliants, known as the Rainbow Herbicides[17]. The Rainbow Herbicides were spread all across the former Republic of Vietnam, the most famous being Agent Orange. At the time, international treaties did not bar the usage of defoliants in war. Additionally, the United States claimed that the herbicides used did not have any ill effects on human health. However, these herbicides would quickly spread into Vietnam's waterways and be ingested by humans.[18]

Since the start of the spreading of the herbicides, especially Agent Orange, adverse effects have been reported. Multiple independent studies identified that several cancers and birth defects were linked to Agent Orange. In a 2019 study, scientists identified that Vietnam had a higher rate of congenital heart defects at birth compared to the rest of Asia.[19] Agent Orange also has negatively affected many American veterans of the conflict suffered high rates of disease after the war. Studies have linked the use of herbicides to the deterioration of Vietnam's local ecosystem, harming wildlife, solid quality, and overall biodiversity.[20] Despite multiple independent linking herbicides to these health problems, compensation required decades of legal battles. The U.S refused to acknowledge or compensate victims until 1991, with the passing of the Agent Orange Act. However, the U.S. has only provided direct compensation to U.S veterans. While the U.S has funded clean up efforts through the, now defunct, organization USAID, Vietnamese victims have not received any direct aid from the U.S, nor any international body outside of NGOs.[21]

The use of defoliants has since been banned under the Chemical Weapons Convention (1993), and the U.S has since gotten rid of its chemical weapons. However, the issue of how to deal with the effects of chemical weapons and compensation for victims is up in the air. While there are mechanisms for the recognition of victims of chemical weapons, much of the dealing with the effect of chemicals relies on the domestic government and NGOs.

Case Study: Iraq

Under the United Nations, there are ways for victims to claim compensation. For example, the United Nations Compensation Commission was set up in order to file claims and compensate victims of Iraq's 1991 invasion of Kuwait.[22] This was an effective way to compensate monetarily, but it did not address any environmental concerns. International litigation has proven to be effective, however as seen with use of herbicides in Vietnam it has its

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[17] United States: Defense Department: Air Force Department, William A. Buckingham, William A. Buckingham, and United States: Air Force.: Office of Air Force History. 1982. *Operation Ranch Hand: The Air Force and Herbicides in Southeast Asia, 1961-1971*. Defense Department. https://purl.fdlp.gov/GPO/LPS48689.

[18] "In Vietnam, the Health Effects of Agent Orange Remain Uncertain 50 Years Later | Science | AAAS." n.d. Accessed January 20, 2026. https://www.science.org/content/article/vietnam-health-effects-agent-orange-remain-uncertain-50-years-later.

[19] Giang, Hoang Thi Nam, Tran Thanh Hai, Hoang Nguyen, Thanh K. Vuong, Lois Wright Morton, and Casey B. Culbertson. 2022. "Elevated Congenital Heart Disease Birth Prevalence Rates Found in Central Vietnam and Dioxin TCDD Residuals from the Use of 2, 4, 5-T Herbicides (Agent Orange) in the Da Nang Region." *PLOS Global Public Health* 2 (10): e0001050. https://doi.org/10.1371/journal.pgph.0001050.

[20] Truong, Kiem N., and Khuong V. Dinh. 2021. "Agent Orange: Haft-Century Effects On The Vietnamese Wildlife Have Been Ignored." *Environmental Science & Technology* 55 (22): 15007–9. https://doi.org/10.1021/acs.est.1c06613.

[21] Yale E360. n.d. "Fifty Years After, A Daunting Cleanup of Vietnam's Toxic Legacy." Accessed January 20, 2026. https://e360.yale.edu/features/fifty-years-after-a-daunting-cleanup-of-vietnam-toxic-legacy-dioxin-agent-orange.

[22] McGovern, Francis. 2009. "Dispute Systems Design: The United Nations Compensation Commission." *Harvard Negotiation Law Review* 14 (January): 171–93.

shortcomings. Vietnamese victims of herbicide usage during the Vietnam War have sued the U.S government under the Alien Tort Statute, but U.S courts cited the statute of limitations and government sovereignty, ultimately striking down the claims.[23] There is no standard international framework for victims of CRBN warfare to claim compensation from any government, or international body.

Furthermore, international bodies are often prevented from addressing the usage of chemical weapons due to sovereignty concerns. CRBNs since Agent Orange have largely been used in domestic conflicts that the United Nations have little influence over. The United Nations additionally often relies on countries being transparent enough to report and destroy their chemical stockpiles. In many cases in which countries refused to allow U.N. observers to access CRBN sites, outside coercion had to be relied on. For example when Saddam Huessein was the leader of Iraq, he refused to allow U.N. observers access to any of Iraq's nuclear or chemical weapon sites. He refused to comply with international treaties that dictated their destruction. It wasn't until in late 1998, that three days of military strikes by joint U.S. - U.K. forces and multiple sanctions did Saddam Huessein allow limited access to CRBN sites.[24]

These restrictions also extend to observing areas impacted by CRBNs, and limits how much the U.N. can respond to the effects of CRBNs. In cases of civil war, or domestic strife, U.N observers are often under constant threat which hampers how effective they can be at their jobs. Many countries that suffer from the effects of CRBNs rely on international technical guidance in order to address the effects. However, these concerns fall to the wayside due to larger conflicts taking center stage. This issue often continues after conflict when the economic state of areas affected by CRBNs prevents countries from addressing the effects. Degradation of key infrastructure, such as roads and hospitals, prevents effective addressing of CRBN effects.[25]

Domestic usage of CRBNs proves to be problematic. The limited domestic use of "riot control agents", such as tear gas, is expected from the limitations placed on chemical weapons.[26] However, this term is often vague and has been used to justify the usage of lethal chemicals in cases of domestic strife. The United Nations is always limited in how it can interfere in civil conflicts. Much of this boils to division within the Security Council, especially among its five permanent members. For example, when the Assad regime used chemical weapons in Syria the Security Council passed resolution 2118. However, this failed to go far enough in dismantling the regime's chemical weapon enterprise. Divisions among the Security Council prevented complete dismantlement of all of Syria's chemical weapon sites.[27] These disagreements stem from an inability to agree on proper actions, and the own political biases of each member.

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[23] Chemical & Engineering News. 2025. "Agent Orange Suits Dismissed." January 21. https://cen.acs.org/articles/86/i9/Agent-Orange-Suits-Dismissed.html.

[24] "Iraq: A Chronology of UN Inspections | Arms Control Association." n.d. Accessed January 20, 2026. https://www.armscontrol.org/act/2002-10/features/iraq-chronology-un-inspections.

[25] Opatowski, Sarah Ruth. 2023. *Addressing Chemical and Biological Weapons in the Context of a Middle East WMD-Free Zone – Workshop Report*. UNIDIR. https://doi.org/10.37559/MEWMDFZ/2023/CBW.

[26] "Riot Control Agents." n.d. Accessed January 20, 2026. https://ihl-databases.icrc.org/es/customary-ihl/v2/rule75.

[27] "Action Urgently Needed to Clarify, Eliminate Syria's Chemical Weapons, Senior Disarmament Official Warns Security Council | UN Meetings Coverage and Press Releases." n.d. Accessed January 20, 2026. https://press.un.org/en/2026/sc16272.doc.htm.

Conclusion

In order to address the effects of chemical, biological, and nuclear threats, the committee should focus on two key areas. First, the development of strengthened international litigation and accountability mechanisms is essential to provide clearer, enforceable pathways for victims to obtain compensation and recognition, particularly in cases where state responsibility or regulatory negligence has been established. Organizations like the UN-OPCW Joint Investigative Mechanism are instrumental in this regard. Second, the committee must address the transparency, verification, and infrastructure limitations that hinder effective response, including gaps in monitoring dual-use materials, uneven national preparedness, and political barriers within the United Nations system. Agreements like the Chemical Weapons Convention are good starting points, but must be supplemented with an emphasis on preparedness and additional verification. By improving coordination, investing in capacity-building, and reinforcing compliance frameworks, the international community can move beyond reactive measures and more effectively mitigate the long-term humanitarian, environmental, and developmental consequences of CBRN hazards.

Guiding Questions

1. How can the United Nations increase transparency in order to more effectively address the effects of CRBN usage?
2. In what ways can an international litigation system be set up in order to compensate victims of CRBNs?
3. In places of conflict, how can CRBN usage and their effects be addressed by the United Nations without the need for military intervention?
4. In places of degraded infrastructure, how can the United Nations better address the effects of CRBNs?
5. In what ways should the United Nations address the domestic usage of CRBNs in cases of domestic/civil conflict?