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Radiological and nuclear terrorism:
definition, nature, scenarios and
deterrence

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Abstract:

This article seeks to analyze and understand the radiological and nuclear terrorism phenomenon in order to develop adequate strategies for its deterrence and to address the different scenarios in which it can manifest. Starting from the legal definition of radiological and nuclear terrorism, this paper elaborates a study of its main characteristics, focusing on the non-state nature of the terrorist actors within the context and dynamics of the second nuclear age.

Based on this analysis, this paper will briefly portrait the different scenarios that can be encountered when addressing a case of nuclear terrorism, mainly, the liberation of radiological and nuclear elements and possession of nuclear artifacts and elements by terrorist non-state actors. Finally, several adapted deterrence strategies are proposed, crystalized in deterrence by punishment and deterrence by denial.

Keywords:

Terrorism, radiological and nuclear and terrorism, horizontal proliferation, non-state actors, weapons of mass destruction, second nuclear age.

***NOTE:** The ideas contained in the Opinion Papers shall be responsibility of their authors, without necessarily reflecting the thinking of the IEEE or the Ministry of Defense

Introduction

According to the International Convention for the Suppression of Acts of Nuclear Terrorism of the United Nations, in 2005, nuclear terrorism “may result in the gravest consequences and may pose a threat to international peace and security”. The same document recognizes that the matter is worthy of deep concern because of “the worldwide escalation of acts of terrorism in all its forms and manifestations¹”.

By combining the articles 1 and 2 of this Convention, it is possible to establish a broad definition of nuclear terrorism as: *The possession, use, or the credible threat of using, nuclear or radiological materials, devices or installations by non-state actors in order to cause physical or material damages, whose final goal should be achieving a political purpose.*

This definition encompasses a material dimension (*actus reus*), that would be the illegal possession or use of radioactive or nuclear materials or installations (Art. 2.1.) linked to an intention or subjective dimension (*mens rea*). In this case, that intention would involve causing (or threatening to cause) personal or material damages in order to coerce an actor, be it an institution, individual or state, to comply with the terrorist group’s demands. That is, pursuing a political objective through fear.

This scenario assumes that non-state actors might “go nuclear”. And such is not a vain threat, as it is known that terrorist groups have been actively trying to obtain nuclear materials and knowledge². For instance, Al-Qaida, or the Chechen separatists³. In 2006, Al-Qaida’s leaders called for nuclear

¹ “International Convention for the Suppression of Acts of Nuclear Terrorism”. Naciones Unidas. 2005. Available at: <https://treaties.un.org/doc/db/Terrorism/spanish-18-15.pdf>. Consulted: 22.11.2018.

² RHULE, Michael. “Analysis. The nuclear dimensions of jihadist terrorism.” The NATO review, 2007. Available at: https://www.nato.int/docu/review/2007/Growing_Dangers/Nuclear_jihadist_terrorism/EN/index.htm. Consulted: 22.11.2018.

³ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 46-49, 95.

scientists to join the *jihad* on Iraq⁴, a trend that other terrorist groups⁵ have been actively following, including the ISIS⁶ in recent times⁷.

In 2004 the United Nations Security Council unanimously passed the Resolution UNSCR 1540, that labels non-state actors and terrorist control of weapons of mass destruction as a threat to international peace and, thus, invites member states to enforce enough regulatory measures in order to contain such threats⁸. Figures like Barack Obama, Vladimir Putin and IAEA's (International Atomic Energy Agency) Director General Yukiya Amano, further labeled this threat as real in 2013⁹.

These statements take out of any reasonable question about the existence of this peril. However, so far there are no confirmed cases of nuclear terrorist attacks and, therefore, the present study has to bear a speculative element to some extent.

Vertical and horizontal proliferation. The two nuclear ages

It is possible to distinguish two broad “nuclear ages” each one of them involving its own concerns and strategic concept that marked how the world understood the advent of nuclear weaponry.

⁴ BUNN, Matthew & BIELEFEND, Tom. “Reducing nuclear and radiological terrorism threats”. Harvard University, 2007. P, 1-2.

⁵ “9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks Upon the United States”. National Commission on Terrorist Attacks upon the United States, the 1st ed. (New York: Norton, 2004), p. 245.

⁶ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 9, 13-14.

⁷ “The smugglers trying to help ISIS make a dirty bomb”. New York Post. 2015. Available at: <https://nypost.com/2015/10/07/the-smugglers-trying-to-help-isis-make-a-dirty-bomb/> Consulted::22.11.2018.

⁸ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 117.

⁹ BUNN, Matthew. et al. “Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?”. Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P.14.

First nuclear age: vertical proliferation and Cold War

The most important scenario in which atomic weaponry can be placed is the Cold War. Tension between the two main nuclear powers of that time and their blocs, Western and Eastern, constituted the most characteristic dynamic of the first nuclear age, that started when the first atomic weapons were used in Hiroshima y Nagasaki (1945) and lasted until the fall of the Soviet Union (1991) and the end of the Cold War itself.

This era was characterized by the presence of a few states that accumulated great amounts of nuclear weaponry¹⁰ (vertical proliferation). It was a very stable bipolar system, as it was assumed that both the United States and the Soviet Union, being state-actors, would act in a rational way, taking into account their best interest and seeking their own survival. An all-out conflict between them, thus, would lead to a Mutual Assured Destruction (M.A.D.) scenario, with no positive outcome whatsoever¹¹.

The second nuclear age: horizontal proliferation

Within the second nuclear age, that still lasts today, atomic annihilation no longer seems probable, but nuclear weapons are still present in the international scenario and the threat they represent might have changed, but it has not vanished

Probably, the most significant element that characterizes this second nuclear age is horizontal proliferation, as opposed to the previous vertical proliferation. This means that, even if the number of nuclear warheads that the state-actors have has not increased and, in fact, it has been reduced thanks to international agreements (like the Non-Proliferation Treaty), currently, there are many more atomic-capable actors. That is why uncertainty in this new scenario is far greater than it was on the “stable

¹⁰ NORRIS, Robert & KRISTENSEN, Hans. “Global Nuclear Stockpiles”, 1945–2006. Bulletin of the Atomic Scientists, 2006. Vol. 62, No. 4, pp. 64-67

¹¹ CALDUCH, Rafael. “Relaciones internacionales” Ediciones Ciencias Sociales, Madrid, 1991. P, 385, 388-392, 397.

and predictable” Cold War’s bipolar system.

The historical trend that contributes to the scientific knowledge’s spread¹² has increased the number of countries and non-state actors with nuclear capabilities. Thus, there is a chance for non-state elements to take control of atomic devices. The traditional idea of a nuclear proliferation occurring only between states has proven false in this new second nuclear age¹³, that remains filled with uncertainty about the actors that could master nuclear technologies for illegal purposes, their intentions and strategies.

Even within state-actors, that do share the same overall nature, we cannot neglect the fact that each one of them has a different strategic culture, their own perception of the world, of their interests and of the intentions of other actors, etc. Because of this, perfect compliance with deterrence models or theories is not to be expected. If this is true for state elements, the uncertainty in this scenario is greatly increased if non-state actors are involved. Non-state actors, being essentially different, must be studied accordingly¹⁴.

The especial nature of terrorist non-state actors

Terrorism can be widely defined as the use of violence (be either effective use or threat) carried out by non-state actors in order to achieve a political purpose through fear and coercion¹⁵. When talking about non-state actors, both terrorist groups and individuals (“lone wolves”) can be included¹⁶.

Without getting involved in the complex topic of terrorism, it is important to highlight the fact that these groups do follow violent, extremist and radical

¹² CALDUCH, Rafael. *Ídem*. P, 373-374.

¹³ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 19-21.

¹⁴ BUNN, Matthew et al. “Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?” Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P. 17-19.

¹⁵ DE LA CALLE, Luis. & SÁNCHEZ-CUENCA, Ignacio. (2011) “*What We Talk About When We Talk About Terrorism*”. *Politics & Society*, 2011. 39: 451. P, 452-455.

¹⁶ For the purposes of this article, by using “terrorist groups” we encompass both realities.

motivations in any dimension¹⁷. Thus, it can be assumed that it is possible that these terrorists do not act as it could be expected from a rational actor. And this must be taken into account when trying to design a strategy able to deter them.

Another element to note is the fact that terrorism uses asymmetrical warfare tactics due to the huge military power gap that exists when compared to states. Direct victory, thus, is impossible for the smaller groups, like the terrorists, and they must rely on sabotages, assassinations, hijacks, etc.¹⁸ Even if these attacks are able to cause a certain degree of attrition on the enemy troops and a sensation of fear on the population, important victories are not likely to be achieved. And here is where nuclear weaponry can contribute by providing the terrorist group with a destructive power that could be easily employed without the rational, legal or moral constraints that shackle state-actors¹⁹.

Nuclear weaponry, therefore, would be another way the terrorists could follow in order to achieve their political objectives within their “Grand Strategy” and this is especially dangerous for certain organizations that seek to cause as many victims as possible²⁰, even if that implies the elimination of the group itself or its members.

On top of this, terrorist actors lack territory²¹. This inevitably leads to the next conclusion: they do not fear retaliations, not in the traditional sense at least. Many terrorist groups do not dread elimination and, in fact, can willingly embrace self-destruction, as it is the case with suicide bombers. Considering that the terrorists are usually mingled with the local

¹⁷ BUNN, Matthew. et al. “Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?” Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P, 22-23.

¹⁸ PINEDO, Carlos Antonio. “Caracterización de la guerra asimétrica en el contexto de las relaciones internacionales”. Nueva Granda Militar University, 2013. P, 48-49.

¹⁹ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 35-37.

²⁰ GREGG, Heather. “Defining and Distinguishing Secular and Religious Terrorism”. Perspectives on terrorism. Volume 8, Issue 2. 2014. P. 38-39.

²¹ DE LA CALLE, Luis. & SÁNCHEZ-CUENCA, Ignacio. “What We Talk About When We Talk About Terrorism”. Politics & Society, 2011. 39: 451. P, 457-459.

population, they do not have defined facilities and territories²² and they act underground, a traditional military or nuclear attack would make little sense. Furthermore, the decentralized, multinuclear nature of these groups and their loose command chains increase their resilience against such actions²³.

Traditional concepts of nuclear deterrence, like the M.A.D., therefore, are no viable option. Because of this, new ways to address nuclear terrorism must be seek and, in order to do that, it is pivotal to understand the different scenarios in which nuclear terrorism may occur.

Different strategies/scenarios of nuclear terrorism

Terrorist access to nuclear elements

The possibility of terrorist groups being able to access radiological or nuclear elements must be addressed. Because of the first steps on the development of both nuclear weapons and nuclear energy being largely the same, it is possible for terrorist groups to buy or steal radioactive elements, like plutonium or uranium. Many civilian radiological/nuclear repositories²⁴, like research facilities, are not sufficiently controlled and protected, even in the most advanced economies, and they would not be able to withstand a terrorist assault²⁵. Industrial or medical products containing radioactive elements can be used for illegal purposes as well²⁶.

The efforts that terrorists have spared trying to steal nuclear materials are not scarce. The IAEA's Incident and Trafficking Database (ITDB), created

²² With some exceptions, like the ISIS.

²³ PINEDO, Carlos Antonio. "Caracterización de la guerra asimétrica en el contexto de las relaciones internacionales". Nueva Granda Militar University, 2013. P. 42-43.

²⁴ BUNN, Matthew. et al. "Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?". Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P. 24-25.

²⁵ BUNN, Matthew & BIELEFEND, Tom. "Reducing nuclear and radiological terrorism threats". Harvard University, 2007. P. 1-3.

²⁶ "Preventing Nuclear Terrorism. Fact Sheet". Union of Concerned Scientists, 2004.

in 1995, holds records of incidents of illicit possession or trafficking of nuclear and other radioactive materials reported by the member states. During the year 2016, 189 incidents in 34 different states were accounted, making for a total of 3.068 confirmed reports since 1993. Out of them, 270 cases are labeled as highly dangerous²⁷.

Releasing radiologic/nuclear materials

Probably the most cost-efficient option for a terrorist group is the creation of a “radiation dispersal device” (RDD) or, as it is usually known, a “dirty bomb”²⁸. This is a simple artifact that employs conventional explosives for spreading radioactive materials. Those elements represent an inherent danger for the population’s health, especially if they are released over sensitive areas, like train stations or water reservoirs²⁹. The persisting and lethal effects of radiation could render inhabitable extensive areas during long periods of time with the subsequent social and economic shock. This is why dirty bombs are called “weapons of mass disruption”.

A dirty bomb does not require specialized facilities³⁰, costly equipment or a vast know-how. In fact, it does not even require weapons-grade fissile material, being enough the usage of other radioactive sources that can be more easily found, like strontium or cesium, that are used on hospitals³¹.

The usage of a dirty bomb would, furthermore, benefit from the asymmetrical warfare tactics and from the *modus operandi* on which these groups already have operational experience and, therefore, they know

²⁷ “Incidents of nuclear and other radioactive material out of regulatory control. 2017 Factsheet”. IAEA Incident and Trafficking Database. 2017.

²⁸ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 46-50.

²⁹ BUNN, Matthew. et al. “Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?”. Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P. 1-4, 9, 13, 98-99.

³⁰ “Backgrounder on Dirty Bombs”. U.S. Nuclear Regulatory Commission. Available at: <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-dirty-bombs.html>. Consulted: 22.11.2018.

³¹ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 46.

how to optimize their resources in order to fulfill this kind of attacks.

Another option would involve attacking pre-existent nuclear facilities³², like power plants or atomic fuel storages, in order to damage them, destabilize them and create a leak of these materials.

Taking into account the terrorist's experience on this field, they could easily use bomb cars or other vehicles in order to crash them against these nuclear installations, or they could use conventional weaponry or explosives to damage them. However, even if these actions can cause leaks of nuclear material, it is not possible to create a nuclear explosion on a civilian reactor³³. Internal sabotages carried out by sleeping cells or infiltrated terrorists, however, can cause meltdowns and nuclear disasters.

These acts allow the terrorists to carry out radiological/nuclear attacks without possessing radiological/nuclear materials themselves. While dirty bombs do require a small amount of these elements, that can be difficult to obtain, attacking a nuclear facility can be fulfilled through conventional means.

Finally, it is also possible to carry out cyber-attacks that could compromise the stability of nuclear facilities, for instance, the "Stuxnet" virus³⁴.

Terrorist groups in possession of nuclear warheads

There are three ways that non-state actors can use in order to reach nuclear capabilities: transference, theft (seizure) and self-production³⁵.

Transference is defined as the deliberated and arranged sale of a weapon, its key components or technological know-how.

³² BUNN, Matthew. et al. "Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?". Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P. 114-115.

³³ "Nuclear Terrorism Fact Sheet". Belfer Center for Science and International Affairs, 2010.

³⁴ "Stuxnet worm hits Iran nuclear plant staff computers." BBC News. Available at: <https://www.bbc.com/news/world-middle-east-11414483>. Consulted: 23.12.2018.

³⁵ LITWAK, Robert. "Deterring nuclear terrorism". Woodrow Wilson International Center for Scholars, Washington, 2016. P, 41-46.

The creation of an atomic bomb itself it is a very unlikely endeavor for a terrorist group to embark on, no matter the amount of money or resources it might have³⁶. However, it is not impossible for these organizations to have access to nuclear devices via smuggling, or even buying them from nuclear-capable countries.

North Korea, in fact, has stated its willingness to sell nuclear weaponry to anyone that can afford it³⁷. The Black Market³⁸ may also be a feasible source of opportunities for terrorist groups.

Theft, on the other hand, can be defined as the unauthorized seizure of a nuclear weapon, its components or materials³⁹. It might happen, among many other reasons, because of the lack of governmental vigilance or accountability over atomic devices or elements⁴⁰.

Even assuming that the terrorists are able to acquire or seize a nuclear warhead, its launch, for instance, through an expensive and complex ballistic missile would not be a feasible option. A terrorist missile could be easily intercepted and destroyed by modern BMD (Ballistic Missile Defense) systems, like the NORAD (*North American Aerospace Defense Command*)⁴¹.

Again, the best option for these groups is using a *modus operandi* that they already know and master. Should they be able to acquire an atomic warhead⁴² small enough to be carried on a suitcase or a car (the lightest nuclear weapons can weight around 25 or 30 kg), it could be easily

³⁶ LITWAK, Robert. *Op. Cit.* P, 44-45.

³⁷ *Ídem.* P, 6, 13, 30, 69-71.

³⁸ RHULE, Michael. "Analysis. The nuclear dimensions of jihadist terrorism." The NATO review, 2007. Available at: https://www.nato.int/docu/review/2007/Growing_Dangers/Nuclear_jihadist_terrorism/EN/index.htm. Consulted: 22.11.2018.

³⁹ Esto implica, por tanto, que dichos componentes o armas deben ser sustraídos de un actor con capacidad nuclear, normalmente un Estado.

⁴⁰ LITWAK, Robert. "Deterring nuclear terrorism". Woodrow Wilson International Center for Scholars, Washington, 2016. P, 43-44.

⁴¹ *Vid:* NORAD. Available at: <http://www.norad.mil/>. Consulted: 28.11.2018.

⁴² "Nuclear Terrorism Fact Sheet". Belfer Center for Science and International Affairs, 2010.

disguised, transported and detonated on the target. Security controls may make this endeavor much more difficult indeed, but here is where the expertise and operational experience of the terrorists in those areas must be carefully considered, as terrorist attacks on developed countries under strong security measures are not scarce. Other option for them would be striking the Third World, whose cities usually lack strong security measures, or other areas with no strong vigilance, making these attacks much easier.

Finally, even considering the complexity of nuclear devices, it is still possible that terrorist groups could produce their own improvised artifacts⁴³ instead of obtaining them through other ways⁴⁴, which gives them a higher degree of autonomy.

In order to produce a nuclear weapon, the group would need fissile material and a detonation system⁴⁵, be either a “gun-type” or implosion mechanism.

“Gun-type” nuclear weapons use conventional explosives for propelling two sub-critical pieces of fissile material together in order to start the chain reaction. They are far simpler to design and construct and, thus, it would be the natural choice for most terrorist groups. The implosion bomb needs less fissile material, but it is more complex, as it requires the usage of conventional explosives to compress the core of fissile material until it reaches the critical mass needed to start the reaction.

⁴³ LITWAK, Robert. “Deterring nuclear terrorism”. Woodrow Wilson International Center for Scholars, Washington, 2016. P, 44-46.

⁴⁴ BUNN, Matthew et al. “Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?” Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P. 4, 88.

⁴⁵ “Science Behind the Atom Bomb”. Atomic Heritage Foundation, 2014. Available at: <https://www.atomicheritage.org/history/science-behind-atom-bomb>. Consulted: 17.11.2018.

Fissile material needed by each detonation system

| Type of fissile material / Type of device | Uranium (HEU) | Plutonium |
|--|------------------|--------------|
| Simple gun-type weapon | 40 – 50 kg | Not possible |
| Simple implosion weapon | 9 – 12 kg | 6 kg |

Table 1: Fissile material needed by each detonation system.

Source: Preventing nuclear terrorism. Fact Sheet. Union of Concerned Scientists, 2004.

Deterrence

Deterrence can be defined⁴⁶ as a relationship between two actors in which one of the parties (deterrer) tries to induce the other (deterred) to carry out or not to carry out certain actions by employing the threat of causing damage, but not necessarily involving the use of actual force or the execution of said threat.

The effectiveness of the deterrence effect can be calculated using the following formula. Therefore, any effective deterrence policy should involve the capability of actually carrying out the stated threat and the intention or will to fulfill it and, thus, to cause enough damage on the other actor for it to feel deterred and, eventually, comply⁴⁷. This damage can be military, economic, political, etc. and has to be unavoidable, otherwise, this value would be zero. And a zero value in any variable would involve a zero in the final outcome.

Deterrence effect= Estimated capabilities of the actor x Estimated intentions of the actor x Estimated damage output of the measures.

However, non-state actors, like terrorist groups, do not fully adapt to the classical Cold War deterrence models. As a complementary option, in order to tackle the menace that these organizations might pose, this article

⁴⁶ CALDUCH, Rafael. "Relaciones internacionales". Ediciones Ciencias Sociales, Madrid, 1991. P, 380-381.

⁴⁷ CALDUCH, Rafael. *Op. cit.* P, 383-385.

proposes the usage of the classical threat formula and analyzes how each one of its components should be addressed in order to minimize the final value⁴⁸.

Threat = (Intentions × Capabilities) – Counteractions.

Even if these deterrence strategies are not fully able to cope with terrorist organizations, sponsor states, as rational state-like actors with a territory, and a population, are still vulnerable to slightly adapted classical deterrence. This article proposes several deterrence strategies that could be applied, but they should be effectively combined and integrated in order to successfully address nuclear terrorism.

Intentions and deterrence by punishment

Intentions are the most difficult variable to address in this equation, as they are defined as the moral or political motivations that drive the terrorists⁴⁹. Intentions are exclusively managed by the terrorists themselves and, thus, it is a variable in which the state cannot fully intervene.

Through certain actions (economic aids for the population, support for pacific religious or moral discourses, etc.) it is possible to undermine, to some extent, the motivations of the terrorist groups⁵⁰. Appeasement can be also considered in order to reduce this variable, but this option should be carefully considered.

Deterrence by punishment⁵¹ plays a vital role, especially when addressing sponsor states. This strategy aims to prevent countries from sponsoring nuclear terrorism actions through the statement of a credible threat of

⁴⁸ BUNN, Matthew. et al. "Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?" Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P. 26

⁴⁹ Also applicable to sponsor states.

⁵⁰ RHULE, Michael. "Analysis. The nuclear dimensions of jihadist terrorism." The NATO review, 2007. Available at: https://www.nato.int/docu/review/2007/Growing_Dangers/Nuclear_jihadist_terrorism/EN/index.htm. Consulted: 22.11.2018.

⁵¹ LITWAK, Robert. "Deterring nuclear terrorism". Woodrow Wilson International Center for Scholars, Washington, 2016. P, 82-84, 119-122.

punitive countermeasures (Invasion, bombardment, nuclear retaliation, economic embargoes, etc.) Assuming a rational calculation, a country would act according to its interests and seek its own interest and survival, following this formula.

$$\text{Rational decision} = (\text{Potential benefits} \times \text{Probability of benefits happening}) \\ - (\text{Potential damages/losses} \times \text{Probability of damages/losses happening})$$

For nullifying the intentions of a country of sponsoring nuclear terrorism, the negative side of the equation must be increased as much as possible, so the benefits of said action will be overwhelmed by the potential damages. The potential damages would be defined by the scope and nature of the threat, while the probability would be mostly influenced by the threatening country's credibility or actual possibility of carrying out said punitive measures.

Applied to nuclear terrorism, deterrence by punishment would involve tracking illegal or dangerous transferences of any nuclear material or device to its source and, then, holding the country that has provided these elements to the terrorist groups as fully accountable of all the consequences, making it fear the possible retaliations.

This strategy, mainly followed by France, Great Britain and the United States, presents two practical problems. First, it is difficult to draw a "red line" between peaceful transactions with another countries and transferences with terrorist groups, and it is equally difficult to track a certain element or material to its very source with pinpoint accuracy. Secondly, holding a country as fully accountable has no effects whatsoever if it is not accompanied by an actual retaliation or a credible threat that, in many occasions, can be forfeited because of a variety of reasons.

Means and deterrence by denial: arms control

Capabilities do refer to the actual physical, material means that the terrorist groups possess in order to fulfill their intentions and goals. Those elements do include personnel, money or other material resources, but also know-how, operational experience, etc.

Capabilities are considered, somehow, as a mixed ground, for its value depends on both the state actor's policies for diminishing them, and on the terrorist organization's efforts to acquire them

Deterrence by denial is, thus, defined as the strategy that aims to affect the capabilities of states or non-state actors by preventing them to actually reach the resources that they need in order to undertake action⁵². It takes two different approaches: denial by arms control and denial by defensive measures.

Deterrence by denial through arms control focuses on reducing or regulating the proliferation of nuclear weapons and reducing the already existing stockpiles of nuclear warheads. By diminishing the number of these devices or weapon-grade materials, the probability of any of them falling in the hands of terrorist groups is also reduced. This form of deterrence can be applied through international agreements and measures and, thus, requires some degree of interstate cooperation and negotiation, but non-cooperative measures can also be adopted.

However, due to the anarchic nature of the international system, there is no way to enforce these treaties, the presence of multiple parts makes difficult to hold a reasonable degree of control and, plus, adhesion to these tools is voluntary⁵³.

⁵² LITWAK, Robert. *Op. cit.* P, 23-24,122-128.

⁵³ The "arms control paradox" should also be taken into account here, as it states that arms control is possible when it is not necessary and it is impossible when it is necessary.

Counteractions and deterrence by denial: defensive measures

Finally, the counteractions and defensive measures are the variable in which the state actors have more influence, as they can increase or diminish the resources that they are going to allocate at will. By increasing the quality or quantity of the state's countermeasures, it is possible to locate the potential terrorist threat, disable it or resisting its effects. Within this topic, proactive and reactive measures can be discussed.

First, proactive, preventive, measures should involve trying to keep the terrorist groups from getting access to dangerous materials or devices⁵⁴. Increasing internal and transport measures might be a convenient way for detecting and disabling any smuggling attempt. Enforcing protection and accountability programs in nuclear facilities is also pivotal in order to avoid assaults and seizures⁵⁵.

By keeping the terrorists from obtaining the materials they need, therefore, the immediate configuration of the threat is nullified⁵⁶. If, for any reason, the terrorist group successfully creates a nuclear weapon, then the threat is materialized and reactive measures should be taken.

The localization and elimination of nuclear-capable terrorist cells (or Black Market elements) emerges, then, as a vital objective. This is a preemptive conception, as it would involve a military action whose final state would be neutralizing and immediate threat that, even if it has not been yet executed, it would doubtless be in the near future.

If all these measures fail and the threat is successfully executed, countries should have strong contingency and damage control plans. The main goal of these plans would be resisting or minimizing the harmful effects of said

⁵⁴ Even if the number of said materials has not been reduced, as it has been stated in the arms control case.

⁵⁵ BUNN, Matthew. et al. "Preventing Nuclear Terrorism. Continuous Improvement or Dangerous Decline?". Harvard Kennedy School, Belfer Center for Science and International Affairs, 2016. P, 70-75, 104-108.

⁵⁶ LITWAK, Robert. "Deterring nuclear terrorism". Woodrow Wilson International Center for Scholars, Washington, 2016. P, 26-27, 30, 41, 117-119.

attack, for instance, by quickly cleaning the area contaminated by a dirty bomb, by repairing a leak on a nuclear facility, etc.

Conclusion

Horizontal proliferation, within the second nuclear era's dynamics, has allowed non-state actors to acquire nuclear technologies and has created radiological and nuclear terrorism as a new and important threat.

These terrorist groups have a different nature when compared to state actors, and they follow different logics. Therefore, they cannot be addressed following the classical models. It can be assumed that terrorist groups are not fully rational actors (at least according to the traditional conception), that they can incorporate nuclear weaponry to their asymmetrical warfare tactics, that they lack a defined territory and that they mingle with the population. Therefore, they do not fear retaliation, and retaliation is actually difficult to be executed on them.

Terrorists could perform this kind of radiological/nuclear attacks through the releasement of radiologic/nuclear materials (dirty bombs, attacks to facilities, etc.) or even have their own bought, seized or self-produced nuclear devices. In any case, they should use these resources by taking advantage of their ample operational expertise on asymmetrical warfare tactics.

Any deterrence strategy against nuclear terrorism must be addressed in a very flexible way by modifying and adapting the traditional conceptions. On this issue, it is recommended to work on the intentions and capabilities that constitute the terrorist threat and on the possible state counteractions through the adequate combination of deterrence by punishment and deterrence by denial strategies.

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