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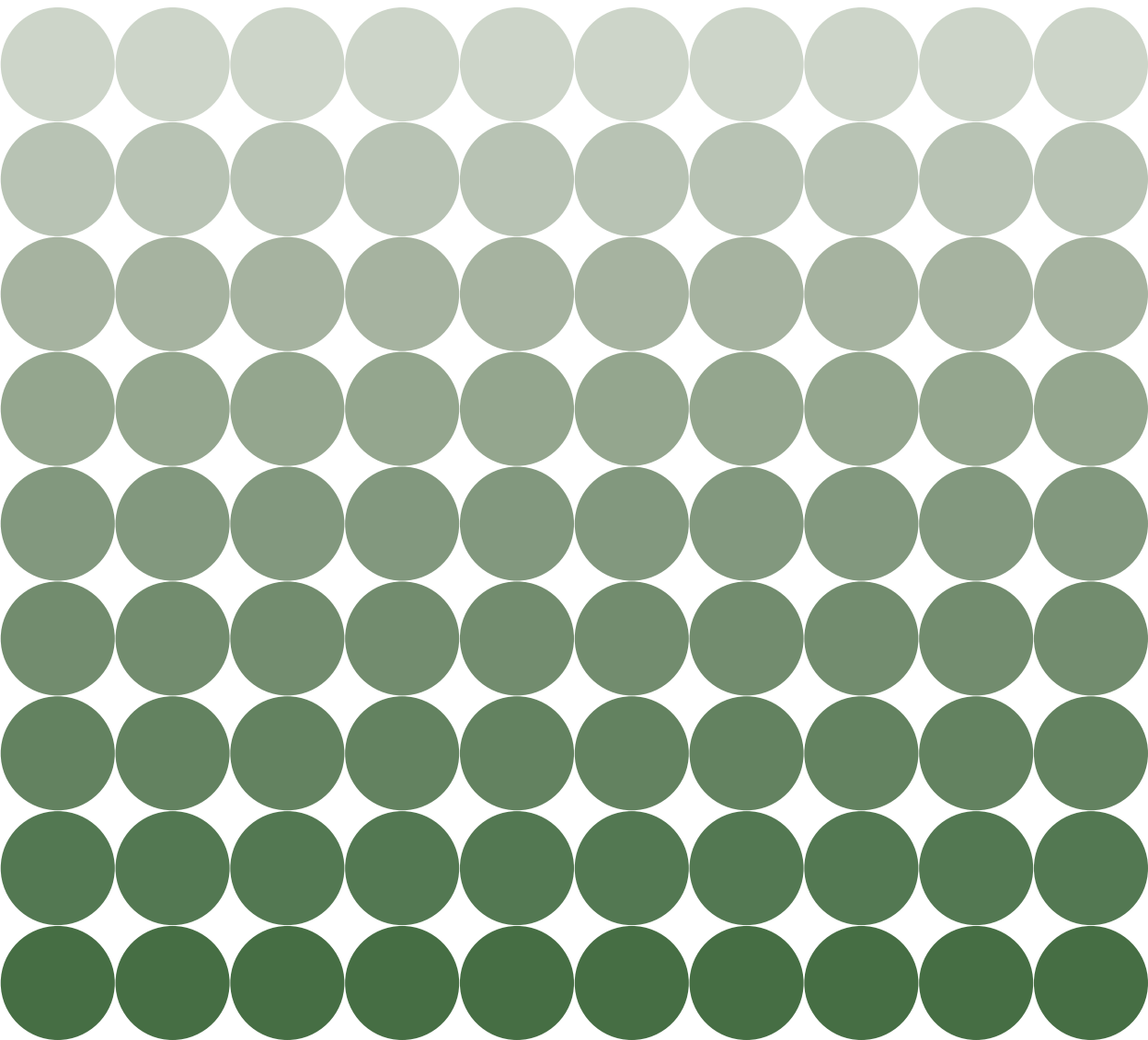
NUCLEAR SECURITY IN THE BLACK SEA REGION

Contested Spaces, National Capacities and Multinational Potential

VITALY FEDCHENKO AND IAN ANTHONY



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Preface

In the 1990s, the dissolution of the Soviet Union generated a range of challenges for international policy-makers. Among them were the risks created by the concomitant dissolution of its integrated system of governance and control of a vast nuclear fuel cycle. This was a primary nuclear security concern. In the 2000s the concern about nuclear smuggling was combined with the fear that nuclear and radioactive materials would be used in mass-impact terrorist attacks. By the 2010s the nuclear security agenda had expanded further, to take account of new risks such as the targeted use of poisonous materials in terrorist attacks and the vulnerability of critical facilities to cyberattacks.

The period after the end of the cold war saw a progressive expansion in nuclear security cooperation from emergency measures on the territory of the former Soviet Union to a broader effort to address specific nuclear security risks. To generate the political support necessary to sustain the national, regional and international efforts a 2009 Summit on Nuclear Non-proliferation and Nuclear Disarmament established a precedent for the United Nations Security Council to engage regularly on the issue of proliferation risks and how they should be managed. Between 2010 and 2016 four Nuclear Security Summits focused high-level political attention on reducing any risks arising out of unregulated access to sensitive and dangerous nuclear and radiological material by non-state actors.

The wider Black Sea region has been in focus in the past because it both holds a high degree of nuclear security risk and has rich experience in efforts to cooperate on risk reduction.

Recent security developments in the wider Black Sea region raise important questions. Have nuclear security risks (including nuclear smuggling) increased, in either number or severity? How have existing regional nuclear security regimes and cooperative projects responded to the changing security environment? Where new risks have emerged, what steps could minimize them? Can the momentum behind maintaining the regional nuclear security regime be reinforced and, if so, how?

To address these questions and identify next steps for policymakers and practitioners, SIPRI initiated the project assessing the state of the nuclear security regime in the wider Black Sea region that forms the basis of this policy paper.

Dan Smith
Director, SIPRI
Stockholm, December 2018

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IFIN-HH played a central role in the organization of an international conference in Bucharest on 24–25 April 2018 that made an important contribution to the success of the project. We would also like to thank the Ministry of Foreign Affairs (MFA) of Romania for its assistance in organizing the conference. The conference was attended by representatives from Armenia (MFA and the Armenian Nuclear Regulatory Authority), Belgium (Belgian Nuclear Research Centre), the European Commission (Joint Research Centre Karlsruhe and Directorate-General for International Cooperation and Development), Georgia (State Security Service and Civil Council on Defense and Security), Moldova (Customs Service, Security and Intelligence Service, and NARNRA), the Netherlands (Netherlands Forensic Institute), Norway (Norwegian Radiation Protection Authority and Nordisk Sikkerhet), Romania (IFIN-HH, MFA, Romanian Border Police, Romanian Intelligence Service, Directorate for Investigating Organized Crime and Terrorism of the Prosecutor's Office, National Commission for Nuclear Activities Control), Russia (I.I. Leypunsky Institute of Physics and Power Engineering), Serbia (Ministry of Interior), Sweden (Swedish Radiation Safety Authority), Ukraine (Odessa Center for Nonproliferation, State Border Guard Service, State Nuclear Regulatory Inspectorate), the United Nations (United Nations Interregional Crime and Justice Research Institute and International Atomic Energy Agency) and the United States (Department of State, Federal Bureau of Investigation and Middlebury Institute of International Studies at Monterey).

This report would not have been possible without the information provided in interviews conducted in late 2017 and early 2018 with nuclear security stakeholders both in and outside the Black Sea region. The authors would like to thank them for freely giving their time and expertise. They would also like to personally thank Andrei Apostol, Angela Sidorencu and Dmytro Chumak for their invaluable contributions to the whole project, as well as to the text of this publication.

Finally, the authors would like to acknowledge the contribution of the editors at SIPRI, and thank them for the thoroughness and expertise with which they edited the manuscript and prepared it for publication.

Summary

Some of the most significant known cases of illicit trafficking of nuclear materials have taken place in the wider Black Sea region. Recent developments in the region—including the conflict in Ukraine—make it important to understand whether nuclear security risks have been exacerbated or multiplied as a consequence.

Interviews with nuclear security stakeholders conducted for this study suggest that most countries in the region have not significantly changed their national nuclear security risk assessments, despite the changes in the wider security environment. However, their sense of awareness has heightened in line with concern about the potential for mass-impact terrorist attacks in Europe.

Among the countries in the region, Ukraine is a special case. It faces specific and serious new nuclear security risks both on land and in the maritime domain. These risks include the challenge of reconstructing and adapting the legal and administrative elements of its national nuclear security regime in the midst of emergency conditions, where responsible authorities have lost access to and control of state territory, including long stretches of the border. Along with the loss of situational awareness regarding the location and movement of nuclear material and radioactive sources, Ukraine has lost equipment and infrastructure that was destroyed in the conflict and the facilities and personnel that played an important role in national nuclear security training and in equipment repair and maintenance. Moreover, cooperation with Russia, the other major nuclear security stakeholder in the wider Black Sea region, has broken down.

The contested space that has opened in eastern Ukraine is not unique in the region. However, stakeholders in the region have little knowledge of how to identify and mitigate nuclear and radiological security risks in these contested spaces—such as Abkhazia, Nagorno-Karabakh, South Ossetia and Trans-Dniester—and this issue needs further investigation. Nonetheless, there are isolated success stories, such as the experience of Moldova in removing radioactive sources from Trans-Dniester.

Almost all of the countries in the wider Black Sea region have made significant progress in developing national-level planning documents defining responses to nuclear security incidents. However, these plans still need to be tested and further upgraded through a systematic programme of national and, wherever possible, international exercises to ensure that they would function as expected if faced with a real contingency. The development of the plans has been advancing on a national basis, guided by key international institutions and partnerships, most notably the International Atomic Energy Agency (IAEA). In contrast, there has been relatively little horizontal communication between states within the region.

Recommendations

A systematic investigation of options to improve radiation protection and reduce nuclear security threats in contested spaces in the Black Sea region is needed.

Closer involvement of the Organization for Security and Co-operation in Europe (OSCE) and the IAEA, perhaps in a joint initiative, would be a useful framework for such an investigation.

Where viable, Black Sea states should work to develop national, bilateral or regional capabilities to follow up when a nuclear security breach is detected. Beyond simply responding to an illicit trafficking event, the traffickers' supply chain should be investigated to identify as many of those involved as possible. This practice is necessary for prevention of future nuclear security events.

Donors should analyse their nuclear security assistance to identify good practices and to assess impact. One element of that analysis should be a greater focus on the human capital created through assistance and cooperation, for example by following up on the future progress of trained personnel and the ways in which assistance proved useful in their career development.

Sharing of good practice and the systematic organization of existing knowledge in the region could promote a sustainable regional nuclear security regime based on local resources. Mutual assistance among stakeholders within the region could be used to repair and maintain equipment, train personnel, and organize exercises in ways that are tailored to local conditions.

As nuclear security response planning matures, a logical next step would be to consider a regional dialogue to see how far national response plans could be harmonized, in particular between neighbouring countries.

All states in the Black Sea region could develop a register based on functions and responsibilities, rather than institutional affiliation or job titles, to clearly specify who is responsible for what within the nuclear security regime. This catalogue would help to maintain mutual awareness of stakeholders in the region, minimize functional overlaps within a state, and facilitate mutual assistance and cooperation.

Abbreviations

BMWG	Border Monitoring Working Group
CBRN	Chemical, Biological, Radiological and Nuclear
DBT	Design-Basis Threat
DPR	Donetsk People's Republic
EU	European Union
EUSECTRA	European Nuclear Security Training Centre
G7	Group of Seven
G8	Group of Eight
GICNT	Global Initiative to Combat Nuclear Terrorism
GP	Global Partnership Against the Spread of Weapons and Materials of Mass Destruction
GUAM	Georgia, Ukraine, Azerbaijan and Moldova
HASS	High-activity sealed radioactive sources
HEU	Highly Enriched Uranium
IAEA	International Atomic Energy Agency
IED	Improvised explosive device
Interpol	International Criminal Police Organization
ISI	Information Sharing Initiative
ITDB	Incident and Trafficking Database
JRC	Joint Research Centre
LPR	Luhansk People's Republic
MORC	Material outside regulatory control
NAP	National CBRN Action Plan
NARNRA	National Agency for Regulation of Nuclear and Radiological Activities (of Moldova)
NNSA	National Nuclear Security Administration
NRWMC	National Radioactive Waste Management Company (of Moldova)
NSDD	Nuclear Smuggling Detection and Deterrence (programme)
OSCE	Organization for Security and Co-operation in Europe
RDD	Radiological dispersion device
RPM	Radiation portal monitor
SNRI	State Nuclear Regulatory Inspectorate (of Ukraine)
SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority)
SUNEI	Sevastopol National University of Nuclear Energy and Industry
UkrDO Radon	Ukrayinske Derzhavne Obyednannya (Ukrainian State Corporation Radon)
UN	United Nations

1. Introduction

The most high-profile nuclear smuggling cases over the past three decades have occurred in the wider Black Sea region. Across the region—which brings together the six littoral states (Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine) and a hinterland including the South Caucasus and Moldova—large amounts of nuclear and other radioactive materials, as well as radioactive sources and waste, were left poorly guarded or abandoned after the dissolution of the Soviet Union in December 1991. Economic instability and territorial conflicts in the former Soviet states were enabling factors for smugglers. These factors were particularly prominent in areas of protracted conflict such as Abkhazia and South Ossetia, which broke away from Georgia, and Trans-Dniester, which broke away from Moldova. These territories not only hosted dangerous materials but also became areas where the control of the flow of goods over borders and the detection of illicit trade and trafficking were far more complicated, and where smugglers could seek safe haven. The nuclear dimension of this trafficking received international attention after a number of high-profile interceptions of highly enriched uranium (HEU) in countries around the Black Sea: in Bulgaria in 1999; in Georgia in 2003, 2006 and 2010; and in Moldova in 2011.[1]

Although states in the region, donor states and international organizations have achieved notable successes in curbing trafficking over the past three decades, the threats associated with the nuclear and other radioactive material outside regulatory control (MORC) remain significant, and problems that exacerbate nuclear security risks are still unresolved. With the end of the Nuclear Security Summit process in 2016, high-level political attention has now been diverted away from issues related to nuclear security.[2]

This study is based on the assumption that the events in the Black Sea region since 2014, in particular the crisis in and around Ukraine, have been so profound that they are likely to have significantly exacerbated nuclear security threats and to have undermined nuclear security regimes across the region. This, in turn, would have manifested itself in an increase in nuclear smuggling incidents. Interviews conducted for the purpose of this study with nuclear security stakeholders (i.e. nuclear security experts or representatives of organizations involved in the strengthening of nuclear security) both inside and outside the Black Sea region highlighted that the deterioration in the regional security situation since 2014 has indeed created new nuclear security threats and reduced the capacity or political will of certain states in the region to address the existing threats.[3] Three

[1] Zaitseva, L. and Steinhäusler, F., 'Nuclear trafficking issues in the Black Sea region', EU Non-proliferation Consortium, Non-proliferation Paper no. 39, Apr. 2014.

[2] Four Nuclear Security Summits were held in 2010–16: in Washington, DC, 2010; Seoul, 2012; The Hague, 2014; and Washington, DC, 2016. See e.g. Joint Statement by Carnegie Corporation of New York and the John D. and Catherine T. MacArthur Foundation on a Civil Society Gift Basket, 30 Mar. 2016; and Davenport, K., 'Nuclear Security Summit at a glance', Arms Control Association, Aug. 2017.

[3] In the Black Sea region, interviews were conducted with government officials in Armenia, Bulgaria, Georgia, Moldova, Romania and Ukraine. In addition, experts from relevant United Nations agencies—

major themes emerged in the interviews with stakeholders: the events in Ukraine since 2014; the role of 'contested spaces' in the region; and the need to increase coordination and collaboration to maintain the nuclear security infrastructure.

The deterioration in the security situation in the Black Sea region has encompassed the sharp reduction in Russia's participation in nuclear security cooperation, the failed coup attempt in Turkey in July 2016 and the political and security changes that followed it, and a general increase in concern and awareness among regional nuclear security stakeholders about mass impact terrorism in the light of high-profile attacks carried out in Europe. Without a doubt, however, the events in Ukraine since 2014—the takeover of Crimea by Russia, the start of the internationalized civil war in eastern Ukraine and the formation there of territories outside central government control—have had the most profound effects on the security situation in the Black Sea region. While measuring the impact in other countries in the region of the events in and around Ukraine requires a nuanced assessment, those events had a clear and severe effect on Ukraine's nuclear security regime: since 2014 the Ukrainian State Nuclear Regulatory Inspectorate (SNRI) has lost regulatory control over nuclear materials, installations, radioactive sources and nuclear security infrastructure in both Crimea and the separatist-controlled areas of eastern Ukraine.[4]

The events in Ukraine, the nuclear security threats that they precipitated and the alleviation of those threats are of crucial concern to Ukraine and its nuclear security stakeholders. However, these developments are not necessarily viewed with the same level of concern by nuclear security stakeholders in other countries in the Black Sea region. Many interviewees elsewhere in the region suggested that they had not detected significant changes in their own, local nuclear security threats since the events in Ukraine. Indeed, some experts noted a slight decline in recent years in the number of incidents related to the illicit trafficking of nuclear materials that they had reported to the Incident and Trafficking Database (ITDB) of the International Atomic Energy Agency (IAEA). Some attributed this to the deterrent effect of the publicly available information on past nuclear smuggling prosecutions.

Most interviewees based outside Ukraine indicated that the majority of the nuclear security threats that they have to deal with are connected not to the events in Ukraine but to the 'contested spaces' in their own territory or in their immediate neighbourhood: Abkhazia, Nagorno-Karabakh (Artsakh), South Ossetia and Trans-Dniester.[5] Even though the Ukrainian case differs dramatically

including the International Atomic Energy Agency (IAEA) and the UN Interregional Crime and Justice Research Institute (UNICRI)—the European Commission (including the Joint Research Centre), Norway, Sweden and the United States were also interviewed. The interviewees cited here are not named, to allow them the opportunity to more freely express their opinions.

[4] Chumak, D., 'The implications of the Ukraine conflict for national nuclear security policy', EU Non-proliferation Consortium, Non-proliferation Paper no. 53, Nov. 2016, p. 3; Ukrainian State Nuclear Regulatory Inspectorate, Author correspondence, Mar. 2018; and Ivko, V., 'Ukraine: security in nuclear sphere in hybrid warfare conditions', Presentation at the Nuclear Security in the Black Sea Region conference, Bucharest, 24–25 Apr. 2018.

[5] The term 'contested spaces' was chosen as a neutral collective term for these territories, whose political realities differ.

in the intensity of the ongoing conflict, the impact of the Ukrainian crisis on nuclear security threats in Ukraine itself fits this narrative in the sense that the territories currently outside Ukrainian control, especially in Donetsk and Luhansk in eastern Ukraine, are the source of far more immediate nuclear security threats to the country than anywhere else—similar to the way in which contested spaces in other countries are often the main source of those countries' nuclear security threats.

In the interviews, nuclear security stakeholders frequently raised the need for increased coordination and collaboration between all relevant stakeholders in order to maintain the established nuclear security infrastructure and for the further development of the national nuclear security regimes in the region in general. Since the 1990s major international donors, such as the European Union (EU), Norway, Sweden, the United Kingdom and the United States, and many international organizations (e.g. the IAEA and the International Criminal Police Organization, Interpol) have invested substantial funds and efforts to assist in the development of the national nuclear security regimes and infrastructure of countries in the Black Sea region. The terrorist attacks on the USA of 11 September 2001 alerted international donors to the possibility of non-state actors obtaining nuclear or other radioactive materials. The high-profile intercepts of HEU in Georgia (in 2003, 2006 and 2010) and Moldova (in 2011) prompted more focused assistance to nuclear security stakeholders in the region to secure nuclear MORC.[6] Interviewed experts and officials in the region were in agreement that clear progress on establishing and developing nuclear security regimes in the region had been made by 2018, particularly with regard to the installation of infrastructure for the detection of radioactive material at borders and transportation hubs. However, the assistance programmes to support the creation of this detection infrastructure have entered their final stages and the international political impetus for improving the nuclear security regimes in the Black Sea region has diminished since the end of the Nuclear Security Summit process.

This policy paper continues in chapter 2 with background information on the history, underlying causes and extent of the nuclear security threats in the Black Sea region. It also assesses how nuclear security assistance in the region has evolved. Chapters 3–5 then elaborate on each of the three major themes in turn. Chapter 6 presents the conclusions.

[6] See Zaitseva and Steinhäusler (note 1).

2. The evolution of nuclear security in the Black Sea region

The circumstances facilitating nuclear security threats: materials, poverty and conflicts

There are at least five main reasons behind the poor nuclear security environment in the Black Sea region.

First, the Soviet Union produced and placed throughout its own territory and that of its allies large quantities of nuclear and other radioactive materials, including sealed radioactive sources. The dissolution of the Soviet state and its security apparatus left those materials and sources without proper oversight, abandoned or located at facilities with inadequate physical protection, accounting and control.

Second, the dissolution of the Soviet Union and the ensuing economic hardships endured by the population of the former Soviet Union created incentives for theft and corruption. Some of those hardships remain even now, while some have been caused or exacerbated by new crises and conflicts in the region.

Third, the break-up of the Soviet Union and the uncontrolled grievances, conflicts and acts of aggression that ensued in the former Soviet territory created contested spaces. Due to their nature and the reasons for their existence, it is almost impossible to establish internationally recognized controls on material in contested spaces. Additionally, contested spaces themselves became breeding grounds for economic hardship, exacerbating an already difficult situation. In interviews or correspondence, officials from countries across the Black Sea region stated that most or sometimes even all known cases of illicit trafficking of nuclear material in their countries were associated with the contested spaces in or neighbouring their respective countries.

Fourth, conflicts over territory or due to deep political divisions undermine the process of combating nuclear smuggling across the region by hindering or completely preventing nuclear security cooperation between states. For example, nuclear security cooperation between Russia and Georgia stopped in 2008 following fighting between the two countries in Abkhazia and South Ossetia. Russia's ties with other relevant stakeholders in and outside the Black Sea region have deteriorated since the start of the crisis in Ukraine in 2014, and Russia decided not to participate in the 2016 Nuclear Security Summit in Washington, DC.[7] This followed the recent pattern of reduced participation by Russia in international cooperation efforts in the area of nuclear security, including those with the USA.[8] In other cases, countries in the region effectively abstain from cooperating with each other on nuclear security issues due to territorial disputes, even though officials from those countries privately admit in interviews that such cooperation would be desirable in principle.

[7] Reuters, 'Russia told US it will not attend 2016 nuclear security summit', 5 Nov. 2014.

[8] Nikitin, M. B. D. and Welt, C., 'Recent developments in US-Russian nonproliferation cooperation', CRS Insight, IN10594, Congressional Research Service, 13 Oct. 2016.

Fifth, for some countries in the region the deterioration of nuclear security cooperation is caused by internal instability. In interviews, many nuclear security stakeholders in the region noted that Turkey has always exercised a restrained and selective approach to nuclear security cooperation. The failed coup attempt in Turkey in 2016, and the resulting purges of the Turkish civil service, judiciary, military and police, sparked a further shift away from international cooperation on nuclear security issues: according to some nuclear security stakeholders in the region, Turkey might have become less effective in detecting and preventing nuclear smuggling through its territory due to the loss of experienced personnel. However, three nuclear security stakeholders reported that they were involved in limited ongoing, or recently launched, joint activities with Turkey.[9]

The evolution of nuclear security assistance

The international community, including donor countries, the EU and some international organizations, have been providing what is currently referred to as 'nuclear security assistance' to the states in the Black Sea region since the early 1990s. However, that assistance was initially viewed as an instrument of disarmament and non-proliferation.[10] Before the terrorist attacks on the USA of 11 September 2001 most contemporary publications discussing the threats stemming from nuclear and other radioactive MORC focused on such material being 'a shortcut to nuclear proliferation', in other words a means for a state to obtain nuclear weapon capabilities without the need to develop a domestic infrastructure for production of nuclear material.[11] While there was some discussion of the threat of nuclear smuggling increasing the risk of nuclear terrorism, it was often more an afterthought and not the main issue.[12] The focus of the assistance was therefore initially placed on materials under regulatory control (MURC): upgrading the security of facilities with HEU and plutonium holdings and supporting the consolidation and repatriation of such holdings.[13]

The events of 11 September 2001, the wider realization that nuclear and other radioactive materials represent a terrorism threat, and high-profile HEU interceptions in 1999 (in Bulgaria) and 2003 (in Georgia) all contributed to a reframing of the discussion on nuclear security. This in turn led to agreement of the 2005 International Convention for the Suppression of Acts of Nuclear Terrorism, an IAEA decision in 2005 to define nuclear security as a discipline, and the launches of the Global Initiative to Combat Nuclear Terrorism (GICNT) in 2006 and of

[9] E.g. US Department of Energy, National Nuclear Security Administration (NNSA), 'NNSA and Turkey cooperate to combat nuclear smuggling', 11 Aug. 2017.

[10] Anthony, I. and Fedchenko, V., 'International non-proliferation and disarmament assistance', *SIPRI Yearbook 2005: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2005), pp. 675–98.

[11] E.g. Moscow Nuclear Safety and Security Summit, Declaration, 20 Apr. 1996, IAEA INFCIRC/509, 4 June 1996.

[12] Allison, G. T. et al., *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (MIT Press: Cambridge, MA, 1996), pp. 50–53.

[13] Anthony and Fedchenko (note 10).

the Nuclear Security Summit process in 2009.[14] These developments placed a far greater emphasis on MORC.

The high-profile interceptions of HEU in Georgia revealed other cases of successful illicit cross-border transportation of nuclear material.[15] These highlighted the lack of detection equipment in the Black Sea region, especially at state borders; the introduction of more comprehensive detection capacities thus became a priority issue for donors. The Border Monitoring Working Group (BMWG), formed in 2005, served as the main coordinating mechanism for donors to set up fixed and mobile detection infrastructure in the states of the region, as well as to train the workforce needed to maintain and operate it.[16] The infrastructure and workforce were largely in place in almost all states in the region by 2018.[17] Ukraine is a notable exception. It lost large portions of its border-control and radiation-detection infrastructure after the events of 2014. Multiple donors, including the EU, Norway, Sweden and the USA, have recognized the needs of Ukraine and are addressing them through ad hoc initiatives.

However, once the infrastructure is in place and training of personnel has been provided, international funding and attention often diminishes and donors expect countries to take over the responsibilities related to the maintenance of this infrastructure. The cost of such responsibilities (e.g. maintenance of equipment and training and re-training of personnel) is significant for most of the countries involved. Another related problem is the recruitment of new personnel: salaries in this field are not particularly competitive across the region, which makes it difficult to recruit a new generation of nuclear security professionals, especially in highly skilled positions that require years of on-the-job training and experience. In interviews, nuclear security stakeholders across the Black Sea region indicated that in many cases maintaining adequate levels of local funding is becoming increasingly difficult due to the reduced interest in nuclear security issues at the political level after the end of the Nuclear Security Summit process. This raises concerns as to the sustainability of the achievements that have already been made.

[14] International Convention for the Suppression of Acts of Nuclear Terrorism, opened for signature 14 Sep. 2005, entered into force 7 July 2007, United Nations, Treaty Series, vol. 2445 (2007); IAEA, General Conference, 'Nuclear security: measures to protect against nuclear terrorism: progress report and nuclear security plan for 2006-2009', Report by the Director General, GC(49)/17, 23 Sep. 2005, p. 1; US Department of State, Bureau of International Security and Nonproliferation, 'Global Initiative to Combat Nuclear Terrorism', 29 Mar. 2018; and White House, Office of the Press Secretary, 'Remarks By President Barack Obama In Prague As Delivered', 5 Apr. 2009.

[15] Sokova, E. K. and Potter, W.C., 'The 2003 and 2006 high enriched uranium seizures in Georgia: new questions, some answers and possible lessons', IAEA-CN-154/001, *Illicit Nuclear Trafficking: Collective Experience and the Way Forward*, Proceedings of an International Conference, Edinburgh, 19–22 November 2007 (IAEA: Vienna, 2008), pp. 405–23.

[16] European Commission and European External Action Service (EEAS), *EU Efforts to Strengthen Nuclear Security*, Joint Staff Working Document, SWD(2016) 98 final (European Commission and EEAS: Brussels, 16 Mar. 2016), p. 37.

[17] US Government Accountability Office (GAO), *Combating Nuclear Smuggling*, GAO-16-460 (GAO: Washington, DC, June 2016), pp. 33–34.

3. Nuclear security in Ukraine since 2014

Since 2014 the nuclear security regime in Ukraine has faced the combined challenges of the ongoing systemic transformation inside the country and external shocks.

Domestically, legislation has altered the political and administrative system with knock-on effects on the national nuclear security regime. Key agencies, such as the National Police, are undergoing reform. In 2014 the National Guard was created with law enforcement functions including protection of critical infrastructure such as nuclear facilities, nuclear materials, nuclear waste and other sources of radioactive emission in public ownership.[18]

The IAEA recommends that each member state has an up-to-date design-basis threat (DBT) document, defined as a 'comprehensive description of the motivation, intentions and capabilities of potential adversaries against which protection systems are designed and evaluated'.[19] In 2015 Ukraine revised and updated its DBT for nuclear facilities, nuclear material, radioactive waste and other radiation sources.[20] The revised version introduced all risks related to the conflict in eastern Ukraine. At the time of writing, a new threat evaluation was underway that will probably lead to a further revision of the DBT to take account of the changing threats arising from Ukraine's loss of control over territory in Crimea and in the east of the country. The revised DBT will also cover other kinds of potential threat, including threats to information security and insider threats, based on the most recent information available to the authorities.[21]

There have been two primary external shocks. First, with Russia's takeover of Crimea, Ukraine lost control over territory that hosts nuclear facilities, border control infrastructure and other assets relevant to nuclear security, the protection of borders and oversight of the maritime domain. Second, the fighting in eastern Ukraine, which includes significant external military engagement, has resulted in the loss of control over Ukrainian territory and land borders.

This chapter describes the effects of the internal changes and the two external shocks on Ukraine's nuclear security regime and reviews the range of options for dealing with them.

[18] [Ukrainian Law on the National Guard of Ukraine], Ukrainian Law no. 876-VII as amended, 13 Mar. 2014 (in Ukrainian); Ukrainian National Security and Defence Council, [Decision on urgent measures to ensure the national security, sovereignty and territorial integrity of Ukraine], 1 Mar. 2014 (in Ukrainian); and Chumak (note 4), p. 11.

[19] IAEA, 'Nuclear security series glossary', version 1.3, Nov. 2015, p. 9; and IAEA, Development, *Use and Maintenance of the Design Basis Threat*, Implementing Guide, IAEA Nuclear Security Series no. 10 (IAEA: Vienna, 2009), p. 8.

[20] Ukrainian National Security and Defence Council, [Decree on the design-basis threat to nuclear installations, nuclear materials, radioactive waste and other sources of ionizing radiation in Ukraine], 20 July 2015, approved by Presidential Decree no. 520/14t/2015, 27 Aug. 2015 (in Ukrainian); and 'New potential threat to nuclear facilities identified due to Russian aggression', UNIAN Information Agency, 20 July 2015.

[21] Ukrainian officials, Author interviews, Kyiv and Bucharest, Mar.–Apr. 2018.

Domestic transformation and nuclear security challenges

As a country with a large nuclear industry and a complex nuclear fuel cycle, Ukraine has long experience of addressing security issues—even if safety issues were a higher priority in the years after the accident at Chernobyl in 1986 than in more recent years.[22] Russia has often been a factor in Ukrainian thinking on security of energy supply. Russian–Ukrainian relations became increasingly fractious after the 2004–2005 Orange Revolution in Ukraine. This was reflected in the energy sector and spilled over during the latter part of the 2000s into a series of disputes between the two sides over natural gas supplies, prices and debt repayments.[23] These disputes were an indication of how central the energy sector was becoming to the intertwining commercial and political aspects of Russian–Ukrainian relations. Since it grew out of the shared Soviet legacy, the nuclear industry of Ukraine was arguably the most integrated with (and dependent on) Russian support.

By 2014 Ukraine already viewed its high dependence on electricity generated from nuclear energy as a significant vulnerability, but an accident at the 1000-megawatt reactor at Zaporizhzhya, southern Ukraine, in November that year perhaps served to focus attention on potential risks to critical infrastructure.[24] The event followed shortly after what was seen in Ukraine as a new phase in the conflict in the east, with more direct engagement by Russia.

The events of 2014 motivated Ukraine to perform a comprehensive revision of its entire security establishment, with the objective of creating truly national capacities from which Russian influence was excluded as far as possible.[25] Establishment of the National Guard was one manifestation of this project. Until 2014 physical protection of nuclear facilities had been the responsibility of the Internal Troops under the Ministry of Internal Affairs. The troops were recruited locally, and in 2014 the unit responsible for the physical protection of facilities in Crimea defected to Russia.[26] The creation of the National Guard as, in effect, a new institution with a new legal basis and a national recruitment procedure and staff regulations was a recognition of how far Russian influence had penetrated the existing security sector.[27] The revision of the DBT to include a focus on insider threats was also part of the process of thinking through how to manage the potential security risks posed by high dependence on Russian nuclear fuel, equipment and expertise.

In addition to revising its nuclear security regime by updating legislation and creating new institutions, Ukraine also made important changes in other parts of

[22] World Nuclear Association, 'Nuclear power in Ukraine', Aug. 2018.

[23] Liuhto, K., *Energy in Russia's Foreign Policy*, Electronic Publications of Pan-European Institute no. 2010/10 (Turku School of Economics: Turku, 9 May 2010).

[24] Kasperski, T., 'Nuclear power in Ukraine: crisis or path to energy independence?', *Bulletin of the Atomic Scientists*, vol. 71, no. 4 (July 2015), pp.43–50.

[25] Oliker, O. et al., *Security Sector Reform in Ukraine* (RAND Corporation: Santa Monica, CA, 2016).

[26] Ukrainian State Nuclear Regulatory Inspectorate (SNRI), *Report on Nuclear and Radiation Safety in Ukraine for 2014* (SNRI: Kyiv, 2015), p. 64.

[27] Oliker et al. (note 25).

its national security apparatus that are relevant to nuclear security. First, a new system was set up to analyse critical infrastructure and address identified problems related to protection. The nuclear sector was identified as critical infrastructure.[28] Second, prior to 2014 the Ukrainian approach to counterterrorism was mostly aimed at supporting the international effort to combat transnational terrorist threats. The counterterrorism effort in key institutions such as the State Security Service included cooperation to destroy links between terrorist networks in Ukraine and Russian domestic terrorist groups.[29] The Ukrainian perspective shifted radically after 2014 and became dominated by the potential threats posed by domestic groups, possibly with support from Russia.[30]

The task of transforming a state's national security apparatus in times of conflict is enormous, but it should be seen in the context of the even greater challenges posed by the wider transformation of the Ukrainian economy, politics and society. While some aspects of this go beyond the scope of this policy paper, they are important issues for future assessment. For example, wider national measures to combat corruption apply to the energy sector and, if anti-corruption measures are ineffective, then achievements in narrower fields, such as the enhancement of nuclear security, could be undermined. However, the wider societal transformation in Ukraine also has some direct implications for efforts to improve nuclear security.

First, the simultaneous revision of the laws and structures of multiple administrative agencies is not only a complex task but also has to be carried out in coordination with separate but related changes in the fields of critical infrastructure protection and counterterrorism. If the nuclear industry and operators are confused by contradictions in legislation, regulations, guidance documents and technical documents prepared in separate policy frameworks, then there is scope for misunderstandings at the local level that compromise security.

Second, given the huge number of tasks and challenges associated with national transformation, there is a problem of sustaining domestic political attention on the need for nuclear security risk mitigation. A related issue is the problem of acquiring the resources needed to implement the changes that have been made in the nuclear security apparatus. For example, the requirement for facilities to revise their local practices in line with current legislation could be undermined by the fact that there are only two inspectors currently in place to check on implementation—meaning that it will take years for all facilities to be inspected and the interval between inspections will be long.[31]

Third, the degree to which Ukraine's nuclear sector is intertwined with Russia's, including the fact that Ukraine purchases Russian-made fuel for its power reactors,

[28] Sukhodolia, O. (ed.), *Developing the Critical Infrastructure Protection System in Ukraine* (National Institute for Strategic Studies: Kyiv, 2017).

[29] According to one estimate up to 200 Ukrainian citizens fought against Russia in the 1994–96 First Chechen War. McGregor, A., 'Radical Ukrainian nationalism and the war in Chechnya', *North Caucasus Weekly*, 30 Mar. 2006.

[30] Ukrainian official, Author interview, Kyiv, Mar. 2018.

[31] Ukrainian State Nuclear Regulatory Inspectorate official, Author interview, Mar. 2018.

makes it difficult for Ukraine to transition rapidly to a fully domestic system. This is reflected at all levels, beginning with education. For example, nuclear security instruction has traditionally been given in the Russian language and teaching materials are all in Russian, opening a gap between the existing teaching staff and the next generation of students, who would prefer instruction in Ukrainian or, failing that, English.[32]

In summary, the specific challenges that Ukraine faces in bolstering its nuclear security regime cannot be entirely separated from the wider transformation that Ukraine is undergoing. While it is not possible for external actors to perform the core tasks that only Ukraine itself can undertake, they could provide valuable assistance at the margins that could play a useful role in strengthening the national security regime in ways that reduce risks not only to Ukraine but also to the region.

Nuclear challenges, risks and threats in Crimea

While the Ukrainian Government is adamant that the territory of Crimea remains subject to Ukrainian legislation, including the laws on criminal liability for the unauthorized movement of goods (into, within or out of Crimea), it has no practical mechanism to monitor the implementation of those laws or enforce their application.[33] Ukraine has limited knowledge or situational awareness about what is happening in the nuclear facilities on the Crimean peninsula.

In 2014 Ukraine lost regulatory control over all nuclear materials, installations and radioactive sources located in Crimea, and all access to the nuclear security infrastructure based there. The Ukrainian nuclear regulatory authority, the SNRI, stated in December 2015 that the materials, installations and sources no longer under its control included the IR-100 research reactor and other facilities in the grounds of the Sevastopol National University of Nuclear Energy and Industry (SUNEI) as well as 277 radioactive sources and 53 items with radionuclide radiation sources.[34] Ukraine considers these sources to be 'orphan sources' as defined by the IAEA since the SNRI cannot verify their status, was not informed of any communication between Russia and the IAEA concerning them, and has not been provided with information on them by the Russian authorities.[35] As for the IR-100 reactor, the Ukrainian Government has designated it as a 'national asset beyond the control of the state' and therefore considers that all Ukrainian laws and regulations remain applicable, including criminal liability.[36] On 16 July 2014

[32] Official at the Institute for Nuclear Research, Ukrainian National Academy of Sciences, Author interview, Kyiv, Mar. 2018.

[33] Ukrainian Ministry of Energy official, Author interview, Kyiv, Mar. 2018.

[34] Chumak (note 4), p. 3; and Ukrainian State Nuclear Regulatory Inspectorate, Author correspondence, Mar. 2018. See also Ukraine, 'National statement: Ukraine', Nuclear Security Summit, Washington, DC, 1 Apr. 2016.

[35] Orphan sources are defined in IAEA, *Code of Conduct on the Safety and Security of Radioactive Sources* (IAEA: Vienna, 2004), p. 3.

[36] Ukrainian Ministry of Energy official, Author interview, Kyiv, Mar. 2018.

the SNRI terminated SUNEI's licence to operate the research reactor.[37] The Russian Ministry of Foreign Affairs stated in August 2014 that Russia took full responsibility for the nuclear facilities located in Crimea.[38]

Loss of control over Crimea damaged the Ukrainian nuclear security regime in a number of ways. Not only did Ukraine lose access to monitoring and detection infrastructure, but it also faces many more complications with regard to the proper monitoring and control of its territory near Crimea and the coast of the Sea of Azov. There are at least four specific aspects of this to consider.

First, Crimea hosted a major part of Ukraine's nuclear-detection infrastructure, including, most significantly, in its seaports. For example, the US National Nuclear Security Administration (NNSA) had installed 55 radiation portal monitors (RPMs) in Crimea before 2014.[39] According to Ukrainian Government officials, before 2014 the highest number of detections in Ukraine were in Crimea.[40] The RPMs in Crimea routinely detected radioactive material, most commonly involving deliveries of scrap metal destined to be loaded onto ships in Crimean ports.

Second is the loss of nuclear security education infrastructure. In 2012 the Ukrainian Government approved a regulation on the state system of training in physical protection, accounting and control of nuclear materials.[41] The Ukrainian Ministry of Education and Science and the SNRI were tasked with determining which university should provide the necessary specialist training. Before 2014 almost all university-level nuclear security education (especially focusing on physical protection of nuclear facilities) in Ukraine was provided at SUNEI. Following the loss of access to Sevastopol, Ukraine had to shift its nuclear security education to the National Technical University of Ukraine (Igor Sikorsky Kyiv Polytechnic Institute) and the Odessa National Polytechnic University. The US Department of Energy has provided support to Ukraine in developing training materials for a new master's degree in physical protection, which is to be launched at the National Technical University in 2019.[42]

The George Kuzmych Training Centre for Physical Protection, Control and Accounting of Nuclear Materials, Kyiv, provides nuclear security training to employees of Ukrainian nuclear facilities and the I. Momot Training Centre of the Ukrainian State Border Guard Service, located near Cherkasy, provides such training to Ukrainian border guards.[43] The work of these two centres was not interrupted by the events of 2014.

[37] Ukrainian State Nuclear Regulatory Inspectorate (note 26), p. 75.

[38] Russian Ministry of Foreign Affairs, [Comment by the Information and Press Department of the Russian MFA in connection with the statements of the Ukrainian MFA on the legal status of nuclear facilities in the new subjects of the Russian Federation—the Republic of Crimea and the City of Sevastopol], 16 Aug. 2014 (in Russian).

[39] US Government Accountability Office (note 17), p. 25.

[40] Ukrainian officials, Author interviews, Kyiv, Mar. 2018.

[41] Ukrainian Cabinet of Ministers, [Decree on approval of the Regulation on the state system of professional training, retraining and advanced training of specialists in physical protection, accounting and control of nuclear materials], Decree no. 263, 21 Mar. 2012 (in Ukrainian).

[42] Ukrainian Ministry of Energy and Coal Industry, [Ministry of Energy and Coal Industry and Kyiv Polytechnic Institute launch a master's programme in nuclear security], 21 Feb. 2018 (in Ukrainian).

[43] Official at the Institute for Nuclear Research, National Academy of Sciences of Ukraine, Author

Third, the takeover of Crimea by Russia has undermined Ukraine's management and supervision of the maritime domain and created additional problems at some land borders. Crimean seaports were important entry and exit points for commercial traffic both within the Black Sea and beyond, but Ukrainian border controls can no longer be applied to ships arriving at and departing from those ports. Ukraine has called on its trading partners—including Turkey—to stop using Crimean ports for commercial traffic, but this has met with only partial success.[44] Ships and aircraft belonging to Ukrainian military, paramilitary and police forces now face significant risks if they conduct physical patrols in the eastern Black Sea, which has contributed to a reduction in Ukraine's situational awareness in the maritime domain.[45] In addition, Ukraine's request to put in place new arrangements for the exchange of information between members of a network of ship operators in the Black Sea region has so far been ignored. The information-exchange meetings are generally held in Novorossiysk, Krasnodar Krai, Russia. Ukraine has argued for a new arrangement that excludes Russia, or at least for the meetings to be held outside Russia, but other countries are satisfied with the existing arrangement.[46]

Russia's takeover of Crimea has given it complete control over entry and exit to the Sea of Azov through the Kerch Strait. Ukraine has raised concerns over the harassment of Ukrainian ships in international waters in the Sea of Azov and Russia has begun to carry out its own controls on international shipping heading to ports in Ukraine on the coast of the Sea of Azov.[47] Implementing controls in the wetlands of Karkinit and Dzharylhatskyi bays to the north-west of Crimea and the central and eastern areas the Syvash lagoons, to the north-east of Crimea, present new problems to Ukrainian authorities. The terrain is difficult and the Ukrainian State Border Guard Service is not equipped or configured to address what are still internal areas from a legal perspective.[48] In addition, Ukraine is determined to ensure that no border control measures put in place should give the impression that it accepts a new international border.[49]

Fourth, Ukraine had made significant investment in infrastructure (e.g. radars, sensors and towers) at a maintenance facility of the Ukrainian State Border Guard Service in Crimea. The former responsibilities of this facility have been transferred to a border guard facility in Odessa.[50]

In addition to the four issues described above, many Ukrainian nuclear security stakeholders expressed concern in interviews that the military denuclearization of Crimea that was achieved in the 1990s may have become reversible after 2014. It has been widely reported that Russia has invested heavily in reopening multiple

interview, Kyiv, Mar. 2018. The George Kuzmych Training Centre is a part of this institute.

[44] Ukrainian State Border Guard Service official, Author interview, Kyiv, Mar. 2018.

[45] Ukrainian State Border Guard Service official, Author interview, Kyiv, Mar. 2018.

[46] Ukrainian State Border Guard Service official, Author interview, Kyiv, Mar. 2018.

[47] Miller, C., 'Sea of troubles: Azov emerging as "tinderbox" in Russia–Ukraine conflict', Radio Free Europe/Radio Liberty, 7 Aug. 2018.

[48] Ukrainian State Border Guard Service official, Author interview, Kyiv, Mar. 2018.

[49] Ukrainian State Border Guard Service official, Author interview, Kyiv, Mar. 2018.

[50] Ukrainian officials, Author interviews, Kyiv, Mar. 2018.

Soviet-era military facilities in the region and has constructed new bases and stationed military personnel there.[51] In 2015 Mikhail Ulyanov, director of the Department for Non-proliferation and Arms Control of the Russian Ministry of Foreign Affairs, was quoted as saying that, while he was not aware of any actual or planned deployment of nuclear weapons in Crimea, 'in principle Russia can do it'.[52] It is impossible to verify the degree to which these concerns are actually justified. In interviews, Ukrainian nuclear security stakeholders readily admitted that they have no real understanding or details about what is happening in Crimea.[53] This ambiguity is relevant for the nuclear security discussion in Ukraine: the uncertainty surrounding Russia's intentions probably affects the DBT and other general requirements of the nuclear security regime in Ukraine.

Nuclear challenges, risks and threats in eastern Ukraine

In April 2014 intensive hostilities began in eastern Ukraine between government forces and separatist armed forces loyal to Donetsk and Luhansk oblasts. In the same month, parts of Donetsk and Luhansk declared themselves to be independent republics, the Donetsk People's Republic (DPR) and the Luhansk People's Republic (LPR). The Office of the Prosecutor General of Ukraine declared both the DPR and the LPR to be terrorist organizations on 16 May 2014.[54] Between 2014 and 2018 the Ukrainian Government described its actions to recover control over its territory from the DPR and the LPR as a large-scale counterterrorist operation.[55] On 30 April 2018 Ukrainian President Petro Poroshenko formally replaced this operation with the Joint Forces Operation, explaining that the change facilitated the engagement of more elements of the Ukrainian defence and security sector, including protecting public agencies helping internally displaced citizens, and restoring services and utilities to people living in liberated areas.[56]

Large portions of Donetsk and Luhansk oblasts remain outside Ukrainian Government control, including regulatory control over radioactive materials. Although the DPR and the LPR do not occupy the majority, by area, of Donetsk and Luhansk oblasts, together they control most of the industrial centres in the two regions. In 2014 the Ukrainian Government issued a list of populated areas that were temporarily outside government control. The list included 24 regional centres and 136 settlements in Donetsk and Luhansk oblasts, as well as 114 settlements located on the line of contact.[57] Almost all coal mining enterprises

[51] E.g. 'In Crimea, Russia signals military resolve with new and revamped bases', Reuters, 1 Nov. 2016.

[52] 'Russia says has right to deploy nuclear weapons in Crimea: report', Reuters, 11 Mar. 2015.

[53] Ukrainian officials, Author interviews, Kyiv, Mar. 2018, and Bucharest, Apr. 2018.

[54] Interfax-Ukraine, 'Ukraine's prosecutor general classifies self-declared Donetsk and Luhansk republics as terrorist organizations', *Kyiv Post*, 16 May 2014.

[55] Anthony, I., 'The Ukraine crisis: from popular protest to major conflict', *SIPRI Yearbook 2015: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2015), p. 59.

[56] President of Ukraine, 'President signed a decree: the Joint Forces Operation on deflection and deterrence of Russia's armed aggression in the Donbas began on April 30, 2018', 30 Apr. 2018.

[57] Ukrainian Cabinet of Ministers, [Order on approval of the list of settlements in the territory of which the state authorities temporarily fail to exercise their powers, and the list of settlements located on the line of contact], Order no. 1085-p, 7 Nov. 2014 (in Ukrainian).

in Ukraine's industrialized Donbas region (including the Donetsk Coal Energy Company and the Luhanskvuhillia Coal Mining Enterprise) and half of all iron and steel companies in south-eastern Ukraine are in populated areas in this list.

The conflict in eastern Ukraine and the loss of government control over the territories of the DPR and the LPR present major problems from a nuclear security perspective. The first is the existence of a large number of radioactive sources and radioactive waste in territory controlled or formerly controlled by armed non-state actors (on sources and materials returned to government control see below and on those that remain in uncontrolled territories see chapter 4). The second problem is the loss of radiation detection infrastructure on Ukraine's eastern border with Russia (see below).

Radioactive sources and materials in eastern Ukraine

Before the beginning of hostilities in eastern Ukraine, the SNRI's South-Eastern Inspection—which is formally in charge of the Donetsk and Luhansk oblasts, among others—exercised regulatory control over the work of about 1000 organizations that use radioactive sources and materials. Almost 800 of them are medical establishments, the rest are industrial facilities.[58] After the outbreak of hostilities, Ukraine reportedly lost control over 1192 radioactive sources, of which 914 are located in Donetsk and 278 in Luhansk.[59] As of early 2018, 73 facilities using radioactive sources were located in populated areas outside Ukrainian regulatory control, including 8 institutions using high-activity sealed radioactive sources (HASS) and the radioactive waste-management facility Donetsk Specialized Plant belonging to the Ukrainian State Corporation Radon (Ukrayinske Derzhavne Obyednannya Radon, UkrDO Radon).[60]

The largest users of radioactive sources in eastern Ukraine are metallurgical plants and coal and other mining enterprises.[61] Together, two radioactive source storage facilities in Donetsk—the Vugleisotop Special Centre and the Donetskstal Metallurgical Plant—were known to host about 500 sealed radioactive sources as of 2014.[62] The Donetsk Coal Energy Company and the Luhanskvuhillia Coal Mining Enterprise are also large users of radioactive sources, reportedly hosting 142 HASS as of 2014.[63]

According to Ukrainian nuclear security stakeholders, when territories are returned to Ukrainian Government control, the government's policy is generally to restore the facilities located there to their previous functions rather than, for

[58] Ukrainian State Nuclear Regulatory Inspectorate (SNRI), [Report on the activities of the Ukrainian State Nuclear Regulatory Inspectorate for 2017] (SNRI: Kyiv, 2018), (in Ukrainian) p. 55.

[59] Ivko (note 4).

[60] Ukrainian State Nuclear Regulatory Inspectorate, 'Results of activities of SNRIU in 2017 and priority directions for 2018', Presentation at the SNRIU Collegium, 15 Feb. 2018, p. 105; and Ukrainian State Nuclear Regulatory Inspectorate (note 58), p. 55.

[61] Ukrainian State Nuclear Regulatory Inspectorate (note 58), p. 55.

[62] Ukrainian State Nuclear Regulatory Inspectorate (SNRI), *Report on Nuclear and Radiation Safety in Ukraine for 2015* (SNRI: Kyiv, 2016), p. 83.

[63] Ukrainian State Nuclear Regulatory Inspectorate (note 58), p. 55; Ukrainian State Nuclear Regulatory Inspectorate (note 60); and Chumak (note 4), p. 3.

example, to relocate or consolidate them elsewhere.[64] This, however, may prove complicated or temporarily impossible in some cases, especially as far as facilities with radioactive sources or materials are concerned.

In places where state control is restored the first task is to stop the conflict and stabilize the security environment. After that there has to be a serious effort to remove landmines, explosive remnants of war, booby traps and improvised explosive devices (IEDs) from the territory.[65] The third step is to reinstate all facilities into the regulatory system, which includes the reintroduction of key personnel, facility-level documentation and procedures and the completion of a new inventory and other necessary inspections.

Ukrainian assessments suggest that when facilities known to have held radioactive sources are returned to government control they have been looted of all items that could be removed.[66] Two Ukrainian nuclear security stakeholders referred to a hospital located in territory recovered from separatist control in the town of Maryinka, 23 kilometres south-west of Donetsk city centre in Donetsk oblast. Maryinka was occupied by separatists and later recovered by Ukrainian Government forces but is still subject to frequent shelling and attacks. The hospital was known to have used medical radioactive sources before 2014. When Ukrainian authorities visited the hospital in September 2016 they found that it had been looted of everything except the paper patient records. The current location of the hospital's radioactive sources is unknown.[67]

The above case highlight the need for a fourth step in the process of returning facilities in regained territories to normal operation: the use of mobile radiation-detection equipment to search for and, where feasible, retrieve removed sources. The relevant authorities can also use this equipment to determine whether the regained territory is contaminated with radiation.

The SNRI maintains Ukraine's State Register of Sources of Ionizing Radiation.[68] In principle, if a recovered orphan sealed radioactive source has identifying features (e.g. serial number) intact, it should be possible for the SNRI to ascertain its original owner using the register, unless the source was in the use of the military or was not included in the register for other reasons. In the case of radioactive material in bulk form or radioactive waste, the process of attribution will be more complicated and will probably require an investigation involving full nuclear forensic analysis.[69]

The Ukrainian authorities have already conducted some search and recovery work in regained territories. This has sometimes yielded unexpected results. According to Ukrainian nuclear security stakeholders, surveys of territories recovered from separatist control using mobile laboratories (i.e. vans installed

[64] Former Ukrainian law enforcement official, Author interview, Kyiv, Mar. 2018.

[65] Protection Cluster Ukraine, 'Mine action in Ukraine', Feb. 2018, p. 2.

[66] Former Ukrainian law enforcement official, Author interview, Kyiv, Mar. 2018.

[67] Ukrainian officials, Author interviews, Kyiv, Mar. 2018.

[68] Ukrainian Cabinet of Ministers, [Resolution on setting up the State register of sources of ionizing radiation], Resolution no. 847, 4 Aug. 1997 (in Ukrainian).

[69] For an outline of nuclear forensic methods see Fedchenko, V. (ed.), SIPRI, *The New Nuclear Forensics: Analysis of Nuclear Materials for Security Purposes* (Oxford University Press: Oxford, 2015).

with radiation-detection equipment) have occasionally led to the discovery of previously unregistered radioactive material. In one case, a previously unmapped radioactive material storage facility was reportedly found 'with signs and no fence around it' and with 'local residents using the concrete entrance for barbecues'.[70] This facility certainly existed before 2014 and is likely to date from the Soviet era. However, the fact that its existence was not known and that it was discovered only by chance adds another level of complexity to the nuclear security regime in Ukraine. The more routine cases involve the discovery and disposal of items such as abandoned flasks containing radioactive liquids or radioactive metal cylinders.

One nuclear security stakeholder made an observation on a certain type of sealed radioactive source that is of relevance to the whole Black Sea region but is perhaps particularly important in the case of eastern Ukraine.[71] A significant number of sources with a plutonium–beryllium neutron source—essentially a mixture of plutonium-239 or plutonium-238 with beryllium-9 in a double hermetically sealed steel container—produced since the 1950s are scattered, disused across Eastern Europe.[72] The security of such sources needs particular attention because many of them contain from a few grams up to tens of grams of plutonium-239, which is a weapon-usable fissile material.

The crisis in eastern Ukraine has created its own set of challenges, such as looting, the unauthorized removal of radioactive sources and the trafficking of such sources (see chapter 4). It has also revealed some existing nuclear security and radiation protection problems that were previously unknown. Interviewed nuclear security stakeholders pointed to the existence of systemic problems with local authorities that should have had a much better control system in place but lacked the means and had strong competing priorities.

The loss of radiation-detection infrastructure at the border

By 2014 Ukraine had a border-control infrastructure that was fairly well-equipped with RPMs. The USA and other donor countries have provided significant assistance to Ukraine to improve its stationary radiation-detection capabilities at land border crossings, rail border crossing points, airports and seaports. Ukraine is the second largest recipient of assistance in the world (after Russia) from the NNSA's Nuclear Smuggling Detection and Deterrence (NSDD) programme (formerly known as the Second Line of Defense programme).[73] Since the start of the crisis Ukraine has lost not only its entire nuclear security infrastructure in Crimea (see above) but also at least 29 RPMs at border crossings in eastern Ukraine, which were destroyed in the fighting.[74]

[70] Former Ukrainian law enforcement official, Author interview, Kyiv, Mar. 2018.

[71] UN official, Author interview, Bucharest, Apr. 2018.

[72] Bagi, J., Lakosi, L. and Nguyen, C. T., 'Neutron producing reactions in PuBe neutron sources', *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, vol. 366 (Jan. 2016), pp. 69–76.

[73] US Government Accountability Office (note 17), p. 34.

[74] US Government Accountability Office (note 17), p. 25.

This has created an unusual problem for the Ukrainian State Border Guard Service, which can no longer access a 409-km stretch of the eastern border with Russia. At the same time, it currently has to control the 396-km line of contact with the DPR and the LPR as well as the administrative boundary line with Crimea.[75] Ukraine is unwilling to install stationary RPMs along those two lines as a matter of policy: such action might be misconstrued as acceptance of the status quo. The Ukrainian State Border Guard Service has five mobile laboratories but they are not designed for continuous stationary monitoring as RPMs and can only provide ad hoc coverage. They are also needed elsewhere in the country as discussed above. The Ukrainian Government is reportedly investigating possible options of cooperation with international donors in this area. These options could include 'deployable' radiation detection solutions that would allow for radiation monitoring at checkpoints along the line of contact in eastern Ukraine or along the administrative boundary with Crimea without creating the impression that Ukraine was conceding the border.[76]

[75] Ivko (note 4), p. 2. The administrative boundary line between the Kherson oblast and Crimea comprises a stretch of land of about 10 kms and a stretch of water of about 160.5 kms, which includes parts of the Black Sea, the Sea of Azov and a body of fresh water. OSCE, Special Monitoring Mission to Ukraine, 'Freedom of movement across the administrative boundary line with Crimea', Thematic Report, SEC.FR/511/15, 22 June 2015, p. 4.

[76] Ukrainian officials, Author interviews, Mar. 2018, and US officials, Author interviews and correspondence, Washington, DC, Mar. 2018, Karlsruhe, Germany, May 2018 and Chisinau, Sep. 2018.

4. Nuclear security threats posed by contested spaces

The vast majority of nuclear security stakeholders interviewed for this study identified the contested spaces in the wider Black Sea region as the primary source of nuclear security threats.[77] More specifically, stakeholders identified the contested spaces within or in the immediate vicinity of their states as the main nuclear security threats. Many noted that smuggling of nuclear and other radioactive material through their local contested spaces is a major issue, even though other smuggling routes (through 'regular' border crossings and 'green borders', i.e. land borders between border crossings) exist as well. However, they did not view the contested spaces elsewhere in the Black Sea region as potential sources of nuclear and other radioactive materials intercepted in their own states. For example, officials of Moldova's National Agency for Regulation of Nuclear and Radiological Activities (NARNRA) stated on a number of occasions that all known cases of trafficking of nuclear materials in their country were associated with that country's contested space.[78]

While acknowledging that contested spaces pose a major threat, stakeholders in the region agreed that the lack of clarity on the situation in those contested spaces meant that it was difficult to understand the nature or precise parameters of the nuclear security threats stemming from them. Experts at one government organization with nuclear security responsibilities noted that they had tasked their state's intelligence agency to prepare a report on a specific facet of a nuclear security threat from a contested space on their state's territory, but the report was never delivered.[79] Nuclear security stakeholders suggested that the analysis of open sources has proved useful in the absence of more specific and reliable information. However, this information has limited value and is normally not sufficiently timely. In this situation, it seems that most nuclear security stakeholders affected by threats from contested spaces need to be prepared to respond to the worst imaginable scenario, which complicates and probably at times skews the distribution of the limited resources available for the maintenance of the nuclear security regime.

Despite these challenges, there is a general suspicion among nuclear security stakeholders that contested spaces can, in principle, serve as actual or potential safe havens for smugglers because legitimate governmental control is not possible in those spaces. They expressed concern not only that contested spaces might be used by smugglers to store or hide MORC, but also that a contested space itself might be a source of nuclear material. For example, an inventory conducted in 1997 found that up to 2 kilograms of HEU had gone missing from the Ilia Vekua Sukhumi Institute of Physics and Technology in Abkhazia. The material was

[77] On the interview process see chapter 1 and note 3.
[78] NARNRA officials, Author interviews, Bucharest, Apr. 2018 and Chisinau, Sep. 2018.
[79] Ukrainian official, Author interview, Kyiv, Mar. 2018.

never recovered. The IAEA has reportedly suggested that around 7 kg of other nuclear material (i.e. not HEU) went missing from the institute at the same time.[80]

Most of the interviewed nuclear security stakeholders were at a loss to explain why the creation of the DPR and the LPR—together forming the largest contested space in the Black Sea region and the one with the highest volume of radioactive material—had not had a significant effect on nuclear smuggling in the region. One put forward a theory of a 'delayed effect': it is far harder and riskier to profit from looted nuclear and other radioactive materials outside regulatory control than from other material assets, and therefore the illicit trafficking of MORC from the DPR and the LPR should be expected only after the non-state actors have exhausted other possibilities to profit.[81] However, other stakeholders in the region provided no corroboration of this theory.

Although nuclear security stakeholders in the Black Sea region might not notice the direct effects of the smuggling of MORC in contested spaces outside their immediate neighbourhood, the political reasons for the creation and existence of those spaces do influence nuclear security regimes across the region. Some stakeholders report that they have no confidence that certain governments in the region would share any timely or relevant information in the case of a major nuclear security or even nuclear safety incident. Speaking more broadly, while states in and outside the Black Sea region often view the region as a single area for the purposes of political geography or foreign policy, the nuclear security regimes there are fragmented, with communications between nuclear security stakeholders being at times intermittent or in some cases non-existent.[82] According to the interviewees, Russia and Turkey, for different reasons, seem to be the states that are least open to direct and especially operational nuclear security contact with other states in the region. The lack of communication is alleviated somewhat by the existence of multilateral frameworks for nuclear security (e.g. the GICNT, the IAEA and the Nuclear Forensics International Technical Working Group) and international information-exchange mechanisms (e.g. the IAEA's ITDB and Interpol).

Radioactive materials and sources in contested spaces

It is common for different nuclear security stakeholders to analyse the nuclear security threats that they face in different ways and address the threats presented by contested spaces accordingly. Stakeholders draw a clear distinction between nuclear material and 'other radioactive' material (including sealed radioactive sources and radioactive waste in all forms). While none of the interviewed nuclear security stakeholders in the region disputed the importance of combating illicit trafficking of fissile materials, many indicated that, in their day-to-day work,

[80] Galeotti, M., 'A dirty business: nuclear smuggling in the former Soviet states', *Jane's Intelligence Review*, Mar. 2007, p. 60.

[81] Georgian officials, Author interviews, Tbilisi, Feb. 2018.

[82] See e.g. Romanian Ministry of Foreign Affairs, 'Neighbourhood of interest to Romania as EU member: the Black Sea Region', [n.d.].

orphan radioactive sources and improperly stored radioactive waste represent a far clearer and more immediate nuclear security threat.

This distinction is perhaps most visible in Ukraine because the conflict there began relatively recently and because a far larger volume of radioactive sources and waste fell outside regulatory control than in other contested spaces in the region. As noted above, the DPR and the LPR together represent the largest contested space in the region and the one with the highest volume of radioactive materials. Among nuclear security stakeholders contacted for this study, Ukraine's SNRI was probably the most forthright in presenting its views on the main nuclear security threats in the region. In a document analysing the situation in eastern Ukraine, it stated that:

> it can be concluded that the main potential threat in the area of the Anti-Terrorist Operation [i.e. Ukraine's actions to recover control over its territory from the DPR and the LPR] is illicit trafficking of radiation sources and radioactive waste from the territory from beyond Ukrainian control that could result in public exposure and radioactive contamination of the environment due to unsealing of radiation sources or their use as a 'dirty bomb'.[83]

The Ukrainian State Border Guard Service also supports this position. It has reportedly paid special attention to the threat of illicit trafficking (and thus the existence outside regulatory control) of 'industrial ionizing emission sources'.[84]

Despite the lack of access to territory outside Ukrainian Government control in eastern Ukraine, the SNRI still sometimes receives notifications on radiation incidents from licensees located there. These have included unexplained indications of illicit trafficking of radioactive sources, at least between the DPR and the LPR. In one case the Yenakiyeve Iron and Steel Works, a large steel-making enterprise in Donetsk oblast, reported the discovery of an abandoned container with radioactive sources, which was presumed to have been trafficked from its original location, the BIK enterprise in Sverdlovsk, Luhansk oblast.[85]

Another potential threat located in eastern Ukraine is the existence of a radioactive waste storage facility co-located with the Donetsk State Factory of Chemical Products. The facility, which is discussed in more detail below, is currently outside the Ukrainian Government's control and presents a serious risk with regard to the production of radiological dispersion devices (RDDs) (i.e. weapons designed to spread radioactive materials).

Although the threats associated with radioactive MORC in Ukraine currently pose perhaps the gravest challenge, such threats are certainly not unique to that country and its contested spaces. Nuclear security stakeholders in Georgia and Moldova also referred to multiple cases of illicit trafficking of radioactive MORC associated—either directly or on the basis of intelligence information—with Abkhazia and South Ossetia (in the case of Georgia) or Trans-Dniester (in the case of Moldova). These items included containers with or without radioactive

[83] Document in English provided by the Ukrainian State Nuclear Regulatory Inspectorate, Author correspondence, Mar. 2018.

[84] Ivko (note 4).

[85] Ukrainian State Nuclear Regulatory Inspectorate, Author correspondence, Mar. 2018.

sources, sealed vials with radioactive substances, or other orphan radioactive sources. In one notable case the Moldovan nuclear regulator successfully recovered orphan radioactive sources from Trans-Dniester. The case, which is discussed in detail below, is exceptional in that contested spaces are normally inaccessible to governmental authorities.

The Donetsk State Factory of Chemical Products

The Donetsk State Factory of Chemical Products, located in the Kuibyshevskyi district of Donetsk city, has been controlled by the DPR since June 2014. The factory was part of Ukraine's legacy from the Soviet military–industrial complex. Set up in 1940s, it was a major producer of landmines and artillery shells for the Soviet military, as well as explosives for the mining and other industries. The production of ammunition stopped in 1991, and since then the factory has mostly produced industrial explosives and engaged in the large-scale dismantlement and disposal of decommissioned ammunition.[86] Shortly before the outbreak of hostilities in eastern Ukraine the factory reportedly started the production of an advanced industrial explosive developed to satisfy the needs of nearby coal mining enterprises.[87] The exact size of the stockpile of explosives available at the factory by 2014 is difficult to estimate, but it was clearly substantial.

The factory also hosts another part of the Soviet industrial legacy: a radioactive waste storage facility, formerly known as the Donetsk State Specialized Industrial Complex on Radioactive Waste Management and now known as UkrDO Radon's Donetsk Specialized Plant. It was built in 1961 to store mostly low-level radioactive waste and radioactive sources from local research and medical facilities. In 1966 this radioactive waste storage facility was closed down, sealed and administrative responsibility for it was transferred to the Donetsk State Factory of Chemical Products.[88]

The storage facility is an underground bunker, 20 metres in length, 10 metres in width and 3 metres in height (i.e. a volume of 600 cubic metres).[89] It was reportedly poorly maintained, has suffered at least one breach of its structural integrity, in 1997, and was threatened by a fire at the factory where it is located in 2010.[90] Ukraine has had plans to open up the storage facility and relocate its contents to a plant at Dnipro (formerly Dnipropetrovsk) since 2002. The necessary studies were conducted between 2002 and 2004, but the relocation never took place due to a lack of funds.[91] As the Ukrainian Government was unable to evacuate the Donetsk Specialized Plant after the outbreak of hostilities in 2014, the facility's newer stocks of radioactive waste and the waste sealed in 1966 were both still in place when the DPR assumed control. The newer stocks were reportedly stored in

[86] Podrobnosti, [Donetsk plant began dismantlement of anti-personnel mines], 10 July 2002 (in Russian).

[87] UNN, [Production of a new type of industrial explosive has begun in Donetsk oblast], 19 Feb. 2014 (in Ukrainian).

[88] Ukrainian State Nuclear Regulatory Inspectorate, [On the radioactive waste storage facility located in the grounds of the Donetsk State Factory of Chemical Products], 5 Aug. 2015 (in Ukrainian).

[89] Tucker, M., 'Ukraine says pro-Russia rebels are building a dirty bomb', *Newsweek*, 31 July 2015.

[90] Podrobnosti, [Chemical plant burned in Donetsk], 2 Sep. 2010.

[91] Ukrainian State Nuclear Regulatory Inspectorate (note 88).

the vicinity of the sealed waste in containers placed in a 'temporary hangar-type storage'.[92]

On 8 July 2014 the mayor of Donetsk city, Oleksandr Lukyanchenko, confirmed that the Donetsk State Factory of Chemical Products was under the control of the DPR.[93] Ukraine has had almost no knowledge of the status of the explosives or the radioactive waste or sources at the factory since then. In July 2015 *Newsweek* published documents provided to it by the Ukrainian State Security Service that allegedly indicated that the prime minister of the DPR, Alexander Zakharchenko, was making arrangements to transfer the contents of the storage facility to Russia.[94]

The waste storage facility presents both radiation safety and nuclear security risks. The Donetsk State Factory of Chemical Products has suffered multiple fires and large-scale explosions since 2014, and concerns about possible radioactive contamination of the surrounding area prompted Ukraine to request that the Special Monitoring Mission (SMM) of the Organization for Security and Co-operation in Europe (OSCE) monitor for radioactivity in June 2015.[95] No radioactive contamination associated with the facility had been reported as of mid-2018.

The nuclear security risks include the potential production of RDDs by opportunistic non-state actors (or their subgroups) and the illicit trafficking of radioactive materials through or from contested spaces. Regardless of the authenticity of the documents published by *Newsweek*, the DPR officials interviewed by the magazine showed clear awareness of the existence of the radioactive waste storage facility at the Donetsk State Factory of Chemical Products. According to one knowledgeable nuclear security stakeholder in Ukraine, the location of the radioactive waste in the vicinity of an explosives factory heightens the risk that RDDs could be produced and, given the location of the factory, easily be transferred through the uncontrolled line of contact. Similarly, the possible smuggling of radioactive material from facilities such as the Donetsk State Factory of Chemical Products cannot be excluded.[96] Non-nuclear facilities, such as chemical plants, often host radioactive sources but do not enjoy the same level of physical protection as nuclear facilities, where the National Guard is present.

Technical efforts to regain control over radioactive materials in Trans-Dniester

The lack of progress in finding a settlement to the protracted conflict in Trans-Dniester continues to challenge security and stability in Moldova. The Moldovan state authorities' lack of control over both the territory of Trans-Dniester and the Trans-Dniestrian segment of the Moldovan–Ukrainian border creates nuclear security threats (including illicit trafficking) and radiation protection threats to the populations of Moldova and neighbouring countries. Unlike in the case of

[92] Uatom, 'Radioactive waste on territories beyond control—who takes care of safety?', 13 Dec. 2016.

[93] OstroV, [The mayor of Donetsk confirms that the DPR fighters occupied the explosives production plant], 8 July 2014 (in Russian).

[94] Tucker (note 89). The documents in question are available at 'Donetsk radioactive waste documents', Scribd, 3 Aug. 2015.

[95] 'Ukrainian Minister urges OSCE SMM to check radiation background in Donetsk over possible containment site breach', Interfax-Ukraine, 22 June 2015.

[96] Former Ukrainian law enforcement official, Author interview, Kyiv, Mar. 2018.

the Ukrainian nuclear regulator and the territories of the DPR and the LPR, the Moldovan nuclear regulator, NARNRA, does not even have an outdated register of radioactive sources or inventory of nuclear materials in Trans-Dniester. Moreover, in contrast to other contested spaces in the Black Sea region, all sides to the conflict understand the severity of the threats represented by radioactive MORC and have undertaken efforts to address those threats even in the absence of a general political settlement of the underlying conflict.[97]

In 2012 the OSCE Mission to Moldova facilitated an agreement between Moldova and Trans-Dniester to ensure the removal and adequate physical protection of radioactive industrial waste from an enterprise based in Ribnita, Trans-Dniester, to the National Radioactive Waste Management Company (NRWMC) near Chisinau.[98] In 2014 NARNRA initiated a project aimed at the detection, identification and collection of orphan radioactive sources and other radioactive MORC, and their transportation to the NRWMC for characterization, registration and storage.[99] In 2015 alone NARNRA collected radioactive MORC on 329 occasions, including 5 cases involving nuclear materials—an unusually large number.[100] By the end of 2016, under the project, NARNRA had regained control over more than 3500 radioactive sources from abandoned industrial sites in Moldova, including 1500 recovered from the Trans-Dniestrian region. The work was co-financed by the Swedish Radiation Safety Authority (Strålsäkerhetsmyndigheten, SSM) and the British Department of Energy and Climate Change, with political support from the OSCE Mission to Moldova. The OSCE mission facilitated the collection of the 1500 radioactive sources recovered from the Trans-Dniestrian region and their transportation to the NRWMC.[101]

The project is notable because it demonstrates that the need to protect radiation protection and combat nuclear security threats can transcend the lack of progress in settling a regional conflict. It has also been cost-effective: the total cost to donors was 980 000 Swedish kronor (*c.* €100 000) between 2014 and 2017.[102] The project also highlights the value of cross-cutting cooperation between 'traditional' nuclear security stakeholders (e.g. NARNRA) and organizations that have a broader security mandate, such as, in this case, the OSCE with its experience in conflict management and post-conflict rehabilitation. This suggests that options for the involvement of the OSCE in addressing radiation protection and nuclear

[97] Moldovan nuclear security officials, Author interview, Chisinau, Dec. 2017.

[98] OSCE Mission to Moldova, 'OSCE helps Chisinau and Tiraspol remove and store radioactive waste', 16 Mar. 2012.

[99] Swedish Radiation Safety Authority (SSM), *Nuclear Security, Safety and Non-proliferation: Sweden's International Cooperation in 2014* (SSM: Solna, 2015), p. 19.

[100] Swedish Radiation Safety Authority (SSM), *Nuclear Security, Safety and Non-proliferation: Sweden's International Cooperation in 2015* (SSM: Solna, 2016), p. 19.

[101] Swedish Radiation Safety Authority (SSM), *Nuclear Security, Safety and Non-proliferation: Sweden's International Cooperation in 2016* (SSM: Solna, 2017), pp. 15–16; and Written report provided to SIPRI by NARNRA, Mar. 2018.

[102] Swedish Radiation Safety Authority (SSM), *Nuclear Security, Safety and Non-proliferation: Sweden's International Cooperation in 2017* (SSM: Solna, 2018), p. 19; and Swedish Radiation Safety Authority (notes 100 and 101).

security threats should be systematically investigated in other contested spaces in the Black Sea region.

Understanding the involvement of organized crime and balancing investigations and prosecutions

There are ongoing discussions between some nuclear security stakeholders in the region regarding the optimal way to conduct investigations and prosecutions of nuclear smuggling cases. The interviews conducted for this study highlighted that these discussions are characterized by a lack of agreement between certain of the stakeholders on the degree of involvement of organized crime and other organized groups in illicit the trafficking of nuclear or other radioactive materials, and therefore on the most appropriate means to address the threat.

There is a general tendency to describe smugglers as short-sighted opportunists or scammers who are motivated by money and who are always looking for the path of least resistance. According to one UN official with good knowledge of the matter, most of the relatively few trafficking attempts in the region have been of an opportunistic nature by persons trying to sell low radioactive material and fake nuclear materials (scams).[103] As far as it is possible to judge from the available open sources, this description of a typical nuclear smuggler is probably correct, at least in the vast majority of cases. One nuclear security stakeholder estimated that about 95 per cent of all illicit trafficking cases involve scams or a grave overestimation on the part of the smuggler of the value of the substance being transferred.[104] Most of the officials interviewed agree that nuclear smuggling is a 'supplier-driven business'. However, some stakeholders reported that they have serious concerns about the involvement of organized crime in a few cases of illicit trafficking, including some involving HEU.[105]

Some law enforcement officials in the region seem content with an approach where a detection of an instance of nuclear smuggling is directly followed by the arrest of the perpetrators and the initiation of a prosecution on the grounds of possession or transportation of nuclear or other radioactive material. However, this is not a view shared by all nuclear security stakeholders. Others claim that, while such an approach may be sufficient in terms of dealing with opportunistic smugglers, it makes it difficult to uncover the whole supply chain of illicit trafficking conducted by organized crime groups, including the identification of buyers (if they exist), all middlemen, suppliers and, ultimately, the point at which legitimate control over the material was lost. It is true that investigations into organized crime often require a long-term investment of resources unavailable to the entities typically involved with responding to illicit the trafficking of

[103] UN official, Author interview, Bucharest, Apr. 2018.

[104] US Government official, Author interview, Washington, DC, Mar. 2018.

[105] Kupatadze, A., 'Organized crime and the trafficking of radiological materials: the case of Georgia', *Nonproliferation Review*, vol. 17, no. 2 (July 2010), pp. 219–34; and Birch, D. and Smith, R. J., 'The fuel for a nuclear bomb is in the hands of an unknown black marketeer from Russia, US officials say', Center for Public Integrity, 12 Nov. 2015.

MORC. Many countries struggle to strike the correct balance between conducting long-term investigations against making quick arrests and promptly removing material from circulation, especially when that material is radioactive. However, discussions with nuclear security stakeholders make it clear that, where viable, countries should work on developing bilateral or regional capabilities to follow up on detection, not simply by stopping a shipment, but by tracking it through the supply chain to identify as many of those involved as possible.

5. Nuclear security cooperation in the Black Sea region

The international community has spent many years and millions of dollars and euros on assisting countries around the Black Sea to set up and develop their nuclear security regimes. The EU and the USA have been the largest donors, with Norway, Sweden, the UK and other states also providing important and consistent contributions. International organizations such as the IAEA, Interpol, the UN Interregional Crime and Justice Research Institute (UNICRI) and the UN Office on Drugs and Crime (UNODC) have also assisted the development of national nuclear security regimes and infrastructure in the region within the limits of their respective mandates.[106] Since the terrorist attacks on the USA of 11 September 2001, and especially after the high-profile interceptions of HEU in Georgia (in 2003, 2006 and 2010) and Moldova (in 2011), this assistance has focused in particular on securing nuclear MORC. By 2018 these various assistance efforts had resulted in a situation where detection infrastructure—arguably the most capital-intensive part of the nuclear security regime—was installed in most cases. The onus then fell on the countries in the region to take on the responsibility for the operation and maintenance of the equipment, the training of personnel, and the further development of the nuclear security regime.

This chapter first discusses the efforts of international assistance providers to develop the nuclear security regime across the region. It then makes a case for intensifying nuclear security coordination at the national level (in particular upgrading national response plans and increasing the frequency with which they are exercised). It also proposes the deepening of collaboration at the regional level (including the harmonization of national response plans between neighbouring countries, where appropriate, and with the EU's plans), and the joint use of existing regional nuclear security capabilities. Finally, the chapter suggests that there are benefits in the joint regional planning of future upgrades of nuclear security regimes. These steps would allow for the more efficient use of limited funds and enhance the sustainability of the nuclear security systems and measures in operation.

Donor coordination and the sustainability of the nuclear security systems in operation

In interviews conducted for this study, some representatives of organizations that provide assistance to countries in the region noted the importance of being aware of the goals and activities of other donors as well as the internal structures, political and organizational realities, and even personalities within assisted states. As

[106] A useful overview of national and international efforts is provided in Nuclear Security Summit 2016, 'Highlights of national progress reports', 5 Apr. 2016. More detailed information for each country is contained in Nuclear Security Summit 2016, '2016 national statements', 1–4 Apr. 2016.

one knowledgeable representative put it, 'it is important to know who is doing what before you go in'.[107]

Donors have used multiple coordination mechanisms to adjust the modalities of the assistance offered to reflect changes in the political situation and in the threat environment as well as to harmonize their efforts and avoid unnecessary overlap. Some donor states have set up bilateral communication processes with other donors and assistance recipients. Existing international forums such as the IAEA and Interpol provide a number of ad hoc opportunities for coordination and communication. The most effective and focused mechanisms are, however, multilateral groups created specifically for the purpose of coordinating the provision of assistance.

In the context of the nuclear security assistance to the wider Black Sea region the most relevant multilateral coordination mechanisms are the BMWG, the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (GP) and the Information Sharing Initiative (ISI).

Of the three, the BMWG is most clearly associated with the prevention of illicit trafficking of nuclear or other radioactive materials in the Black Sea region as a whole. Formally established in 2005 to serve as an information-exchange mechanism between the IAEA, the EU's Joint Research Centre (JRC) and European External Action Service, and the relevant US Government agencies, (e.g. the Department of State and the Department of Energy), the BMWG has expanded to include the input of other donors over the years. It serves as the primary mechanism of information exchange on donors' efforts to provide fixed and mobile radiation-detection equipment and work towards its compatibility and interoperability. It also supports the sustainability of detection infrastructure by assisting recipient countries with equipment maintenance, training and capacity building in governmental entities involved in combating nuclear smuggling.[108]

The GP was launched in 2002 at the Group of Eight (G8) summit in Kananaskis, Canada, with a mandate to 'prevent terrorists and those that harbor them from acquiring weapons and materials of mass destruction and their means of delivery'.[109] From the outset the GP's mandate was much broader than nuclear security. It initially focused on Russia and other states of the former Soviet Union before assuming a global mandate in 2008. Following the events in Crimea in 2014, the rest of the G8 excluded Russia and continued as the Group of Seven (G7). This change also affected groups working under the G7, including the GP, which by that time had the largest membership of all such groups. The GP has had a special focus on Ukraine since the events of 2014, including policy discussions on the coordination of the implementation of nuclear security projects there.[110]

[107] Norwegian official, Author interview, Oslo, Nov. 2017.

[108] European Commission and European External Action Service (note 16), p. 37.

[109] Global Partnership Against the Spread of Weapons and Materials of Mass Destruction, 'About the Global Partnership', [n.d.]. See also Anthony and Fedchenko (note 10).

[110] Swedish Radiation Safety Authority (note 101), p. 5

According to participating donors, the GP is an active, high-level coordination forum.[111]

The ISI was launched by the Norwegian Radiation Protection Authority (NRPA) with the specific purpose of coordinating nuclear security and safety projects in Ukraine (in which it differs from the BMWG). The ISI is an informal arrangement focused on implementation and coordination, as opposed to policy discussions (which distinguishes it from the GP). Since the first meeting of the ISI in Oslo in 2016, its membership has grown to include Canada, France, Germany, Italy, Norway, Sweden, the UK, the USA and the EU.[112]

The BMWG, the GP, the ISI and other channels of nuclear security coordination have proven to be versatile in practice, despite the fact that each donor (e.g. a state or an international organization) usually has some degree of restriction on the way it can legally provide assistance. For example, some governments provide their state agencies with an annually updated list of the countries with which those agencies may work, and that list can change over time. In practice, some donors may be better positioned to fund procurement of hardware, while others may find it much easier to provide training or to assist with improving relevant regulations. The key is to combine efforts to achieve the desired result. In one specific case of which the authors have first-hand knowledge, a recipient state had funds to purchase all the measurement equipment required by a particular site. However, before the equipment could be purchased, the space where the equipment was to be housed needed to be renovated. Although the recipient state had more than enough funds to cover the cost of renovation as well, those funds were specifically earmarked for equipment procurement and therefore could not be used for any other purpose. In this case, a donor state stepped in to cover the costs of the renovation (which were modest compared with the equipment costs). This allowed the procurement funding to be spent and permitted the recipient state to continue with the installation of the measurement equipment.

According to interviews conducted for this study, donor coordination is normally versatile enough not only to accommodate cases such as this, but also to react to larger political changes.[113] The transformation of the GP to focus on Ukraine has clearly been directly influenced by the crisis in and around that country, while the creation of the ISI was meant to deal with the nuclear safety and security challenges created or uncovered by that crisis. While no donor has reported conducting a centralized systematic study of the impact of the crisis on the nuclear security assistance needs in the region, the crisis has rendered some actors and communication mechanisms redundant, which has resulted in a corresponding adjustment to other forms of assistance.

[111] Norwegian Radiation Protection Authority officials, Author interviews, Oslo, Nov. 2017 and US Government officials, Washington, DC, Mar. 2018.

[112] Norwegian Radiation Protection Authority officials, Author interviews, Oslo, Nov. 2017 and Washington, DC, Mar. 2018; and Swedish Radiation Safety Authority (note 102), p. 10.

[113] Norwegian Radiation Protection Authority officials, Author interviews, Oslo, Nov. 2017 and US Government officials, Washington, DC, Mar. 2018.

Interviewed nuclear security stakeholders indicated that donor coordination on issues of sustainability could be improved.[114] Some donors focus more than others on the assessment of the impact of their assistance programmes, including by way of follow-up checks on equipment that they provided or visits to infrastructure that they helped to create. For example, the NNSA's NSDD programme has a dedicated sustainability element that collects and analyses data from the equipment provided by the programme and 'conducts assurance site visits to ensure that partner country site operations are performing properly'.[115] Not all donors are as focused on verifying a sustained use of the equipment they provide, possibly since they consider such verification to be too intrusive, complicated, costly or politically problematic.

Some nuclear security stakeholders noted that sustainability and impact assessments should be built into every assistance initiative at the design stage.[116] It is certainly up to each donor to decide the level of assurance that they require. Furthermore, the main aim of donor coordination is to accomplish an agreed goal with maximum efficiency, and each donor will want to be confident that the assistance provided by others will play its allotted role. Thus, donors should be open to sharing more widely their good practices on assessing the impact of assistance and ensuring its sustainability.

Radiation-detection equipment

'Detection of nuclear security events' is specifically listed by the IAEA as an 'essential element' of any nuclear security regime, which should include measures to detect, assess and notify competent authorities about nuclear security events.[117] In the case of nuclear or other radioactive MORC, detection is one of the three fundamental stages of its management—the other two being prevention (of the occurrence of MORC) and response. While the response measures can be expensive in extreme cases, the radiation-detection instrumentation and infrastructure are arguably the most capital-intensive components of the nuclear security regime of any country. They are certainly one of the costliest elements of nuclear security assistance aimed at dealing with MORC that can be provided by a donor.

As a result of donors' significant and sustained long-term investment and engagement in the Black Sea region, as of 2018 most of the equipment necessary for detection of nuclear or other radioactive materials, in particular at borders or in transit, had been provided or was in the final stages of being installed. Detection infrastructure (and equipment necessary for nuclear security response) remains in need of improvement in a number of countries and locations around the Black Sea, but overall any lack of detection infrastructure is being addressed.

[114] UN official, Author interviews, Bucharest, Apr. 2018.

[115] US Government Accountability Office (note 17), p. 8.

[116] EU official, Author interview, Brussels, Nov. 2017.

[117] IAEA, *Objective and Essential Elements of a State's Nuclear Security Regime*, Nuclear Security Fundamentals, IAEA Nuclear Security Series no. 20, (IAEA: Vienna, 2013), p. 8.

A few nuclear security stakeholders in the Black Sea region noted in interviews that they simply do not need any more detection equipment.[118]

The NNSA's NSDD programme has been the largest donor of detection equipment to countries in the region, specifically Armenia, Azerbaijan, Bulgaria, Georgia, Moldova, Romania, Russia and Ukraine. In each of these countries, the equipment has been installed and the NSDD programme is either still providing transitional support and assistance or has handed over full responsibility.[119] In short, while there are still notable gaps in equipment in some countries (e.g. Armenia, Moldova, possibly Turkey and, as discussed above, Ukraine) and other gaps will probably be identified in the future, the bulk of work to provide equipment for the Black Sea region has been done. This emphasizes the necessity of ensuring that the detection infrastructure is put to good use and the equipment is maintained and operated by well-trained personnel. In other words, the availability of detection equipment brings into focus the need to ensure the sustainability of the detection stage in the management of the nuclear security regime.

Nuclear security training

No equipment is useful unless it is operated by trained personnel and is part of a functioning national nuclear security system for detection.[120] It is not unusual for nuclear security authorities in any country to have a relatively large turnover of personnel and therefore a regular need to train a new batch of officials or officers in the detection of radioactive substances and radiation protection. Over the years donors have provided and facilitated numerous training activities in the Black Sea region on various facets of nuclear security, including prevention, detection and response to nuclear security events involving MORC.

Such training normally consists of exercises, ad hoc seminars and regular courses for nuclear security personnel. In some states (e.g. Russia and Ukraine), both donors and recipients invested in the development of nuclear security components at pre-existing specialized training centres (e.g. in border guard services) and institutions of higher education. The IAEA facilitates the coordination and development of such training centres through the International Network for Nuclear Security Training and Support Centres.[121] The IAEA also facilitates the development of university-level education in nuclear security through the International Nuclear Security Education Network.[122]

On the donor side, one of the largest recent nuclear security training initiatives has been the European Nuclear Security Training Centre (EUSECTRA), which was set up by the European Commission's JRC. EUSECTRA is open to officials of national authorities involved in the detection of and response to nuclear security events from all countries, whether EU members or not. Its aim is to familiarize

[118] Georgian official, Author interview, Tbilisi, Feb. 2018.

[119] US Government Accountability Office (note 17), pp. 8, 33–34.

[120] IAEA, *Nuclear Security Recommendations on Nuclear and Other Radioactive Material out of Regulatory Control*, Recommendations, Nuclear Security Series no. 15, (IAEA: Vienna, 2011), p. 14.

[121] IAEA, 'International Network for Nuclear Security Training and Support Centres', [n.d.].

[122] IAEA, 'International Nuclear Security Education Network (INSEN)', 27 Sep. 2017.

such officials with radiation detection, radiation hazards, and the best practice in measuring and relaying the technical information obtained from equipment for subsequent analysis and action as required by the relevant state's national nuclear security response plan.[123]

As in the case of equipment provided by donors, many of the nuclear security stakeholders interviewed for this study advocated taking steps to build sustainability into the nuclear security training programmes. Thus, donors should be open to the exchange of good practice in their efforts to follow up on the future progress of trained personnel, and they should gather objective feedback on the usefulness of the training provided, such as data on promotions obtained by trained personnel.

Nuclear security coordination and cooperation at the national level

The establishment and proper functioning of a nuclear security regime demand much more than the introduction of detection infrastructure and a trained workforce to operate it. Preventing (and deterring), detecting and responding to illicit trafficking of nuclear and other radioactive material in a region is a complex endeavour that requires the coordinated collaboration of a wide range of different stakeholders, expertise and equipment at both the national and international levels. At the national level, typical stakeholders in the nuclear security regime are (*a*) intelligence and security personnel; (*b*) operational personnel (e.g. frontline officers and first responders); (*c*) investigators and prosecutors; (*d*) policy, legal and regulatory subject matter experts; and (*e*) technical experts.

A functioning coordination and collaboration between all the nuclear security stakeholders at the national level is important for two reasons. First, it is a key requirement for prevention, detection and response to a nuclear smuggling incident. Second, it contributes significantly to ensuring the sustainability of the national nuclear security regime.

Essential elements of a nuclear security regime

The most fundamental IAEA nuclear security guidance considers the 'identification and definition of nuclear security responsibilities' of competent authorities and 'planning for, preparedness for, and response to, a nuclear security event' by those authorities as 'essential elements' of any state's nuclear security regime.[124] The more specific IAEA guidance on prevention, detection and response to nuclear smuggling strongly suggests that the states 'should have a comprehensive national response plan for nuclear security events in combination with, [among other things], the national radiological emergency plan'.[125] Nuclear security is widely accepted as being a national responsibility, so the specific structure, details and naming of plans differ from country to country. Normally, however, a national

[123] Galy, J., 'EUSECTRA: half a decade of operation in strengthening nuclear security through continuous professional development and training', *ITWG Nuclear Forensics Update*, no. 6 (Mar. 2018), pp. 1, 3.

[124] Essential elements 2 and 11, respectively, in IAEA (note 117), pp. 4, 7, 9.

[125] IAEA (note 120), p. 22.

framework for managing the response to a nuclear security event includes multiple, nested plans. For example, a national response plan for nuclear security events would incorporate a national interpretation of the IAEA's concept of a nuclear forensics model action plan that would govern sections of the response related to nuclear forensics and parts of the radiological crime scene management.[126]

In interviews, nuclear security stakeholders in the region frequently expressed their dissatisfaction with the current state of national response planning and reported on the various efforts being made to develop new or update existing but outdated response plans for a nuclear security event. On average, the general level of satisfaction of regional stakeholders with the state of their national response planning (and its exercising and use in actual cases) seems to be lower than their level of satisfaction with available detection infrastructure or equipment. Putting this in terms of the IAEA's nuclear security guidance documents that define the essential elements of a state's nuclear security regime, the interviews indicated that, in general, stakeholders perceive that Essential Element 10 ('detection of nuclear security events', including infrastructure and equipment) is better developed in most cases than essential elements 2 ('identification and definition of nuclear security responsibilities') and 11 ('planning for, preparedness for, and response to, a nuclear security event').[127]

Strengthening nuclear security response planning

In an effort to strengthen nuclear security response planning in the Black Sea region, nuclear security stakeholders from outside the region are engaged in providing assistance to develop and implement the response plans or their components. For example, the US Department of State's Office of Weapons of Mass Destruction and Terrorism (WMDT) has signed joint action plans with Armenia, Georgia, Moldova and Ukraine (as well as 10 other states outside the Black Sea region).[128] As part of those plans the USA is assisting its partner countries to strengthen their national response frameworks by establishing a nuclear smuggling incident protocol—a planning instruments that is roughly equivalent in scope to the IAEA's concept of a nuclear forensics model action plan.[129] The European Commission's JRC addressed the same issue in the past by developing the Response to Illicit Trafficking of Nuclear Material (RITNUM) handbook that describes the roles and responsibilities of each actor involved in the response to a case of illicit trafficking.[130] In addition, the IAEA provides important assistance in

[126] IAEA, *Nuclear Forensics in Support of Investigations*, Implementing Guide, Nuclear Security Series no. 2-G (Rev.1) (IAEA: Vienna, 2015), p. 7.

[127] IAEA (note 117), pp. 4, 8, 9.

[128] Limage, S., 'US nonproliferation programs: sustaining the momentum', *Arms Control Today*, vol. 47, no. 4 (May 2017); and US Department of State, Bureau of International Security and Nonproliferation, Office of Weapons of Mass Destruction and Terrorism, 'Counter Nuclear Smuggling Unit', [n.d.].

[129] US Department of State, Bureau of International Security and Nonproliferation, 'US cosponsors tabletop exercise on nuclear smuggling incident protocol in Kyiv', Press release, 20 Jan. 2017; and IAEA (note 126), p.7.

[130] von Zweidorf, A., 'Combating illicit trafficking and criminal use of radioactive and nuclear material', BEOBAL training seminar, Feb. 2006; and Cromboom, O. et al., 'A multi-country project on combating illicit trafficking of nuclear materials', AEA-CN-154/036, *Illicit Nuclear Trafficking* (note 15), p. 492.

this area through its International Nuclear Security Advisory Service (INSServ) and can support the drafting of an integrated nuclear security support plan at the request of and in consultation with a member state.[131]

Further efforts are necessary throughout the Black Sea region to strengthen national response planning. The interviews with regional stakeholders indicated that existing plans need to be upgraded in a number of different ways, depending on the country. First, nuclear security response planning should be comprehensive so as to cover all relevant functions, contingencies and stakeholders. In some countries such planning exists but, for example, covers only operations at certain locations, such as borders. Second, national response planning and its components should be formalized and distributed across governmental authorities: stakeholders noted in interviews that, even in the states with more developed nuclear security regimes, not all authorities are aware of their responsibilities. Third, in order to improve the sustainability of a national response plan, it should be adopted at the appropriate level and authorities' responsibilities should be binding. One stakeholder mentioned in an interview that a concept of operations that was signed by four national authorities as part of a response plan remains 'a gentlemen's agreement' and is not legally binding.[132] Fourth, and quite importantly, the national response plan should be tested regularly, including through unannounced exercises, and possibly using 'live' materials or sources (as appropriate from the point of view of radiation-protection regulations). Fifth, the national response plan should be reviewed regularly to incorporate findings from exercises or experience from real illicit trafficking cases.

Nuclear security coordination and cooperation at the international level

Generally speaking, the nuclear security stakeholders interviewed for this study agree that the development of a response plan at the national level—in combination with regular exercises, tests and evaluations—is crucial for a properly functioning nuclear security regime. According to the stakeholders, such plans remain in need of further improvement due to a lack of either political will or resources. With the end of the Nuclear Security Summit process the general political attention on, and thus the funding available for, nuclear security programmes is diminishing. With this in mind, states in the region should attempt to harmonize response plans bilaterally with neighbours or with the EU. They should also consider the joint use of the region's resources and assets, including those in the two EU member states, Bulgaria and Romania.

Harmonization of response

National response plans (the names of which vary by country and scope; e.g. 'concept of operations', 'nuclear smuggling incident protocols' etc.) normally focus on interactions between national stakeholders and, as a result, are often incompatible

[131] IAEA, 'Nuclear Security information coordination and analysis', 25 Aug. 2016.
[132] NARNRA official, Author interview, Chisinau, Dec. 2017.

with the response plans of neighbouring states. Thus, the first argument in favour of increased harmonization is that, without it, cases of incompatibility are more likely to arise in practice, especially in urgent situations involving cross-border illicit trafficking. The same argument can be made even in more trivial cases, such as interceptions involving items contaminated with radioactive material: greater harmonization between states would help to facilitate the return of such items to the state of origin.

Second, harmonization of response plans between the EU member states in the Black Sea region and non-EU member states, as appropriate, would promote further regional cohesion and integration—a powerful driver for several states in the region.

Finally, international engagement may, of itself, help to raise awareness about and contribute to the sustainability of nuclear security efforts. In some cases, a state can become energized to upgrade parts of its nuclear security regime to keep pace with the improvements being made by a neighbouring state.

Leveraging capabilities existing in the region for joint use

According to the IAEA's guidance on nuclear security, states with functioning nuclear security regimes are expected to cooperate with other states, including by sharing information on relevant nuclear security threats and events and by responding to requests for nuclear security and legal assistance and technical support.[133] The need for this is underlined by the unsurprising fact that the countries in the Black Sea region have differing nuclear security capabilities, including with regard to (*a*) nuclear security education and training facilities, (*b*) nuclear forensic laboratories, (*c*) the detection and recovery of orphan sources (at times from contested spaces), and (*d*) experience in intelligence operations relevant to combating nuclear smuggling.

Most of the nuclear security stakeholders in the Black Sea region interviewed for this study indicated that cooperation between the countries of the region has been insufficient in terms of the sharing of resources, joint training and cooperation on responses to real cases.[134] Although states in the region have conducted joint operations and exercises and have exchanged information on potential trafficking routes and perpetrators, such cooperation has been ad hoc only. Further international collaboration and coordination in the Black Sea region should be promoted in multiple ways.

First, national nuclear security stakeholders should be aware of their counterparts in other states and be able to rely on stable channels of communication to exchange information regarding specific cases. The key challenges to overcome here are the fast turnover of personnel and the frequent reshuffling of governmental structures, which sever the links between counterparts that are formed during the joint handling of cases or international exercises. One regional stakeholder recommended that each state create and maintain a 'catalogue of functions

[133] Essential Element 6 in IAEA (note 117), p. 7.

[134] Officials, Author interviews, Chisinau, Dec. 2017, Tbilisi, Feb. 2018, and Bucharest, Dec. 2017.

and responsibilities' (as opposed to job titles) that would clearly specify who is responsible for what within the nuclear security regime. This catalogue would help to maintain mutual awareness of stakeholders with the same function in neighbouring states regardless of their title, even after governmental restructuring. It would also facilitate the planning of bilateral and regional exercises, enhance international cooperation, and minimize functional overlap.[135]

Second, bilateral and multilateral tabletop and field exercises are another crucial element of a sound regional cooperation system, as they provide opportunities to test how interstate cooperation works in practice, which can help to identify shortcomings and the necessary corrective actions. International assistance providers have already supported and funded such exercises, and this practice should be continued and expanded.[136]

Third, the negotiation and implementation of agreements on mutual assistance on specific nuclear security-related issues or the joint or shared use of facilities or capabilities could help to cut costs and enhance sustainability. A widely known example of this approach is the Georgia, Ukraine, Azerbaijan and Moldova (GUAM) Organization for Democracy and Economic Development's regional collaboration in nuclear forensics—a network of nuclear forensics laboratories in Azerbaijan, Georgia, Moldova and Ukraine designed to share their analysis capabilities and therefore avoid the need to duplicate them in each country.[137] At the same time, the increased attention paid to such collaborations due to the international engagement of participants could help to make them more sustainable in the long run. Thus, this approach should be encouraged in other areas of nuclear security. However, such initiatives should be designed and maintained as true partnerships. Each partner's contribution should be recognized, valued and encouraged. As explained by regional nuclear security stakeholders in interviews for this study, designating one collaboration partner as, for example, 'an obvious regional leader' is politically insensitive and counterproductive.[138]

Fourth, there might be additional benefits to planning jointly. The information collected from interviews suggests that there is a generally positive attitude to the approach of the EU Chemical, Biological, Radiological and Nuclear (CBRN) Centres of Excellence, which promotes the development of National CBRN Threat Reduction Strategies and associated National CBRN Action Plans (NAPs). Georgia has developed and adopted both documents.[139] As of November 2018, Moldova had finalized both its strategy and action plan, but they are pending governmental approval.[140] Other countries in the region are continuing to work on their respective documents as well. In developing its NAP, each country identifies the risks relevant to nuclear security, catalogues the existing capabilities to address

[135] Independent Russian nuclear security expert, Author interview, Bucharest, Apr. 2018.

[136] See e.g. Swedish Radiation Safety Authority (note 100), p. 19.

[137] Taberko (note 135), p. 2.

[138] Georgian official, Author interview, Tbilisi, Feb. 2018.

[139] UN Interregional Crime and Justice Research Institute, 'Official approval of the Georgian CBRN National Action Plan', 17 Apr. 2015.

[140] UN official, Author correspondence, Nov. 2018.

those risks, determines gaps by comparing the risks against the existing capabilities, and thus identifies actions to be included in the NAP. The capabilities identified in the course of this work could be considered for joint use. In addition, identified gaps and actions could be addressed through joint planning of further upgrades of the nuclear security regime. Expanding this work to more countries in the region could create further opportunities for pooling resources and allow for a more systematic approach to building nuclear security regimes in the region. Thus, regionalization or harmonization of NAPs across neighbouring countries should be considered by both the Black Sea states and international donors.

As discussed above, current relations between some countries in the region are strained. A joint approach to nuclear security must take account of the political realities. For example, officials of one country indicated in interviews that they were not able to attend regional nuclear security training courses in a neighbouring state due to the dire political relations between the two countries. Nevertheless, it became clear during the course of this study that, generally speaking, there is sufficient political compatibility and goodwill between countries to significantly improve nuclear security cooperation in the Black Sea region, particularly in the north-west and in the Southern Caucasus.

6. Conclusions

The Black Sea region has been greatly affected by nuclear smuggling cases since the dissolution of the Soviet Union in December 1991. According to the interviews conducted by SIPRI, approximately a quarter of all known incidents involving nuclear or other radioactive material outside regulatory control between 1993 and 2017 were reported by the Black Sea littoral states. Meanwhile, the region hosts contested spaces and in recent years has seen political turmoil, armed conflicts and the formation of more contested spaces. The crisis in and around Ukraine, in particular, has had enormous repercussions in every facet of regional security.

In the course of this study, SIPRI and its partners in the project—the Horia Hulubei National Institute for Research and Development in Physics and Nuclear Engineering in Romania, the Odessa Center for Nonproliferation in Ukraine and the NARNRA in Moldova—set out to investigate the impact of the crisis in and around Ukraine on nuclear security threats originating in the region, and in particular the threat of nuclear smuggling. The project began with the assumption that all the events that have happened since 2014 and in particular the crisis in and around Ukraine were so profound that they would have exacerbated the nuclear security threats to the whole region and undermined the health of nuclear security regimes there, which would have manifested itself in an increase in nuclear smuggling incidents registered by countries in the Black Sea region.

According to the information provided by nuclear security stakeholders in interviews conducted for this study, the impact of the crisis itself was not as geographically widespread as initially thought. Its negative effects appear to be concentrated on Ukraine and, in particular, its eastern regions. The single most serious nuclear security threat to any country in the Black Sea region is its nearest contested space, which can serve as a source of radioactive and at times even fissile material and as a potential safe haven for smugglers. The crisis in and around Ukraine has essentially created the largest contested space in the region and halted cooperation between Ukraine and Russia, which are important countries in the region from the perspective of nuclear security.

Ukraine has lost access to all nuclear materials, installations, radioactive sources and nuclear security infrastructure in Crimea. In the east of the country it has lost regulatory control over 1192 radioactive sources and a significant amount of radioactive waste, some of which is co-located with stocks of explosives on territory fully controlled by armed separatists. Additionally, Ukraine has lost radiation-detection infrastructure designed to control the illicit movement of such sources and waste. The states and international organizations that have traditionally assisted Ukraine and other countries in the Black Sea region with combating nuclear smuggling and improving their national nuclear security regimes have reacted by adjusting their assistance programmes to reflect the impact of the crisis. However, more assistance is required.

While nobody in the region disputes the importance of preventing the loss of control over or illicit trafficking in fissile materials (HEU or plutonium), the more

likely threat comes from disused radioactive materials, orphaned radioactive sources and abandoned radioactive waste, all of which are relatively widespread across the region, including in eastern Ukraine due to its sizeable coal mining, steel and other industries. In eastern Ukraine the boundary between nuclear security and radiation protection of the population has at times been blurred. The 1987 accident in Goiânia, Brazil, provides an illustration of the potential consequences: 249 people suffered contamination from radioactive material and approximately 112 000 required medical monitoring. The incident required an extensive clean-up operation, but involved only one radioactive source and no malicious intent.[141]

It is the general impression of the stakeholders interviewed for this study that, barring significant unforeseen events, nuclear security funding levels in the Black Sea region, and indeed in the world, are not expected to increase and will probably decline. In this situation the more efficient use of available assets and resources, as well as the need to ensure their sustainability, becomes a priority. This study has identified a number of potential opportunities for this, all of which require improved coordination and collaboration at all levels: between the national authorities within a state in terms of planning and exercising their nuclear security response, and between nuclear security stakeholders of neighbouring states in terms of harmonizing their legislation and response planning or jointly using and maintaining available assets.

In conclusion, the following actions can be recommended to address the issues described in this paper:

1. A systematic investigation of options to improve radiation protection and reduce nuclear security threats in contested spaces in the Black Sea region is needed. Closer involvement of the OSCE and IAEA, perhaps in a joint initiative, would be a useful framework for such an investigation.

2. Where viable, countries should work to develop national, bilateral or regional capabilities to follow up where a nuclear security breach is detected. Beyond simply responding to an illicit trafficking event, the supply chain should be investigated to identify as many of those involved as possible. This practice is necessary for the prevention of future nuclear security events.

3. Nuclear security assistance should be analysed to identify good practices and to assess impact. One element of that analysis should be a greater focus on the human capital created through assistance and cooperation, for example by following up on the future progress of trained personnel and the ways in which assistance proved useful in their career development.

4. Good practice and the systematic organization of existing knowledge in the region could promote a sustainable regional nuclear security regime based on local resources. Mutual assistance among stakeholders within the region could be used to repair and maintain equipment, train personnel and organize exercises in ways that are tailored to local conditions.

[141] IAEA, *The Radiological Accident in Goiânia* (IAEA: Vienna, 1988).

5. As nuclear security response planning is maturing, a logical next step would be to consider a regional dialogue to see how far national response plans could be harmonized, in particular between neighbouring countries. Regionalization or harmonization of national plans to develop nuclear security regimes across neighbouring countries should be considered.

6. All states could develop a register based on functions and responsibilities, rather than institutional affiliation or job titles, to clearly specify who is responsible for what within the nuclear security regime. This catalogue would help to maintain awareness, minimize functional overlaps, and facilitate mutual assistance and cooperation even after frequent events of governmental restructuring.

Nuclear Security in the Black Sea Region

Some of the most significant known cases of illicit trafficking of nuclear materials have taken place in the wider Black Sea region. Recent events in the region—in particular in Ukraine—make it important to understand whether nuclear security risks have worsened or multiplied as a consequence.

This SIPRI Policy Paper offers a comprehensive overview of perceptions of nuclear security risks in the wider Black Sea region, along with a detailed assessment of how the level and nature of those risks have changed in Ukraine since 2014. The authors examine the measures that the states in the region are taking to manage nuclear security risk today and consider what steps might be taken to enhance the effectiveness of their actions. They pay special attention to risks arising from contested spaces, where regulations are impossible to implement and where it is difficult to maintain awareness of the changing conditions on the ground.

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