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Costs and Consequences

Unplanned Explosions and Demilitarization in South-east Europe

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The Small Arms Survey

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The objectives of the Small Arms Survey are: to be the principal source of public information on all aspects of small arms and armed violence; to serve as a resource centre for governments, policy-makers, researchers, and activists; to monitor national and international initiatives (governmental and non-governmental) on small arms; to support efforts to address the effects of small arms proliferation and misuse; and to act as a clearinghouse for the sharing of information and the dissemination of best practices. The Survey also sponsors field research and information-gathering efforts, especially in affected states and regions.

The project has an international staff with expertise in security studies, political science, law, economics, development studies, sociology, and criminology, and collaborates with a network of researchers, partner institutions, non-governmental organizations, and governments in more than 50 countries.

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About the RASR Initiative

The Regional Approach to Stockpile Reduction (RASR) is a long-term, coordinated, regional approach to address the threats posed by excess, unstable, loosely secured, or otherwise at-risk stockpiles of conventional weapons and munitions.

RASR encourages affected governments and relevant organizations to develop a proactive, coordinated, regional approach to secure and destroy small arms and light weapons, by building local capacity, sharing best practices and lessons learned, and synchronizing resources in order to maximize their efficiency.

The ultimate aim of the RASR Initiative is to prevent disastrous explosions or destabilizing diversions of conventional weapons and munitions.

For more information, visit www.rasrinitiative.org
or email info@rasrinitiative.org.

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Jasna Lazarević was an associate researcher at the Small Arms Survey. She worked at the Survey from 2007 to 2012 where she specialized in researching arms transfers to armed actors and transparency in the small arms trade. Her work covers a variety of issues on Physical Security and Stockpile Management (PSSM). She is significantly involved in the Regional Approach to Stockpile Reduction (RASR) Initiative. She received a Master's degree in international relations from the Graduate Institute of International and Development Studies (GIIDS), Geneva, in 2007. The following year she participated in a GIIDS e-learning programme on gender and development.

Jasna Lazarević authored the Transparency Barometers from 2009 to 2012. In June 2010, she published an Occasional Paper, *Transparency Counts: Assessing State Reporting on Small Arms Transfers, 2001–2008.* She co-authored *A Real and Persistent Danger: Assessing Armed Violence in the Caucasus, Eastern Europe and South-Eastern Europe*, as well as the chapter entitled 'The Other Half: Girls in Gangs' in the Small Arms Survey 2010 publication, *Gangs, Groups, and Guns*. Her latest publications include a co-authored Working Paper, *Tackling Violence against Women: From Knowledge to Practical Initiatives*, and—for the RASR Initiative—the Issue Brief, *South-east European Surplus Arms: State Policies and Practices,* which was translated into Albanian and Serbian.

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Abbreviations and acronyms

AAF	Albanian Armed Forces
APM	Anti-Personnel Mines
AXO	Abandoned explosive ordnance
BAF	Bulgarian Armed Forces
BiH	Bosnia and Herzegovina
BCSP	Belgrade Centre for Security Policy
BGN	Bulgarian Lev
DTRA	Defense Threat Reduction Agency of the US Department of Defense
EOD	Explosive ordnance disposal
ERW	Explosive remnants of war
ESA	Explosives storage area
EU	European Union
EUR	Euro
FY	Financial year
GOF	Government Ordnance Factory
IEDs	Improvised explosive devices
ITF	International Trust Fund (Enhancing Human Security)
KFOR	Kosovo Force
MANPADS	Man-portable air-defence system(s)
MoD	Ministry of Defence
MoE	Ministry of Environment
MoH	Ministry of Health
MoI	Ministry of the Interior
MONDEM	Montenegro Demilitarization Programme
MSIAC	NATO's Munitions Safety Information Analysis Center
NSPA	NATO Maintenance and Supply Agency
NATO	North Atlantic Treaty Organization
OB	Open burning

OD	Open detonation (referred to jointly as OB/OD)
OSCE	Organization for Security and Co-operation in Europe
PfP	Partnership for Peace
PM/WRA	US Department of State, Bureau of Political-Military Affairs, Office of Weapons Removal and Abatement
PPU	Prvi Partizan Užice (Serbian ammunition factory)
PSSM	Physical security and stockpile management
RAA	Risk Assessment Act
RACVIAC	Regional Arms Control Verification and Implementation Asssistance Centre
RASR	Regional Approach to Stockpile Reduction
RPG	rocket-propelled grenade
RSD	Serbian Dinar
R3	Recover, recycle, re-use
SAF	Serbian Armed Forces
SALW	Small arms and light weapons
SEESAC	South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons
SMG	Sub-machine gun
SSR	Security Sector Reform
TNT	Trinitrotoluene
TRZ KG	Tehnički Remontni Zavod Kragujevac (Serbian military ammunition production and disposal facility)
UEMS	Unplanned Explosions at Ammunition Sites
UNDAC	United Nations Disaster Assessment and Coordination
UNIDIR	United Nations Institute for Disarmament Research
UNDP	United Nations Development Programme
UNMAS	United Nations Mine Action Service
UNODA	United Nations Office for Disarmament Affairs
US	United States
USD	US dollar
UXO	Unexploded ordnance
VAT	Value added tax

Introduction

On 11 July 2011, a massive early morning blast at the Evangelos Florakis naval base in southern Cyprus killed 12 people, including the naval base commander, and injured 62 others. The 98 containers that caught fire were filled with explosives seized in January 2009 from a ship coming from Iran and had been placed for more than two years in an open field at the naval base before the conflagration. The fire spread to a nearby power station, which provided about half of the country with electricity, severely damaging surrounding properties. Widespread power cuts affected homes, hotels, and businesses throughout the island, and temporarily silenced the BBC's English-language Middle East service. The Cypriot Defence Minister and the commander of the Cypriot National Guard resigned amidst criticism alleging they had failed to take steps that could have prevented the incident. Following the explosion, Moody's credit agency downgraded Cyprus by two points, on the perceived grounds that the power cuts caused by the explosion would be detrimental to the country's economy (BBC, 2011; Werdigier, 2011).

The Cyprus explosion is a recent, yet not uncommon example of what can happen when weapons and ammunition are inappropriately stored or managed. In this case, the Cypriot authorities left explosives stored in containers in the open air for more than two years, instead of destroying or placing the ordnance in appropriate facilities. Cyprus's credit rating downgrade was an extreme, indirect financial consequence of this mismanagement. Fortunately, not all countries that experience undesirable explosions at ammunition storage sites see their credit ratings lowered. Nevertheless, as this *Special Report* highlights, the direct and indirect impacts of such mishaps can severely harm national and local economies and the health of populations.

Several hundred individuals die or are injured every year, because of failures to maintain and manage (deteriorating) ammunition stockpiles correctly. The impact of explosive events on lives, livelihoods, housing, the environment, and development is difficult to estimate. Nonetheless, the costs in

terms of health care, direct and indirect income loss, material damage, explosive ordnance disposal (EOD), and environmental damage are high.

Regional and international physical and security and stockpile management (PSSM) stakeholders discussed unplanned explosions at munitions sites (UEMS) and their impacts at five RASR workshops held between May 2009 and April 2012 in Zagreb (Croatia), Budva (Montenegro), Sarajevo (Bosnia and Herzegovina) (BiH), Ljubljana (Slovenia), and Durrës (Albania). Workshop participants exchanged their views and experiences including problems encountered in the aftermath of such unplanned events. This *Special Report* is published as a direct follow-up to the five workshops. It aims to provide regional PSSM stakeholders, politicians, and decision makers with a clear, concise overview of the risks posed by poorly maintained, improperly stored, abandoned, damaged, and unstable ammunition stockpiles.

This *Special Report* sheds light on the direct and indirect impacts of UEMS incidents. It aims to raise awareness of the problem and to point out the kinds of international technical and financial support available to address unstable ammunition stockpiles and restore safety to areas after an undesirable explosion has occurred. Above all, it suggests ways in which countries can improve PSSM and find sustainable solutions to deal with their surplus weapons and ammunition.

This *Special Report's* main findings are:

- Between 1998 and 2011, 43 individuals died and 435 were injured as a result of UEMS in South-east Europe.
- UEMS events occur in government facilities, privately owned factories, and demilitarization facilities.
- Clearance of sites contaminated by UEMS events in Albania, Bulgaria, and Serbia took at least four to five years. The longer the clearance operation takes, the more it costs.
- Clean-up operation costs at the Gërdec site in Albania amount to at least USD 10 million, with the overall cost of the incident totalling at least USD 29 million. Preventing the accident would have cost less than USD 6.6 million.
- Clean-up operation costs at the Chelopechene site in Bulgaria amounted to at least USD 4.5 million, with the overall cost of the incident totalling at

least USD 7.5 million. This is eight times more than what regular disposal of the 1,500 tonnes of surplus ammunition would have cost.

- Clean-up operation costs at the Paraćin site in Serbia amounted to at least USD 7.5 million, with the overall cost of the incident totalling at least USD 10 million.
- Overall destruction costs in South-eastern Europe are an estimated USD 1,000/tonne for different types of weapons and ammunition.

The first section of this *Special Report* provides a global and regional overview of UEMS events and presents recent incidents and their impact on populations and states. The second section discusses the costs and benefits of demilitarization in South-east Europe; it presents findings on the overall cost of destruction in the region and illustrates how countries can reduce these costs by selling recycled, scrap material. In its third section, the report presents a typology of the direct and indirect effects of UEMS. This section considers the full range of impacts, and their related costs, in order to illustrate the effect of UEMS events on countries and their economies. The remaining sections present the findings of three country case studies: from Albania, Bulgaria, and Serbia. Each case study estimates the overall impact and costs of specific UEMS events in the country concerned. These studies broadly follow the typology presented in section three and include additional information on emergency responses and questions of responsibility.

The importance of stockpile management

A series of recent explosions at ammunition depots across the world has drawn public attention to the dangers of ammunition storage in many countries. This section of this report profiles the risks that countries face when they fail to invest in addressing their surplus ammunition stockpiles. First, it presents the (possibly growing) incidence of UEMS and their impacts at a global level (see Box 1). Second, it focuses specifically on UEMS in the nine South-east European RASR Initiative states.[1]

Box 1 Definition of unplanned explosions at munitions sites (UEMS)

UEMS include accidents[2] resulting in the explosion[3] of abandoned,[4] damaged,[5] improperly stored,[6] or properly stored stockpiles of munitions[7] and explosives. In this report, munitions sites are defined as comprising storage areas[8] (including those temporarily maintained during demilitarization or explosive ordnance disposal) and processing sites,[9] whether temporary or permanent. Ammunition manufacturing facilities (ordnance factories) are not included, but accidents during ammunition processing operations within ammunition sites are included, where known.

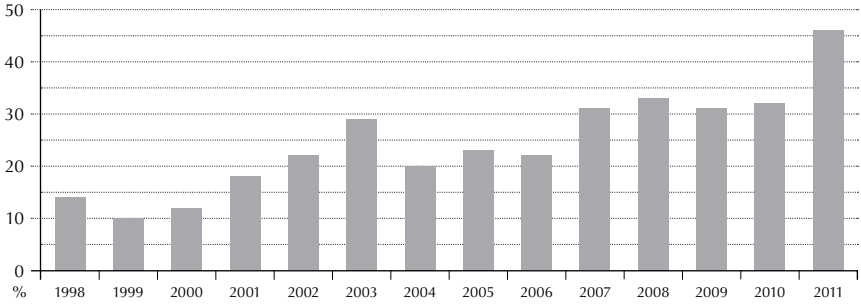
Unplanned explosions: a global perspective

Between 1 January 1998 and 31 December 2011, 343 UEMS occurred in 80 countries. These events affected populations on every continent except Antarctica. Since 1998, the most affected countries have been the Russian Federation, which experienced 46 UEMS, followed by Afghanistan and India, which each experienced 20 such incidents in the same 14-year period (Small Arms Survey, 2012; Wilkinson, 2011; Zahaczewsky, 2011). Research by the Small Arms Survey suggests an increasing frequency of UEMS in recent years. Until 2007, explosions occurred at a rate of less than nine every six months,

worldwide. Since then, the rate has increased by 25 per cent to more than 12 every six months (Berman, Gobinet, and Reina, 2011, p. 2).

Figure 1 presents the number of recorded UEMS by year, from 1998 to 2011. The heavier concentration of incidents after the year 2000 does not necessarily mean there were fewer incidents before. It may simply reflect better reporting. New social media tools allow information—including digital film footage of UEMS incidents—to spread quickly. Reporting aside, there are also plausible technical reasons for the apparent increase in the number of reported UEMS worldwide.

Figure 1 Number of recorded UEMS by year, 1998–2011



Source: Small Arms Survey (2012); Wilkinson (2011); Zahaczewsky (2011)

Much of the world's ammunition stockpile dates from the cold war period. From the 1950s to the early 1990s, heavy militarization and weapon production on a massive scale took place. Today, 20 years after the end of the cold war, much of the ammunition produced in that period is approaching the end of its life and becoming unstable. Not only does this increase the risk of auto-ignition, it also makes ammunition far more sensitive to handling. These factors could have a strong bearing on the apparent increasing frequency of UEMS. An additional factor should also be considered: many nations have downsized and restructured their armed forces, resulting in the loss of qualified ammunition management personnel. This represents a danger from the perspective of safe ammunition storage and may contribute to the apparent increased incidence of UEMS.

Whether UEMS are actually on the increase or not, their impact on human beings remains significant. Between January 1998 and December 2011, available data shows 3,924 individuals were killed and a further 14,267 injured worldwide, as a consequence of UEMS. These figures are certainly an underestimate, however, because casualty data for 36 UEMS that occurred during this 14-year period is not available. In addition, as certain UEMS are not known to the public, they are not recorded in the UEMS Database. By comparison, Landmine Monitor (ICBL, 2001–2011) reports that 20,174 people were killed and 58,457 others were injured by mines between 1999 and 2010. As Table 1 indicates, the probability of dying from injuries sustained in UEMS is 22 per cent, compared to 26 per cent in incidents involving mines, victim-activated improvised explosive devices (IEDs), cluster munitions, or other explosive remnants of war (ERW). Moreover, while mine incidents tend to be concentrated in conflict and post-conflict settings, UEMS often have an impact on communities located outside of such contexts.

Table 1 UEMS casualties compared to mine, IED, cluster munitions, and ERW casualties

	Years	Fatalities	Injuries	Total
UEMS	1998–2011	3,924 (22%)	14,267 (78%)	18,191
Mine, IED, cluster munitions, and ERW	1999–2010	20,174 (26%)	58,457 (74%)	78,631

Sources: ICBL (2001–2011); Small Arms Survey (2012); Wilkinson (2011); Zahaczewsky (2011)

Unplanned explosions: a regional perspective

Since January 1998, with the exception of Macedonia, every RASR Initiative state has recorded at least one UEMS on its territory. Albania and Serbia have experienced five and eight such incidents, respectively. Importantly, 23 of the 26 incidents reported in the region occurred after 2006.[10] This apparent recent increase in the frequency of UEMS underlines the need to invest more resources in sound stockpile management in the region—particularly for the destruction of obsolete and unstable surplus ammunition.

Since January 1998, UEMS in South-east Europe resulted in at least one injury in each of the countries concerned, apart from Croatia and BiH, neither of which reported casualties. The region's 478 casualties, listed in Table 2, represent less than three per cent of global UEMS deaths and injuries for this period, with the number of deaths caused by UEMS accounting for around one per cent of the global figure. UEMS casualty rates vary among the region's states; most deaths and injuries were caused by the munitions explosion in Gërdec, Albania (see Table 2). Although UEMS-related deaths and injuries in the region are low compared to the global casualty toll, they are of concern because many could have been prevented.

A closer look at UEMS incidents in South-east Europe indicates that they occurred both in government-owned factories or depots and in privately owned factories and demilitarization facilities. Twelve of the 27 incidents reported took place in privately owned facilities and 15 in government-owned facilities, including one at a police station. These incidents occurred in government-owned depots (8), government-controlled production factories (5), government-controlled demilitarization facilities (2), privately owned depots (4), privately owned production factories (6), and privately owned demilitarization factories (2). The high level of incidents at privately owned production factories implies that local authorities need to improve the oversight of commercial facilities.

Table 2 UEMS in countries participating in the RASR Initiative, 1998–2011

Country	No. of UEMS	Year	Date, place	Fatal (F)	Injured (I)	Total (T)	Country sub-total (F/I/T)
Albania[a]	5	2006	6 May, Dhemblaj	1	2	3	29/307/336
		2008	15 March, Gërdec	26[b]	300	326	
		2009	6 January, Polican	1	1	2	
		2011	27 April, Polican	0	1	1	
		2011	28 April, Skrapar	1	3	4	
BiH	3	2000	No data (Bihac)	—	—	—	2/0/2
		2003	Derventa	2	0	2	
		2011	30 September, Konjic	—	—	—	
Bulgaria	4	2008	3 July, Chelopechene	0	3	3	0/7/7
		2008	10 August, Kazanlak	0	0	0	
		2010	3 February, Gorni Lom	0	4	4	
		2011	12 November, Sevlievo	0	0	0	
Croatia	2	2001	23 August, Osijek	—	—	—	0/0/0
		2011	14 September, Padjani	0	0	0	
Montenegro	2	2006	8 July, Vir	0	61	61	0/64/64
		2010	7 March, Niksic	0	3	3	
Romania	2	2007	20 September, Dâmbovita	0	8	8	2/9/11
		2011	11 February, Gorj	2	1	3	
Serbia	8	2003	22 January, Čačak	0	3	3	7/46/53
		2006	19 October, Paraćin	0	23	23	
		2007	24 August, Paraćin	0	0	0	
		2008	29 October, Čačak	0	3	3	
		2009	3 September, Užice	7	14	21	
		2010	12 January, Čačak	—	2	2	
		2010	10 May, Valjevo	0	1	1	
		2010	27 December Čačak	0	0	0	
Slovenia	1	2007	18 June, Pivka	3	2	5	3/2/5
Total	**27**			**43**	**435**	**478**	

Notes:

a In Albania, 17 explosions were reported during the 1997 civilian riots that left more than 100 people dead and 50 injured.

b One additional individual has subsequently been reported missing.

Source: Small Arms Survey (2012)

The costs and benefits of demilitarization

A great deal of lobbying is often required before political leaders decide to destroy surplus weapons and unstable ammunition. Frequently, national armed forces, and particularly military General Staff, realize the importance of taking such action only after a catastrophic UEMS has highlighted the risks of ammunition mismanagement. Even then, however, armed forces' command hierarchies often find it difficult to convince their political leaders to allocate financial resources to destroying unstable or unsecured surplus weapons and ammunition.

The reluctance of governments to destroy their weapons, ammunition, and explosives may be attributed to a variety of reasons. First, there may be a strong national identification with military arsenals. Political leaders, and indeed the population at large, often view national defence industries and weapon production as sources of national strength and pride. Such attitudes may reflect deep cultural tradition and certain aspects of social identity. Furthermore, governments tend to perceive their capacity to deter foreign aggression in terms of the size of their weapons and ammunition stockpiles, regardless of the condition they are in. Finally, national governments are often unwilling to destroy surplus weapons and ammunition because of budget constraints and a lack of technical capacity. Faced with these challenges, governments often seek to generate revenue by selling surplus material, rather than to 'spend money' on its destruction.

Governments need to be convinced that the destruction of surplus stockpiles can be of direct benefit to the state and its finances. By regularly identifying and subsequently destroying surplus, states can reduce or even eliminate various potentially costly risks. For example, surplus destruction diminishes the risks of diversion, which leads to illicit arms trafficking and armed crime, and of undesirable explosions. Effective stockpile management also reduces the costs involved in safeguarding large numbers of depots and storage sites; it releases defence and security forces from guard duties at

ammunition storage sites, enabling them to focus on their core functions. The resulting benefits are the rationalization of weapon and ammunition quantities, which are required for the internal and external security of a country. This, in turn, is an important component of effective security sector reform (SSR).

Various methods exist to physically destroy or demilitarize weapons and ammunition, ranging from open burning (OB) and open detonation (OD) (referred to jointly as OB/OD) to highly sophisticated industrial demilitarization and destruction processes. The choice of method depends on a variety of factors. These include: available financial resources; the physical and chemical status of the stockpile; the type and size of the surplus; national financial and production capacities; the availability of existing destruction equipment; national legislation related to explosive safety and environmental regulations; and the value of recovered scrap material (Wilkinson, 2006b, p. 269). The destruction of weapons is a relatively straightforward process. The destruction of ammunition and explosives, however, is technically more demanding. Furthermore, ammunition stockpiles are generally larger than weapon stockpiles, and the risks and hazards associated with their handling, demilitarization, or destruction are far greater.

This section provides order of magnitude information on the costs of destroying surplus weapons and ammunition in South-east Europe and the cost-reduction benefits of the recover, recycle, and re-use (R3) methodology.

Destruction costs

To date, no public reports have provided a full, comparative financial analysis of the stockpile management and surplus disposal costs incurred by states in South-east Europe.[11] This section highlights a variety of factors that play a role in the demilitarization cycle. It concludes by estimating ammunition destruction costs in the region.

Cost factors in the demilitarization cycle

The physical destruction process for weapons and ammunition involves a chain of activities, often referred to as 'the demilitarization cycle'. This cycle

includes: transportation; storage; processing operations; equipment maintenance; staff training; and accounting (Wilkinson, 2006b, pp. 270, 283). Costs related to demilitarization vary according to a range of factors that have an impact at different levels of the demilitarization cycle. These include: the demilitarization site location; the national economy; topography; the surplus type and quantity; equipment and skilled personnel availability; salaries; fuel expenses; and electricity charges.[12] Box 2 provides a list of factors to be considered when overall demilitarization costs are calculated.

Box 2 Factors in overall demilitarization costs

Demilitarization costs stem from a variety of factors, including:

- Weapon and ammunition type
- Existing national capacity and resources (and required development thereof)
- Economies of scale: structure development, technical training, and procurement of equipment decrease the costs for subsequent destruction
- Logistics (plant workload) and transport
- Knowledge and training of local staff
- Explosive and environmental legislation
- Donor conditions (fixed costs as opposed to costs per ammunition type/piece)

Demilitarization budgets include:

- Expenditure on transportation logistics (from the storage site to the demilitarization site)
- Storage expenses (at the depot and the demilitarization site)
- Cost of acquiring demilitarization equipment (such as machines)
- Operational costs (such as employee salaries)

Some of these expenditures are fixed or inflexible. For example, equipment costs are usually fixed, while the need to conduct demilitarization in a safe and secure manner means that the operational costs involved cannot be reduced below a certain level.

Other expenditures are more flexible. Transportation logistics, for example, can represent around 50 per cent of total demilitarization costs. One of the first cost-reduction steps is to optimize logistics. If ammunition cannot be transported economically to the demilitarization facility, national authorities may consider sending mobile demilitarization equipment to the ammunition storage facility.[13]

In order to ease the overall financial burden of surplus weapon and ammunition stockpiles, national governments should implement two broad cost-saving measures: optimizing logistics to lower transportation expenses and reducing storage costs through more efficient demilitarization.

The most challenging task for any study that attempts to evaluate demilitarization expenditure is to identify the destruction cost per unit or tonne of weapons and ammunition. Without this information, it becomes extremely difficult to generate aggregate cost-estimate data by unit or tonne of the material destroyed.

Estimating destruction costs

Countries, organizations, and companies with a long history of involvement in weapons and ammunition destruction provide figures that allow for rough estimates of destruction costs to be made. NATO Maintenance and Supply Agency (NSPA), for example, provides quite detailed estimates of ammunition destruction costs. The data in Table 3 indicates the destruction cost per tonne, or per round, for a variety of ammunition types. Since costs per tonne include the weight of packaging, but exclude transportation costs, it should be stressed that these estimates are not precise.

Table 3 Cost per tonne of ammunition destruction

Ammunition type	Cost per tonne	Cost per unit
Rifle and pistol ammunition (5.56 mm, 7.62 mm)	EUR 1,600 (USD 2,192)	EUR 0.10 (USD 0.14)
Medium-calibre cannon ammunition (20 mm, 25 mm, 30 mm)	EUR 20,000 (USD 27,400)	EUR 5 (USD 6.85)
Large-calibre gun and artillery ammunition (105 mm HE, 120 mm APFSDS-T, 155 mm HE)	EUR 700 (USD 959)	EUR 20 (USD 27.40)
BL755 cluster bomb	EUR 1,000 (USD 1,370)	EUR 250 (USD 342.50)
CBU 89 (GATOR cluster munitions)	EUR 700 (USD 959)	EUR 300 (USD 411)
CBU 99 (MK20 ROCKEYE cluster bomb)	EUR 1,500 (USD 2,055)	EUR 320 (USD 438.4)

Source: Written correspondence with NSPA headquarters, 30 March 2012

The availability of detailed information such as that presented in Table 3 is exceptional, given the many varied factors that affect destruction costs. In 2008, the French Ministry of Defence (MoD) undertook a study on the dismantling of war material, including missiles, guided rockets, and torpedoes. It concluded that the destruction of a variety of ammunition types by the

Table 4 Cost of destruction projects in South-east Europe, by weapon type

	Ammunition		Small arms and light weapons		MANPADS		Mixed (weapons and ammunition)		APM	
Country	**Quantity**	**Destruction costs**	**Quantity**	**Destruction costs**	**Quantity**	**Destruction costs**	**Quantity**	**Destruction costs**	**Quantity**	**Destruction costs**
Albania	11,651 t	EUR 6,400,000 (USD 7,848,960)								
	75,000 t	EUR 35,800,000 (USD 53,000,000)								
	24,000 t	USD 10,000,000								
Bulgaria	14,900 t	BGN 27,000,000 (USD 18,702,900)	76,000 t	USD 400,000						
	39,000 t	BGN 114,000,000 (USD 83,240,800)	23,295 pcs (incl. 10,000 AK-47s)	USD 119,000						
Croatia			25,000 pcs	USD 100,000	929 pcs	USD 1 million = *USD 1,076/missile*	20,000 t[a]	USD 13 million		
Macedonia							700 pcs	USD 200,000 = *USD 285/pcs*		
Montenegro			1,897 pcs	USD 7,588			430 t	EUR 763,428 (USD 1,060,554)		
							927 t[b]	EUR 900,000 (USD 1,250,280)		
							1,497 t	USD 2,476,000		
							1,300 t	USD 1,750,000		
Romania							200,000 pcs SALW; 1,281,524 pcs (7.62 mm); 62,400,000 pcs (7.92 mm)	USD 4,800,000		
Croatia and Serbia			9,435 and 11,715 pcs respectively[c] = 21,150 pcs	EUR 1,600,000 (USD 2,222,720)						
Serbia			20,859 pcs	USD 6.00/weapon = *USD 125,154*	over 9,000 pcs	USD 400/missile = *USD 3,600,000*	129 UXO; 27 ATM; 35 APM; 3,700 MANPADS	USD 6,700,000	1,404,819 pcs	EUR 1,689,966 (USD 2 million) = EUR 1.2/pcs (USD 1.42/pcs)
			17,932 t	USD 19,165,570						

French army cost between EUR 1,000 (USD 1,353) and EUR 5,000 (USD 6,767) per tonne. It indicated that the large destruction cost differences per tonne mainly reflected the varying levels of complexity of the weapons and ammunition systems involved (France, 2008, p. 10).

Various additional costs are often factored in to expenditure estimates for destruction projects. Over and above the projected cost of the actual weapon and ammunition destruction process, estimates may also include funding to cover infrastructure development, the acquisition of destruction equipment, and administrative costs. Expenditure estimates therefore may, in addition to infrastructure and capacity development, cover the destruction per tonne or per round of weapons and ammunition. In such cases, costs per tonne are usually high at the beginning of the destruction process due to capital equipment and infrastructure development expenditure, but decrease as economies of scale take effect.

Table 4 provides information on destruction programmes that have documented the quantities of weapons and ammunition destroyed and it lists the financial resources invested in the destruction of specific weapon and ammunition types. The table provides a comparative illustration of costs, arranged by type of material, including: ammunition, small arms and light weapons, man-portable air defence systems (MANPADS), and anti-personnel mines (APM). A separate category presents the costs of destruction projects involving mixed weapon and ammunition types, or for which it was not possible to determine the relative quantities of weapons and ammunition destroyed.

Ammunition: Available information suggests that the cost of destroying one tonne of ammunition in Albania is between EUR 400 and 550 (USD 540–740),

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Notes on Table 4: t = tonnes; pcs = pieces. Data in *italics* was calculated by the author.

Data is drawn from a more comprehensive listing of destruction projects, appearing in Annexe 1. This data is mainly based on desk research, complemented by information obtained from key informant interviews and input obtained at regional workshops and conferences attended by the author.

a This is not an actual project, but an estimation of the destruction costs. When the problems of surplus emerged, Croatia assessed options for surplus disposal. The MoD estimated that if surplus could not be sold or donated, but required industrial demilitarization, the country would need an estimated EUR 9 million (USD 12 million) to destroy its total surplus, estimated to be 20,000 tonnes (author interviews, and Gobinet, 2011, p. 25).

b As of December 2011, this project was pending and was to be reactivated once funding for it was confirmed.

c This project, which includes activities in Croatia and Serbia, is funded by the EU (EUR 1.6.million = USD 2,222,720). The 21,150 pieces listed in the table are only part of the material to be destroyed under the project. The project aims to destroy at least another 20,000 pieces in Croatia. In Serbia, the number of pieces earmarked for destruction is currently being reviewed.

Sources: Albania: Peugeot, 2009; Albania, 2004; Goodyear, 2010; NATO, 2011, 2012; **Bulgaria**: Bulgaria, 2011; Georgiev, 2004; **Croatia**: Unijat, 2006; Croatia, 2008; Croatia, 2011; US Department of State, 2011; Council of the EU, 2010; SEESAC, 2011a, 2011b; **Macedonia**: US Department of State, 2010; **Montenegro**: Gordan Ivanović (e-mail exchange); John E. Stevens (e-mail exchange), US Department of State, 2011; **Romania**: Faltas and Chrobok, 2004, pp. 29, 94; **Serbia**: SEESAC, 2010; Serbia, 2011b; Griffiths, 2008, p. 194; US Department of State, 2009, 2010.

compared to EUR 900–1,460 (USD 1,200–2,000) in Bulgaria. Field research indicates that a Bulgarian demilitarization company received the following payments per piece of varied ammunition types: USD 0.06 for 7.62 mm, USD 0.23 for 12.7 mm, and USD 0.45 for 14.5 mm cartridges.[14] In comparison, the cost of destroying a 12.7 mm cartridge in an Albanian demilitarization plant is EUR 0.08 (USD 0.12). This lower price is due to the fact that the Albanian company does not pay value added tax (VAT). It has also received significant financial support from bilateral donors and regional organizations to increase its destruction capacities, following the UEMS at the demilitarization plant in Gërdec, Albania. Moreover, the Bulgarian plant has less developed surplus destruction infrastructure than its Albanian counterpart.[15]

Small arms and light weapons: Prices for the destruction of small arms and light weapons are similar for four countries in the region. The approximate respective unit price for the disposal of small arms and light weapons in these countries is: USD 4.00 in Croatia and Montenegro, USD 5.00 in Bulgaria, and USD 6.00 in Serbia. The higher cost for destroying ammunition is attributable to its complexity and the more sophisticated equipment required for its disposal. According to the Serbian MoD, it destroyed nearly 18 tonnes of previously illicitly held small arms and light weapons between 2005 and 2010. The costs related to this destruction are listed in Table 5. On average, the Serbian MoD required around USD 1,000 in order to destroy one tonne of small arms and light weapons.

Table 5 Cost of destruction of illicit small arms and light weapons in Serbia

Year	Quantities (in tonnes)	Disassembly costs (EUR)	Disassembly costs (USD)	Average costs per tonne in EUR (USD)
2005	2,300	1,448,000	1,775,830	630 (772)
2006	3,000	2,200,000	2,906,860	733 (967)
2007	3,200	2,568,000	3,851,230	802 (1,240)
2008	3,300	2,617,000	3,542,110	793 (1,073)
2009	3,132	2,590,000	3,547,780	827 (1,133)
2010	3,000	2,570,000	3,570,240	857 (1,190)
Total	**17,932**	**13,993,000**	**19,194,050**	**774 (1,062)**

Note: The final total, 774 (1,062), indicates an average of the averages.
Source: Serbia (2011b)

MANPADS: Current data does not provide a clear indication of destruction costs for MANPADS because it is only available for destruction operations in two countries: Croatia and Serbia. In 2009, a US-funded project in Croatia destroyed 929 missiles for USD 1 million. This suggests an average destruction cost of USD 1,076 per missile. In 2011, the United States granted Croatia an additional USD 1 million to destroy 71 more of its remaining SA-7 MANPADS, to carry out some PSSM upgrades, and to destroy more of its old stockpiled munitions.[16] The United States also funded Serbia's destruction of its SA-7b (9M32M 'Stella') MANPADS at a cost of USD 400 per missile. Under this programme 9,000 MANPADS were destroyed between 2003 and 2009. The destruction cost was higher in Croatia because the US funding was also used to destroy other material and to improve stockpile infrastructure in that country.[17]

Mixed: It is particularly hard to compare destruction costs in this category because the types of weapon and ammunition vary significantly both from one destruction project to another and from country to country. In 2009 and 2010, for example, Montenegro received funding for surplus destruction from the Organization for Security and Co-operation in Europe (OSCE), United Nations Development Programme (UNDP), and the US Department of State, as part of the Montenegro Demilitarization Programme (MONDEM). In the OSCE- and UNDP-funded first phase of the programme, 430 tonnes of surplus weapons and ammunition were destroyed by means of industrial dismantling, with project (not unit) costs totalling around EUR 1,775 (USD 2,235) per tonne. The US Department of State-funded project costs averaged around USD 1,653 per tonne of (mixed) weapons and ammunition—for the most part, destroyed by means of OB/OD. These prices are slightly higher than the costs reported by the Serbian Tehnički Remontni Zavod Kragujevac (TRZ KG), which carries out industrial demilitarization. TRZ KG data suggests that the overall cost of destroying one tonne of mixed weapons and ammunition is around EUR 780 (USD 1,050). The company plans to invest further in its industrial demilitarization infrastructure and estimates that the cost of destroying one tonne of material might drop to as low as EUR 460 (USD 620) in future (Bobić, 2011). Others estimate that small arms and light weapons in the region can be destroyed for USD 5.00 per unit (Petrović, 2006, p. 41).

Anti-Personnel Mines (APM): Due to a lack of public information, this study can present data only on APM destruction costs for Serbia.[18] Between July 2005 and July 2007, with the assistance of NSPA, Serbia destroyed 1,404,819 APM units, weighing around 2,170 tonnes. The project costs were an estimated EUR 1,689,966 (USD 2 million), which suggests a per unit destruction cost of around EUR 1.20 (USD 1.42) per unit.

This overview of various destruction programmes leads to the conclusion that overall destruction costs in South-eastern Europe can be estimated at about USD 1,000 per tonne for different types of weapons and ammunition.

R3: Gains from scrap material

The recycling of scrap material presents a range of opportunities for recovering demilitarization costs. Although yields vary according to destruction methods, recovered scrap material such as brass, copper, iron, and lead can be of high quality. The R3 approach aims to salvage maximum quantities of recycled material from the demilitarization process, which is a sound way of offsetting disposal costs.

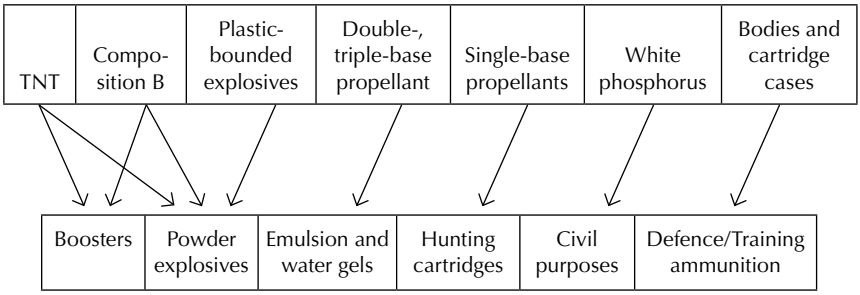
The re-use of scrap material

New technologies help make recycled material cleaner. In some cases, the industrial demilitarization of small arms ammunition yields intact (reusable) cartridge cases and bullets and recycled propellant. These components can be reused in the manufacture of hunting ammunition.[19] Raw materials, such as brass and lead, are also of high value. All these outputs offset the initial costs of investment in industrial demilitarization—revenues that OB/OD techniques do not generate. Experts estimate that R3 approaches can reduce demilitarization costs by 30 to 60 per cent or more (Peugeot, 2009; Mihelić, 2011). It would, however, be misleading to assume that the demilitarization of ammunition is a highly profitable business. Set-up and running costs are relatively high. In addition, while some scrap metals generate relatively high revenues, items such as missiles yield large quantities of non-recoverable materials, such as glass fibres and electronics, which increase disposal costs, instead of offsetting them.

Wilkinson estimates that small-calibre ammunition destruction programmes can recover around 10 per cent of operating and infrastructure costs in the short- to medium-term. Wilkinson also notes that the United States, some Western European countries—and possibly the Russian Federation—have demonstrated the ability to recycle small-calibre ammunition cost-effectively.[20] A separate study of the scrap market generated by demilitarization at national and international levels might help provide better insight into this activity.

Figure 2 illustrates how demilitarized material can be used for civilian or military purposes. For instance, explosive that is steamed from mortar bombs can be used either to manufacture the civilian-sector explosive, trinitrotoluene (TNT), or in the production of artificial diamonds.[21] Any scrap material remaining from the recycling of weapons, ammunition, and explosives can be sold, directly converted into goods for civilian use, and then resold or re-used by the armed forces (for example, in reloaded training ammunition or for OD).[22]

Figure 2 Re-use of recycled material in the civilian sector



Source: Olivan and van Beneden (2011)

Market prices for scrap material

In January 2011, the Small Arms Survey sent a questionnaire, which included questions on market prices for scrap material, to the nine countries participating in the RASR Initiative. Table 6 summarizes price data received from Bulgaria, Montenegro, and Serbia.[23] While the table is incomplete, as not all

the countries replied to the questionnaire, overall scrap prices seem to be similar, except for brass, copper, and steel, for which Serbia has the highest market prices and Bulgaria the lowest. Prices provided by the London Metal Exchange have been supplied for comparison.

Table 6 Market prices for scrap material, in USD per tonne

Scrap metal type	Bulgaria	Serbia	Montenegro	BiH	London Metal Exchange[a]
Aluminium	1,418	1,904	1,402		2,590
Aluminium alloy			1,976		2,370
Brass	3,899	6,800	3,324		
Yellow brass				4,413–5,149[b]	
Copper	5,672	9,248	7,208		9,500
Steel	2,340	408			530
Steel, higher quality		1,768			
Steel, I-class			359		
Steel, II-class			308		
Steel, III-class			282		
Hexogen		476			
Plastic explosives			6,000		
TNT		680	700		

Notes:

a Price indications are from March 2011.

b Author interview with the director of Unis Pretis, an ammunition production and disposal facility in Sarajevo, BiH, 5 November 2010.

Sources: Bulgaria (2011); Serbia (2011a); Montenegro (2011b)

Examples of scrap recovery in South-east Europe

Demilitarization programmes can yield large quantities of recycled material. Experts in Albania estimate that, since 2009, surplus destruction has produced around 20,000 tonnes of scrap.[24] This comprises, inter alia, aluminium, copper, iron, and steel resulting from the destruction of a range of material including ammunition, weapons, aircraft, and armoured vehicles (Sina, 2011). In addition, Albania has acquired around 3,427 tonnes of TNT and

Amatol from the destruction of explosives. Albanian sources suggest that the explosives will either be repackaged and sold for civilian purposes or destroyed if they cannot be sold (Albania, n.d., p. 5).

One study of Bulgaria's estimated 76,100 tonnes of surplus explosive found that more than 7,000 tonnes of powder from propellant charges could be recycled and used for commercial purposes, for example in the mining industry. The same study also estimated that 4,900 tonnes of explosive, 35,000 tonnes of scrap metal, and 23,000 tonnes of packing materials (wood, paper, and plastic) could be recycled (Georgiev, 2004).

In BiH, scrap recovered from demilitarized ammunition at the GoF-18 Doboi ammunition storage site amounted to around 860 tonnes (see Table 7). Applying the price data from Table 6 to the quantities of recovered brass, iron/steel,[25] and TNT at the Government Ordnance Factory (GOF) 18 Doboi site suggests that BiH could gain around USD 1 million by selling scrap (see Tables 7 and 8). This sum could be reinvested to fund further surplus destruction or other expenditures.[26]

It is important to note, however, that research conducted for this report indicates that market prices in BiH might be slightly lower than stated here. Moreover, some of the scrap might not be sold immediately due to market saturation and its quality may differ from similar scrap available elsewhere. In addition, a proportion of the gain from scrap sales might be absorbed by transport, logistics, packaging, and administrative costs. Nonetheless, the figures indicate the potential gains from investing in efficient demilitarization processes, which result in significant yields of scrap material—not to mention a potentially positive impact on the environment, in contrast to other disposal methods.

Sales revenues depend on market prices for raw materials. The current price for recycled explosive is low, because of the widespread use in the civilian sector of ammonium nitrate-based explosives. These explosives sell for approximately EUR 0.70/kg (USD 0.99/kg = USD 999/tonne). At this price, very little income is generated from the sale of recycled military explosives.[27]

Montenegro's experience indicates that sales of scrap material can be advantageous and that revenues can be used to finance further demilitarization projects. Information supplied by Montenegro suggests that the country

generated USD 290,000 through the sale of scrap metal after reducing its stockpile of surplus weapons. Montenegro invested these revenues in the MONDEM programme in order to finance further surplus disposal. Montenegro also invested an additional USD 594,000 from the sale of scrap metal salvaged from tank destruction in the same programme (Montenegro, 2011a). In total, the country reinvested almost USD 1 million in national surplus destruction.

Recycling as much material as possible, with an emphasis on high-quality output, appears to be a lucrative demilitarization option. Experts estimate that such programmes can offset around 30 per cent of the programme contract value, with income generated from the recycling of small arms ammunition higher than that of other materials. Although destruction costs cannot be covered completely, they can be reduced. Practitioners, however, disagree on the extent to which operational costs can be offset by R3 revenues. Some believe that the surplus weapon destruction costs can be offset only through revenues generated by salvaging scrap from large demilitarized ordnance, such as tanks. For all other weapon systems, they claim that quantities in South-east Europe are not large enough and that demilitarization techniques are not sufficiently advanced to achieve full cost recovery from scrap sales (Wilkinson, 2006c, pp. 2–3).

Table 7 Scrap material salvaged at the Doboi facility (BiH)

Scrap	Republika Srpska	BiH-federation	Harvest	Sum in kg
Brass	69,473	116,590	0	186,063
Dirty brass	16,970	45,781	1,640	64,391
Sheet iron, to 3 mm	37,092	45,706	2,052	84,850
Sheet iron, over 3 mm	36,792	39,791	261	76,844
Iron casting	145,692	290,720	0	436,412
Explosive TNT	11,093.6	746,600	0	11,840.2
Explosive Pentrit	2.5	0	0	2.5
Explosive Hal-20	9.3	0	0	9.3
Sum (from source)	**317,124**	**539,335**	**3,953**	**860,412**

Source: BiH (2011)

Table 8 Potential gain from scrap recovery at the Doboi storage site

Scrap material	Quantity in tonnes	Price in USD/ tonne	Total in USD
Brass	186	3,899	725,214
Dirty brass	64	3,899	249,536
Iron, to 3 mm	85	408	34,680
Iron, over 3 mm	77	408	31,416
Iron (cast)	436	408	177,888
TNT	12	680	8,160
Total	**860**		**1,226,894**

Note: The prices in USD per tonne were calculated, based on the lowest indicated market prices presented in Table 6.
Source: BiH (2011)

Direct and indirect impacts and costs of undesirable explosions: a typology

The direct and indirect impact of an undesirable explosion at an ammunition site varies according to the location of the facility, its construction, and its proximity to populations and civilian infrastructure. Impacts can be devastating, as in the case of the Gërdec explosion in Albania in 2008, which resulted in 26 fatalities. They can also be minor, as in the 2011 Padjani explosion that took place in Croatia and caused no casualties.

Categorization of direct and indirect impacts and costs

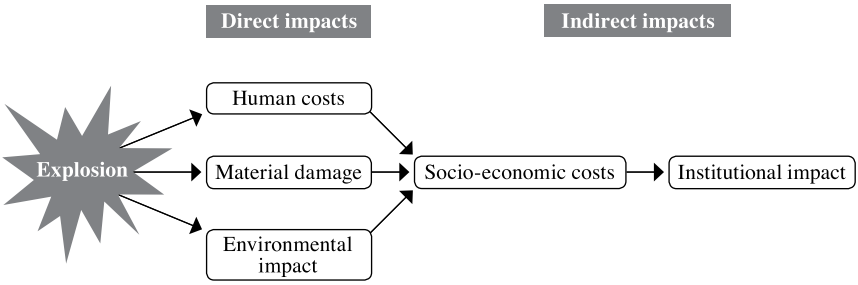
The effects of an UEMS can be measured in direct and indirect impacts. Whether direct or indirect, however, each impact results in both immediate costs and long-term consequences (see Figure 3 and Table 9). Direct effects are easier to define and illustrate than indirect effects, and are also easier to quantify because they are immediate and more visible than long-term or indirect impacts. Quantifying indirect impacts, for example measuring long-term costs, presents certain conceptual and practical difficulties because they are less visible. The following section surveys the consequences of UEMS incidents. This is not, however, an exhaustive list of impacts. As such, incidents have such different impacts, they need to be analysed case by case.

Direct impacts

UEMS can have a series of direct impacts, which can be divided into three areas: human costs, material damage, and environmental impacts.

Human costs: The worst possible direct impact of an UEMS is human death and injury. Casualty rates vary according to proximity. Individuals working at the site when a detonation occurs are usually among the first to suffer, followed by residents in areas close to the explosion site. Populations very

Figure 3 Model illustrating direct and indirect impacts of UEMS



often fall within a blast radius because regulations that define maximum commercial or residential proximity to a depot either do not exist, have been ignored, are inappropriate, or outdated. In some instances depots may also have been built too close to existing civilian populations. Resulting injuries can be allocated to three categories: fatal, heavy, or light. In addition to physical injuries, people may suffer psychological trauma stemming from UEMS incidents.

Material damage: When considering material damage resulting from UEMS incidents, a distinction needs to be made between damaged public infrastructure (such as roads, the ammunition depot itself, administrative structures, schools, nurseries, airports, and other state-owned assets) and damaged private infrastructure (such as houses, cars, fences, shops, and other commercial entities).

The extent of material damage depends on the object's distance from the epicentre of the explosion, the quantity of exploded material, and the design of the storage facility. Material damage can range from scratches on walls and broken glass to the partial or total destruction of homes and buildings. The worst-affected infrastructure is likely to be the ammunition depot itself, although explosive quantity, storage design, and topography may direct the full force of the blast elsewhere.

Often, the main consequence of material damage is the loss of storage facilities and equipment at the ammunition site, which need to be replaced. Destroyed or damaged buildings need to be rebuilt or repaired, necessitating the payment of compensation to private entities. In order to determine the

level of compensation, experts need to estimate the extent of the damage and the repair or replacement costs.

Environmental impact: The cumulative environmental impact of an UEMS may not be as great as, for example, the impact of a major shooting range or demilitarization site that has been used extensively for many years. Nonetheless, UEMS incidents may lead to environmental contamination well beyond the defined perimeter of a military facility. This is largely due to the scattering, rather than detonation, of ordnance during a major explosion.[28] In this event, UXO needs to be cleared from contaminated areas.

The cost of UXO clearance operations is variable and depends on whether UXO is found above or below the surface, or under water in cases where rivers or lakes are located nearby.[29] The saturation level and depth of UXO contamination are important factors in determining clearance costs. Some estimates suggest that the 'rule of thumb' cost of UXO clearance amounts to approximately USD 2 per square metre.[30] This estimate might apply for battle area and subsurface clearance that does not exceed a depth of 20 cm; however, some contaminated areas have to be cleared to a depth of 2 m, which increases costs substantially. For example, UXO clearance at the Gërdec site in Albania found more than 50 tonnes of scrap material in a 25 m^2 area, which took about a month to clear. Such heavy contamination severely prolongs clearance operations and increases costs considerably.

UXO contamination can have long-term impacts, including harvest losses due to contaminated farmland that can no longer be cultivated. The degree and character of soil contamination depends on the use of farmland (intensity and duration of cultivation), the type of UXO (for example, chemical components), and the characteristics of the soil (sand, loam, clay, peat soil, or a mixture of them) (Maring and Meuken, 2011).[31] Moreover, if the ammunition site is located close to populated areas, safety zones need to be established and civilians need to be educated and warned not to touch UXO.

Indirect impacts

In addition to the direct impacts, UEMS incidents often generate wider socio-economic costs (including potential institutional impacts). These costs require further action from national authorities.

Socio-economic costs: UEMS incidents result in a wide variety of socio-economic impacts and related costs. Some are more direct and immediate than others. Emergency response measures following UEMS incidents are the most striking examples in this respect. Police, fire fighters, ambulances, and, in certain cases, the military may be mobilized. Some such events may necessitate the emergency evacuation and sheltering of civilians due to the loss of houses or ongoing safety concerns (including UXO contamination). Entire neighbourhoods sometimes have to be evacuated in order to regulate access and circulation and protect citizens from the effects of secondary explosions.

From the perspective of income generation, employees at the depot stand lose wages if the facility has to close for a certain period of time; or they may even lose their jobs if the facility has been completely destroyed. Shops, restaurants, and other local businesses also lose income if they have to close or restrict their activities due to damaged infrastructure, residual danger, and UXO contamination. The most significant socio-economic cost related to UEMS incidents is the compensation paid to families who have lost relatives, and the financial resources needed—often over long periods—for infrastructure reconstruction and UXO clearance operations.

Institutional impacts: UEMS events can have impacts on national institutions at different levels. The primary consequence is a loss of confidence in the plant management and local or national authorities. In some instances, MoDs have had to resign because weak oversight and control were found to have been instrumental in UEMS incidents.

Who covers the costs?

The financial burden of UEMS incidents cuts across national government departments, foreign donors, commercial entities, and private citizens. At the government level, responsibility usually lies with the defence and security forces concerned, namely the military or police. For example, in terms of direct financial consequences, the MoD may bear the financial responsibility for an explosion at a military stockpile. In contrast, UEMS incidents that occur at private demilitarization facilities may require the Ministry of the Interior (MoI) to cover rebuilding and compensation costs.

Table 9 Direct and indirect costs related to undesirable explosions at munitions sites

	Immediate costs/impacts	Indirect actions/impacts
Human costs	• Lost lives • Heavy injuries • Light injuries	• Compensation for lost lives • Funeral expenses might be covered by public budgets • Long-term medical treatment • Cost of psychological counselling • Indirect deaths or injuries (due to UXO, shock, post-blast heart attacks, etc.)
Material damage	• Damage to the (ammunition) site itself • Damaged private infrastructure (houses, cars, fences, territory, magazines, airports) • Damaged public infrastructure (roads, administrative structures, power plants, schools, military barracks, etc.)	• Compensation for material damage • Replacement of functioning weapons/stable and operational ammunition lost in the explosion → funds for the replacement could have been used for socio-economic purposes • Mobilization of experts to assess damage to private and public infrastructure • Cost of cleaning streets and repairing infrastructure after explosions
Enviromental impact	• UXO-contaminated land • Contamination of land and water, e.g. with arsenic, copper, iron, lead, and mercury	• Cost of subsequent EOD operations at surface, subsurface, and underwater levels • Mobilization of funds/human resources and production of educational materials to alert population to the dangers of accidental contact with subsurface and surface ammunition • Establishment of safety zones to avoid further loss of life • Cost of assessing air, water, and soil potentially polluted by the explosion fallout • Lost harvests due to farming land being contaminated and rendered

	Further consequences
Socio-economic costs	• Emergency responses (police, army, fire fighters) • Emergency evacuations of the population (by bus, train, car) • Temporary shelter provision (such as IDP camps) • Securing areas around a munitions site • Direct employee income loss if the depot has been destroyed (temporary or permanent) • Lost income due to: – temporary closure of surrounding shops, bars, and restaurants – companies having to suspend the delivery of goods and materials to a site that is no longer operational – the closure of airports in the explosion site region; forced redirection of flights • Fear of passing/staying at places close to the site keeps visitors away • Disruptive impact on national infrastructure, such as power plants, mobile phone networks, and water-supply facilities • Missed classes (school) or missed work days • Investigations to determine the cause of the incident and subsequent trials that can last several years

Institutional impacts

- Possible resignations by politicians/authorities/management as an indirect result of the explosion
- Loss of confidence in the government/authorities/plant management
- Potential impact on the credit rating of the country

Regardless of direct responsibility, however, many UEMS events involve multiple ministries. For example, the MoD may have to replace destroyed operational equipment and allocate resources to UXO clearance operations; the MoI may have to fund emergency services; and the Ministry of Social Affairs may have to contribute unemployment benefits to those whose businesses or livelihoods have been disrupted by an explosion.

In reality, the costs of UEMS events radiate outwards from the scene of the explosion and become progressively more difficult to quantify. The disruption caused by explosions often has many secondary financial implications, such as the administrative burden placed on an airport following the closure of another airport, or the impact on insurance premiums elsewhere following damage claims in a specific location. This is not to mention the cost incurred by local populations who may be forced to finance repairs from their own pockets or may face long-term financial hardship resulting from displacement, lost income, or having been denied access to contaminated farmland.

In addition, the financial burden of UEMS events frequently extends overseas. Many states depend on financial support from the international community and donor countries to cover the direct and indirect costs of unplanned explosions. As illustrated below, Albania, Bulgaria, and Serbia have each relied substantially on foreign donor-nation support to clean up areas contaminated by UEMS events.

The impacts and costs of undesirable explosions: Bulgaria[32]

Map 1 Bulgaria: Number of recorded UEMS, 1998–2011

Source: Small Arms Survey (2012)

As a country on the perimeter of the former Warsaw Pact bloc during the cold war, Bulgaria experienced increased construction of ammunition storage sites on its territory. At the end of the cold war, and following two decades of armed forces restructuring, many of these ammunition depots, and the material stored in them, became obsolete. As of May 2011, Bulgaria had a declared ammunition surplus of 15,000 tonnes (Gobinet, 2011, p. 63). Due to a lack of storage sites, Bulgaria stored some of its ammunition in wooden boxes stacked in the open air. Moreover, its ammunition was often kept in inadequate packing, with damaged, incomplete, or incorrect markings.[33]

At least four UEMS occurred at munitions sites in Bulgaria between 2008 and 2011. Two of them took place in 2008, one in July at the government-controlled ammunition depot in Chelopechene and the other in August at the privately owned company, Arsenal JSC, based in Kazanlak. A third explosion occurred in February 2010 at a privately owned ammunition manufacturing company, Midzhur, in Gorni Lom, and a fourth deflagration took place in November 2011 at a privately owned demilitarization company in Sevlievo.

This section presents a comparative analysis of the Chelopechene and Gorni Lom incidents.[34] It assesses direct impacts of the two UEMS events and the subsequent clean-up and socio-economic costs.

The main explosion at the Chelopechene storage site occurred at 06:28 on 3 July 2008. Subsequent explosions continued throughout the day and smaller explosions occurred after midnight and on the morning of 4 July 2008.[35] The Chelopechene storage site is around 450 hectares (ha) in size.[36] At the time of the explosion, it contained around 1,500 tonnes of ammunition and explosives in six storage buildings, including: air defence weapons; small arms and artillery ammunition; anti-tank guided weapons; ground-to-ground missiles; and TNT (see Table 10).[37] The site is situated close to several villages and farmland, on a main arterial road, and within 14 km of Sofia International Airport. As the following sections note, the site's location close to habitation and commerce had a significant bearing on the costs of the UEMS event.

The explosion at the Gorni Lom site occurred during the evening[38] of 3 February 2010, with secondary explosions continuing until the next morning (*Novinite*, 2010a, 2010b). The site had been used to manufacture military explosives and reportedly contained ten tonnes of ammonite. According to authorities, this was nine tonnes over the authorized limit for ammonite storage at a single locality. Furthermore, in violation of regulations, the manufacture and packing of explosives were carried out on parts of the same production line. The explosion completely destroyed the factory, as well as ammunition reportedly stored at the site (*Novinite*, 2010a; SNA, 2010). Moreover, APM scheduled for demilitarization, stored within 500 m of the factory, also detonated during the explosion.[39] Fortunately, however, the site is

situated around 6 km away from the nearest village. Consequently, as noted in the following sections, local populations and commerce suffered far fewer direct impacts than their counterparts in the Chelopechene incident.

Human costs

The Chelopechene explosion reportedly caused several light injuries (MSIAC, 2008, p. 6), but no deaths or serious injuries. Some focus group participants claimed the explosion caused panic among the population, while others said this was not the case. All participants reported, however, that local people were frightened by the explosion and feared possible further and more powerful secondary detonations. Authorities provided a psychologist to help people overcome trauma and related stress. At least one resident refused to return home for two months following the blast.

Similarly, no one perished in Gorni Lom. Reports suggest the incident caused only minor injuries apart from one severe eye wound (*Novinite*, 2010a, 2010b), which reportedly requires ongoing treatment (July 2011).[40] Focus group participants did not report the panic or anxiety among the population mentioned by their Chelopechene counterparts. This is probably due to the fact that Gorni Lom is located around 6 km from the ammunition site, whereas the municipality of Chelopechene is adjacent to the explosion site.

Material damage

The 1,500 tonnes of ammunition and explosives at the Chelopechene site was awaiting disposal,[41] and therefore did not feature in the material damage cost assessment. An estimated 600 houses in the nearby villages of Chelopechene, Kazichene, and Chepintsi were affected by explosion fallout (MSIAC, 2008, p. 6), which caused mainly broken windows and limited structural damage. Focus group participants furthermore reported that the blast cut telephone lines and the power supply. It also broke windows at Sofia International Airport and auto-ignited a rocket-propelled grenade (RPG), which landed within the perimeter of the airport. Authorities redirected incoming flights to Plovdiv International Airport (Kostadinov, 2008), and then arranged transport for passengers from Plovdiv to Sofia.

By contrast, the distant location of the Gorni Lom site meant that the explosion there caused little material damage to surrounding property. Focus group participants noted that the blast caused damage to house and shop windows, which was subsequently compensated for. No farmland was contaminated due to the site's distant location.

Environmental impact

The Chelopechene explosion created six craters. Over time, water flowed into the craters, submerging UXO and making its clearance more complicated. UXO spewed out by the blast contaminated around 3,000 ha of surrounding farmland.[42] Focus group participants expressed concerns over possible air pollution from the explosion and from subsequent controlled UXO detonations at the site, and claimed the authorities did not inform the population of developments. In response, government officials stated that air, water, and soil sampling had proved negative for pollution.[43] The Chelopechene explosion occurred within the perimeters of land forming part of NATURA 2000, a European network of areas benefiting from environmental protection and biodiversity conservation. Clean-up operations in the area reportedly respected ecological standards embodied in national legislation. For example, the clearance and controlled detonation of UXO must not disturb wild bird nest-building, and the MoD constantly monitors air and atmosphere quality during UXO detonation operations in this protected region (Nikolov, 2011).

The Gorni Lom event reportedly did not result in the contamination of local farmland. Air and soil contamination tests reportedly proved negative. From a cost perspective, the land immediately surrounding the plant was deemed safe for use and the explosion did not necessitate clean-up operations. However, Gorni Lom focus group participants—like their Chelopechene counterparts—expressed concerns over potential air, soil, and water contamination. This suggests that populations at each site feared contamination, primarily because they did not know the precise nature of the exploded ordnance and its effects on the environment.

Emergency response and evacuation

The emergency response to the Chelopechene event appears to have been rapid and effective. Focus group participants report that emergency services closed the area, blocked two main roads, and evacuated 1,700 residents from surrounding villages.[44] Local authorities, the mayor of Sofia, police, and military units arrived at the scene and remained there for some time. Although most residents returned to their homes in the evening following the explosion, mobility was restricted for two to three days and residents were warned to keep away from the site and contaminated areas. Perhaps because of these prompt measures, no UXO injuries have been reported. The presence of security forces apparently prevented looting from taking place during the evacuation period.

Following the Gorni Lom incident, local authorities closed the road leading to the factory and cordoned off an area with a 4 km radius around the site (*Novinite*, 2010a).[45] Some focus group participants acknowledged that government responses, which included the visit of a 'crisis team' comprising the district governor, the mayor, and the civil protection service, had been adequate. Authorities decided not to evacuate the nearest villages because of their distance from the blast scene, although some Roma families left the area for three or four days, reportedly fearing damage and pollution from secondary explosions.

Responsibility

Responsibility for the Chelopechene explosion has yet to be determined. At a press conference on 6 July 2008, Defence Minister, Nikolay Tsonev, announced that the results of an investigation would be released the following day (MSIAC, 2008, p. 6). To date, however, the authorities have provided no information regarding the cause of the explosion. This lack of information appears to have fuelled fears among focus group participants of malpractice at the site and some suggested the explosion was deliberate, to hide corrupt practices up to the highest level. In this respect, participants report that various checks and audits had been planned at the site a few days after the explosion occurred. Focus groups furthermore cite the fact that the

explosion happened early in the morning, when most people were sleeping and nobody was at the site, as evidence of intentional detonation. Regardless of these allegations, the local population is clearly concerned that oversight of operations at the site was lacking, and blames the MoD for the incident.

Gorni Lom interviewees also appear to have reacted to the lack of concrete information provided by government authorities by speculating. Like their Chelopechene counterparts, they advanced various hypotheses for the cause of the explosion, including one suggesting that it was due to negligence on the part of a worker, which caused a fire that sparked the blast. Authorities, however, claim that the explosion resulted from a production incident involving the combustion of a damaged electrical heater. The lack of information provided to local communities may also be evidenced by their apparent confusion as to which party was responsible for the incident. Some focus group participants claimed that responsibility lay jointly with the plant management and the state; others stated that responsibility rested with the management and workers. Yet other participants argued that the management had fired competent workers who had demanded higher salaries and had hired unskilled personnel to replace them.

In summary, communities at the Chelopechene and Gorni Lom sites appear to have reacted to a lack of specific information on the causes of each incident by speculating on various hypotheses—including a suspected lack of oversight and regard for health and safety.

What future for the sites?

Chelopechene residents say they want the ammunition depot to be closed permanently. Authorities report that, following a clean-up of the contaminated area, the land where the depot once stood will be sold.[46] Conversely, most Gorni Lom residents report that they wish the plant to remain operational, primarily because it is one of the few employers in the locality.

Comparison between the Chelopechene and Gorni Lom incidents suggests an urban–rural divide. Chelopechene is an urban area located close to Sofia, with relatively abundant employment opportunities. The ammunition depot there posed a demonstrated risk to the local population and offered

few economic benefits. By contrast, due to its distant location, the UEMS incident at the Gorni Lom factory posed little risk to the population, but the factory remains a rare employment opportunity in a region with low economic activity.

Estimated costs

Some costs related to the explosions in Bulgaria are easier to quantify than others. As the following sections indicate, the costs of emergency assistance, clean-up operations, and compensation are easier to capture than costs related to indirect impacts. The latter include socio-economic costs related, inter alia, to the redirection of flights from one airport to another and the disruption of commercial traffic when main roads were closed.

Clean-up operations

UXO clearance operations were not required following the Gorni Lom event, but the Chelopechene incident necessitated a four-year clean-up programme. This programme was divided into several phases involving the Bulgarian Armed Forces (BAF) and a US Department of State, Bureau of Political-Military Affairs, Office of Weapons Removal and Abatement (PM/WRA) grant to the ITF. Under the same grant, the ITF contracted a private US-based company and a regional company for terrestrial UXO clearance operations and the fallout that contaminated an adjoining river, large ponds, and part of a reservoir respectively. On 25 July 2012, four years after the Chelopechene explosion, the UXO clearance operation (including underwater clearance) was formally declared complete.

The first phase of the clean-up operation (from July 2008 to March 2009) served to clear surface contamination within a radius of 3 km (50.4 ha), at a cost of USD 300,000 (Kostadinov, 2009).[47] The operation removed 80,000 pieces of ordnance.[48] The second phase extended clean-up operations to a radius of 9 km.[49] Results from the two phases indicate that more than 95 per cent of the UXO fell within a radius of 2 km. Bulgaria's MoD contributed EUR 700,000 (USD 1 million) and supplied 500 Bulgarian military personnel for the clean-up operation.[50] The costs of the latter continued to rise as the work

proceeded. In April 2011 alone, more than 100 pieces of buried UXO rose to the surface.[51] About 66,000 more UXO units and fragments were found during subsurface clearance work, including 287,122 rounds of white phosphorus ammunition.[52] Elevated levels of nitrogen caused by the UXO have also encouraged rapid vegetation growth, which prolongs the clean-up process and introduces further costs. The US Department of State provided USD 3.18 million for the last phase of the clean-up operations. In total, more than 131,000 UXO units and fragments and over 89 tonnes of scrap munitions were extracted from the ground. A further 2.623 kg of UXO and dangerous scrap were removed from the nearby reservoir, river, and ponds. Subsurface clearance work reached a depth of 21 m in some places.

Excluding personnel costs that were borne by the Bulgarian MoD, total expenditure for the Chelopechene clean-up operations amounted to at least USD 4.5 million.

Wider socio-economic impacts

Some of the socio-economic costs related to the explosions in Chelopechene are easier to quantify than others. These include the cost of emergency assistance and compensation paid to farmers and landlords. Costs resulting from the redirection of flights and the closure of roads cannot be easily quantified.

Emergency assistance at Chelopechene cost an estimated USD 250,000, paid by the US Embassy in Sofia.[53] The Chelopechene incident did not result in lost employment, because the site served solely as a storage depot run by a military unit that was about to disband.[54] The government paid around BGN 3.4 million (USD 2.4 million) in compensation for 600 damaged houses. A reported 573 local people sued the government for higher compensation, estimated at BGN 1,000 each (USD 715), in a case that has yet to be settled (Lex.bg, 2009).

The blast contaminated some 3,000 ha of agricultural farmland for about a year.[55] This resulted in lost harvests in 2008, 2009, and 2010, either because crops were contaminated (2008) or because fields could not be cultivated because they were contaminated (2009 and 2010). Open source information suggests that the government has made a collective payment of BGN 61,000 (USD 42,249) to 15 farmers (Gavazova, 2008) and allocated BGN 500,000 (USD

346,300) in compensation for fields contaminated within 1 km of the site (Staneva, 2008).

At the Gorni Lom site, lost employment appears to have created the most substantial economic cost. The plant had between 100 and 150 employees before the incident, but now employs only 30 workers. This has severe implications for the village economy. While the laid-off workers have received some compensation from the Bulgarian Labour Bureau, focus group participants suggest that compensation equal to two or three months' salary, reportedly promised by the site management, has not been paid. Consequently, the costs of compensation are unclear.

Table 10 Fact sheet, Bulgaria

	Chelopechene	Gorni Lom
Date	3 July 2008	3 February 2010
Time	06:28	18:30
What	National arms disposal depot	Midzhur explosives and ammunition plant
Human costs	4 people with slight injuries	3 people with slight injuries
Material destroyed	1,494 tonnes of ammunition and explosives detonated, including: • 62 tonnes of small arms ammunition • 249 tonnes of short-range ammunition • 872 tonnes of medium- and large-calibre artillery shells • 199 tonnes of different fuses • 69 tonnes of pyrotechnical materials • between 10 and 20 tonnes of TNT[a] 600 houses damaged (broken windows, holes in walls) and total destruction of several Bulgarian military structures on the site itself	• 10 tonnes of ammonite • APM • ammunition
Other impact	• two main transit roads blocked for one day • Sofia airport closed for one day, flights redirected • 1,700 residents evacuated • more than 3,000 ha of farmland polluted with UXO • telephone lines and power supply disrupted	• 70–120 jobs lost at the factory • 4 km area around the site closed • broken windows • mistrust towards plant management
Estimated costs	**Clean-up operations** • USD 0.3 million for operation 'Hot Summer' • USD 1 million for initial clean-up phase • USD 0.38 million for second clean-up phase **Socio-economic costs** • USD 250,000 for emergency assistance • USD 350,000 compensation for UXO contamination • USD 2,400,000 compensation for repair of houses and other infrastructure **Total: at least USD 7,500,000**	• Labour Bureau compensation for those who lost their jobs • Midzhur plant management promises to pay two to three months' salary to workers who lost their jobs

Note:

[a] MSIAC reports that 15–20 tonnes of TNT burned (MSIAC, 2008, p. 6). Bulgarian MoD officials claim that 10 tonnes of TNT burned (author interview with Bulgarian MoD and General Staff officials, Sofia, 12 April 2011); Gerdzhikov claims that 19 tonnes of other ammunition and explosives also detonated (Gerdzhikov, n.d.).

The impacts and costs of undesirable explosions: Serbia

Eight unplanned explosions have occurred in Serbia in the past decade, resulting in seven fatalities and 45 injured persons. This section provides a comparative analysis of the direct and indirect impacts of two of these incidents, one in Paraćin in 2006 and the other in Užice in 2009.[56]

The Paraćin explosion occurred on 19 October 2006, at the Serbian Armed Forces (SAF) ammunition storage site located in Karadjordjevo Brdo (Karadjordjevo hill), around 3 km from the centre of Paraćin and near to the towns of Cuprija and Jagodina. The complex, constructed in 1956, comprised 20 storage depots, 17 of which were destroyed by NATO air strikes in 1999. Following this loss of storage infrastructure, almost 25 per cent of the site's ammunition (960 tonnes) ultimately had to be stockpiled in the open air (BCSP, 2011, p. 4).[57] The first explosion occurred at 03:50 and was followed by eight secondary explosions over a 15-hour period. The strongest explosion was recorded at 06:00 and caused a shockwave that many interviewees and focus group participants described as a minor earthquake. Around 1,300 tonnes of different ammunition types exploded[58] (see Table 11).

The Užice event occurred during the evening of 3 September 2009 at a munitions factory constructed in 1928, located around 200 km west of Belgrade and operated by Prvi Partizan Užice (PPU). A fire at the factory gunpowder unit resulted in an explosion, which was followed by several secondary blasts.

Human costs

Twenty-three people were injured in the explosion, 11 in Paraćin and 12 in Cuprija. The 23 casualties were treated in hospital for minor injuries caused mainly by flying glass from windows shattered by the blast. One other person reportedly suffered a brain haematoma and lapsed into an eight-day coma, while an elderly person died of a heart attack, which may have been precipitated by the explosion. The incident also caused psychological trauma

among the population. Arguably, the fact that the explosion occurred in the middle of the night mitigated the casualty toll. Nonetheless, all focus group participants report that the event induced shock and that they continue to suffer stress—particularly during loud UXO destruction at the site. Furthermore, they criticize the authorities for not providing psychological support to those suffering from stress and trauma.

The Užice explosion killed seven workers, who died from smoke inhalation and a lack of oxygen caused by the fire, and injured 14 others at the site. It appears that the Užice explosion affected the local population to a lesser extent than the Paraćin incident—notably in terms of the shock it caused at the time of the explosion and the residual stress and anxiety.

Material damage

Besides damage to the site, the blast completely destroyed around 600 buildings and damaged many more, including 12 schools and a number of factories and shops. Extensive material damage was recorded, mainly in the form of shattered window glass and window frames,[59] blown-out doors, and destruction caused by the collapsing roofs of inhabited buildings and factories. Local authorities stated that material damage was the single greatest problem they encountered in relation to the incident: 13,375 cases of damage to 4,740 objects were registered by the authorities. Crops, pastures, and orchards suffered considerable damage caused by the scattering of significant quantities of ammunition, including high-calibre ordnance that did not explode on impact.

The value of the ammunition destroyed in the Paraćin explosion is unclear, though it should be noted that some of the ordnance had in any case been earmarked for destruction. Around 1,300 tonnes of different ammunition types are estimated to have exploded (see Table 11). The depot stored around 700 APMs and anti-tank mines; mortar bombs of various calibres; 20 mm, 30 mm, and 40 mm anti-aircraft ammunition; 76 mm, 100 mm, and 128 mm artillery shells; RPGs; 9K11 Maluku anti-tank guided missiles; and different types of fuses and detonators (*The Monitor*, 2011). From a safety standpoint, the shelf life of the ordnance earmarked for destruction was considered to have expired.

By contrast, the Užice explosion occurred in an underground facility around 3 km from the city centre and its impact was limited to the destruction of the factory and its contents. Reconstruction of the facility and its return to commercial operations reportedly took around three months.

Environmental impacts

Following the Paraćin incident, the Minister for Environmental Protection claimed there was no risk to the population or the environment (B92.net, 2006); however, UXO contamination was concentrated up to 800 m from the depot, with some falling to a distance of 1.5 km.[60] Around 830 ha of land, including arable fields, pastures, orchards, a lake, and the grounds of private residences, were contaminated. UXO clean-up operations are still underway.

No UXO contamination or environmental impacts appear to have resulted from the Užice incident, which did not scatter UXO beyond the munitions storage site.

Emergency response and evacuation

In Paraćin, emergency responses included the evacuation of 80 inhabitants. The event resulted in the closure of roads to a distance of 1.5 km surrounding the depot (including the main Belgrade–Niš transit road for 32 hours) and rail services for four hours (B92.net, 2006). Police and military units were deployed to prevent the looting of vacated shops and residences. No looting was reported (B92.net, 2006). In addition, the Serbian Red Cross distributed 26,000 m^2 of plastic foil to protect the interiors of damaged houses from rain. Red Cross volunteers also provided 500 blankets, 150 sleeping bags, and hygiene sets to people whose homes were destroyed or damaged (B92.net, 2006).

The Užice event necessitated the immediate deployment of 50 firefighters and 16 firefighting vehicles. No further information on the deployment of emergency services is available.

Responsibility

Official investigations of the Paraćin explosion determined that it was caused by the chemical decomposition of double-based propellant—possibly resulting from improper storage. This has not prevented some local residents from speculating over the possible causes, including that it may have been an act of terrorism, or deliberate sabotage by personnel to cover up the fact that ordnance had been stolen. Although the commander of the facility has been sentenced to prison, focus group participants report that the local population continues to suspect that the authorities mismanaged the site. They claim various improper practices, including a lack of oversight and the overstocking of ammunition, and report that workers issued warnings about unsafe ammunition storage at the site prior to the explosion.

Focus group participants also report that, in the immediate aftermath of the explosion, the authorities did little to inform the local population about what had happened or to advise whether it was safe for people to return to their homes. In the absence of information, people returned home without official clearance. An outdated legal framework (of the former Yugoslavia) contributed to confusion, because no one knew precisely who was responsible for the various urgent tasks at hand. According to the municipality's president, local authorities faced the choice of helping people and thus breaking the law or of observing the law and doing almost nothing. Meanwhile, as local authorities faced that dilemma, no help was forthcoming from the national government.

In the Užice case, investigations are ongoing and the exact cause of the explosion is reportedly still unknown. The lack of public information is arguably compounded by the fact that PPU employees have been reluctant to speak about the causes of the explosion for fear of losing their jobs. Interviewees have, however, claimed various reasons for the initial fire that led to the explosion, including malfunctioning doors and temperatures that exceeded safe operational parameters. PPU reportedly never respected the legally binding occupational safety and health provisions of the Risk Assessment Act (RAA). Moreover, two interviewees stated that PPU experienced a further incident, although on a smaller scale, only 15 months after the September 2009 explosion.

To date, five people have been indicted in connection with the Užice incident: the site duty manager, an employee in charge of fire protection, a manual worker, a station manager, and the manager of the unit in question. Nonetheless, interviewees were critical of the fact that only two hearings have been held in the two years since legal proceedings began. Interviewees also questioned the impartiality of the hearings.

What future for the sites?

The Paraćin municipality president had planned to approve the construction of a new factory to produce industrial explosives, which would have provided a significant source of employment. The local population, however, opposed the initiative, citing safety concerns, and the site has been allocated to the construction of a sports resort. UXO clean-up operations and the economic downturn have delayed the start of construction.

Conversely, PPU is the main employer in Užice, where it has engaged around 600 full-time and 500 part-time workers. As a result, the local population appears broadly in favour of continued PPU operations, although several interviewees expressed concern over health and safety shortcomings at the plant. Others stress that PPU has strengthened its safety systems through, inter alia, the introduction of video surveillance and a device that automatically halts production if temperatures exceed critical levels.

Estimated costs

Some costs related to the explosions in Serbia are simpler to quantify than others. As the following sections indicate, the costs of emergency assistance, clean-up operations, and compensation are easier to capture than expenditure related to indirect impacts such as the loss of daily income for restaurants and bars (see Table 11).

Clean-up

In Paraćin, the first clean-up phase (2006–2008) involved 150 SAF personnel (later reduced to 40) and entailed the clearance of 89,649 UXO items from 8 km^2 of land.[61] This phase addressed primarily surface (rather than buried)

Table 11 Fact sheet, Serbia

	Paraćin	Užice
Date	19 October 2006	3 September 2009
Time	03:50	21:30
What	SAF munitions storage facility	PPU munitions factory
Human costs	23 casualties with minor injuries	7 deaths, 14 injured
Material destroyed	• 1,300 tonnes of ammunition and explosives detonated (31 per cent of the total material stored) • 12 school buildings were damaged • 600 buildings were destroyed and 4,740 objects damaged, including: – 4,240 residential buildings – 191 office buildings – 21 mixed office/residential buildings – 60 public administration buildings – 13 agricultural buildings – 71 holiday structures – 111 buildings attached to residential homes – 39 private garages – 1 temporary building – 26 plots of agricultural land – 2 other • In Čuprija 2,000 objects were damaged	Part of the factory where munitions were filled with explosives
Other impact	• Main transit road blocked for 32 hours • Railway system closed for 4 hours • More than 3,000 ha of farmland polluted with UXO • 80 individuals evacuated to reception centres	Factory repair work lasting 3 months
Estimated costs	**Clean-up operations** • USD 1,320,600 for first phase • USD 6 million for second phase **Socio-economic costs** • USD 850,000 in emergency aid • USD 2,210,000 for infrastructure repair • USD 19,815,000 in lost trade on main transit roads **Total costs: at least USD 10,436,600**	**Repairs to the factory** • unknown **Socio-economic costs** • USD 10,958 for funerals • USD 316,421 short-term compensation to families • USD 47,943 incident insurance paid to families • USD 112,000 assistance to family members of deceased workers • USD 101.50 scholarship fees per child of deceased workers **Total socio-economic costs: at least USD 487,423 for the families**

UXO and cost the Serbian government at least EUR 1 million (USD 1,320,600). The Russian Federation-financed second phase (2009–2012) included subsurface UXO clearance to a depth of 5–50 cm.[62] This operation cleared 1,627 pieces of UXO from nearly two million m² of land and is estimated to have cost around USD 6 million.[63] A further 600 m² of clearance is underway and scheduled for completion towards the end of 2012. Experts believe that around 4.5 million m² of land remain contaminated.[64]

Clean-up operations at the Užice site, on the other hand, did not require UXO clearance and were concluded within three months. There is no publicly available information regarding the costs involved in the clean-up or site reconstruction.

Wider socio-economic impacts and costs

The Paraćin explosion damaged 12 local schools and forced local bars and restaurants to close for fear of secondary explosions. The financial implications of this damage and lost revenue have not been released. The closure of a main transit road is estimated to have cost around EUR 15 million (USD 19,815,000) in lost trade (Parliamentary Forum, 2008). The total cost of the emergency services' response is not easily quantified. The central government allocated RSD 50 million (USD 850,000) in emergency aid: RSD 35 million (USD 595,000) for building repair work and RSD 15 million (USD 255,000) for immediate emergency relief.

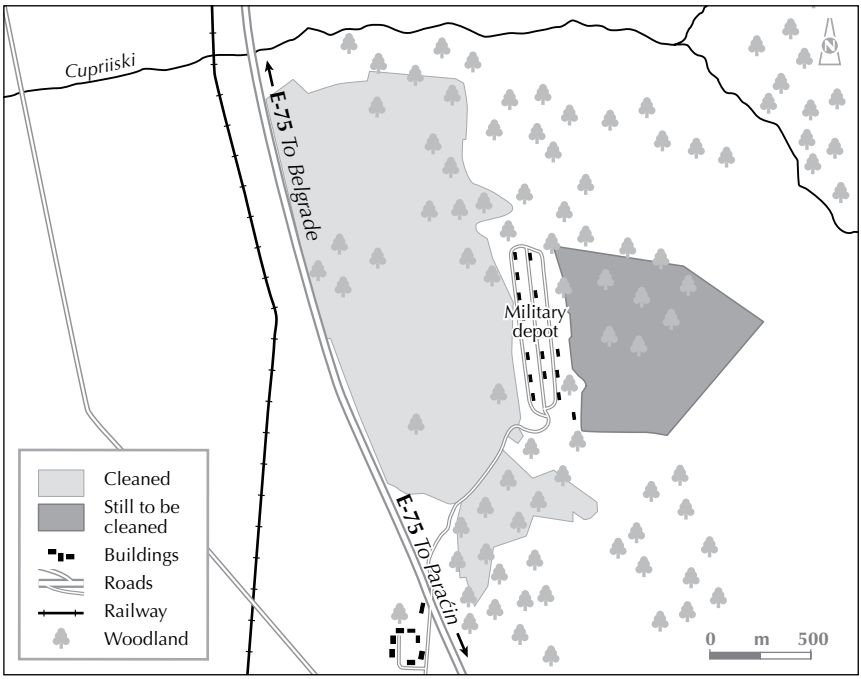
Local government estimated that it required around RSD 130 million (USD 2.21 million) to repair damaged infrastructure, to which central government contributed only RSD 35 million (USD 595,000). By mid-June 2007, the municipality of Paraćin had only received RSD 44 million (USD 831,600) in reconstruction contributions (including the aforementioned central government funds), in addition to RSD 9 million (USD 170,100) in self-raised funds (Paraćin, 2007). This left a declared shortfall of more than USD 1.3 million.

The Serbian government claims that it has paid adequate damage compensation to the population (Serbia, 2011a). Interviewees, however, note (perhaps unsurprisingly) that a discrepancy exists between government assessments of the amount of damage caused by the blast and the damage claims made by the population. In addition, local residents claim that

government assessments of income loss due to contaminated arable land and pasture are inaccurate. One farmer has reportedly sued the government over farmland damage claims.

In contrast, the primary economic burden of the Užice incident has been compensation paid in relation to death and injury. PPU paid combined funeral costs of around EUR 8,000 (USD 10,958) and subsidized scholarships for children of the deceased, valued at around RSD 7,250 (USD 101.50) each.[65] PPU also paid short-term compensation of approximately EUR 33,000 (USD 45,203) for each deceased worker and an occupational incident insurance of EUR 5,000 (USD 6,849) to family members.[66] In addition, PPU offered jobs to spouses, children, and relatives of the deceased, which most families accepted. The Government of Serbia provided a total of RSD 8 million (USD 112,000) in assistance to the families of deceased workers.

Map 2 Overview of UXO clearance in Paraćin, Serbia



Source: Demining Centre of Serbia (2012)

The impacts and costs of undesirable explosions: Gërdec (Albania)[67]

Map 3 Albania: Number of recorded UEMS, 1998–2011

Source: Small Arms Survey (2012)

At the fall of communism, Albania was among the most heavily militarized countries in Europe. In 1992, the Albanian Armed Forces (AAF) had a stockpile of more than 194,000 tonnes of ammunition stored in 955 depots across the country (UNMAS, 2011, p. 14). Today, around 90 per cent of Albania's 75,000 tonnes of surplus ammunition is reportedly over 40 years old

(Lazarević, 2010, p. 6) and much of it is stored in inadequate conditions. Over the past decade, Albania has suffered five UEMS events, including South-east Europe's most deadly one to date: the 2008 Gërdec incident.

The Gërdec site contained an estimated 9,000 tonnes of material, including 600,000 artillery projectiles (ITF, 2011).[68] At around midday on 15 March 2008 an explosion there propelled thousands of unexploded artillery shells, mortar bombs, grenades, and small arms ammunition up to 5 km from the site. Explosions continued for around 14 hours, significantly affecting the towns of Gërdec, Marikaj, Marqinet, and Vore (OCHA, 2008) and contaminating surrounding areas with around 9,000 tonnes of UXO.

Human costs

The Gërdec disaster resulted in the deaths of 26 people[69] and more than 300 injuries, 40 of them severe (Albania, 2008; GICHD, 2008, p.11). The youngest victim was a four-year-old boy (*The New York Times*, 2008). Nineteen people required medical evacuation and were transported to Greece, Italy, and Switzerland (OCHA, 2008; UNDAC, 2008. pp. 4, 10). Lighter injuries included burns, broken limbs, and cuts (Zenelaga, 2009). The casualty toll would arguably have been higher had local villagers not witnessed smoke prior to the explosion and sought refuge in woods and underground bunkers (*The New York Times*, 2008). Many people suffered shock and trauma and required the psychological counselling provided by the government.[70]

Material damage

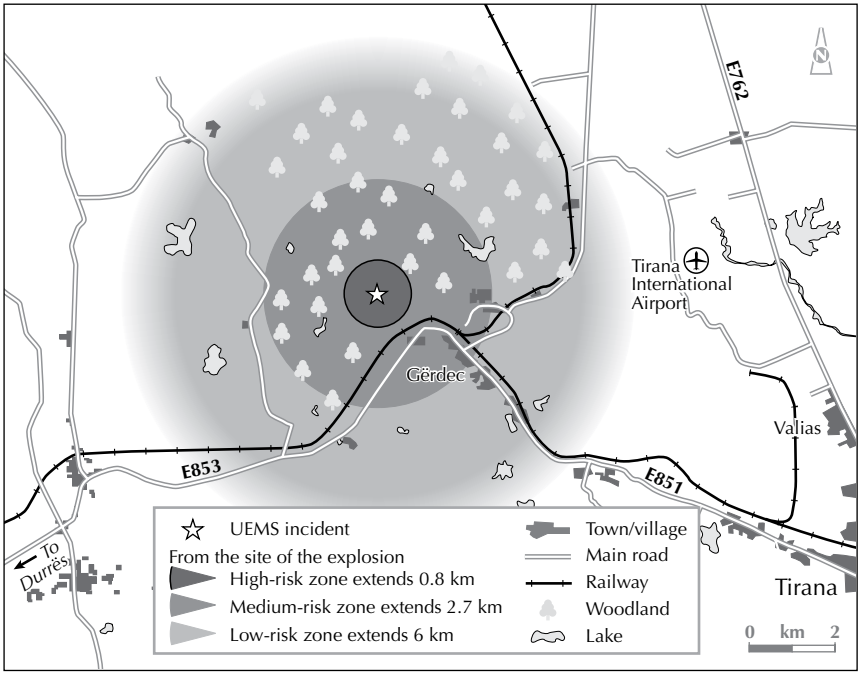
The blast destroyed around 400 houses and businesses, heavily damaged a further 400 residences, and lightly damaged an estimated 3,835 homes. It also damaged public buildings such as schools, nurseries, and health centres (OCHA, 2008; UNDAC, 2008, p. 4). The blast blew out the windows of vehicles travelling on the Tirana–Durrës highway and shattered the glass of Tirana airport's terminal building (GICHD, 2008, p. 11). It also disrupted water and electricity networks. Despite repair work beginning rapidly, it

nevertheless took 10 days to re-establish 50 per cent of the power supply (UNDAC, 2008, p. 8).

Environmental impact

The area affected by UXO contamination was divided into three zones of varying distance from the site of the explosion: a high-risk zone, a medium-risk zone, and a low-risk zone extending 0.8 km², 2.7 km², and around 12 km² respectively from the explosion site (OCHA, 2008; UNDAC, 2008, p. 3). Environmental impact analysis indicated that large quantities of soil needed to be cleared as environmental contaminants were seeping into a local river. The analysis did not, however, reveal any sign of higher levels of mercury, arsenic, or lead (UNDAC, 2008, p. 12).

Map 4 UXO contamination in Gërdec, Albania



Source: UNDAC (2008, p. 3)

Emergency response and evacuation

National and independent agencies suggest that government services provided rapid evacuation and assistance. The government prioritized: evacuating and treating injured people in the locality; removing UXO; and conducting a damage and needs assessment, in order to provide financial and humanitarian support (Albania, 2008; OCHA, 2008).

The blast affected around 10,000 people (OCHA, 2008), 4,000 of whom were evacuated from the area (GICHD, 2008, p. 11). Less than 20 per cent of the evacuees were housed in government facilities; the remainder found refuge with friends and relatives and in local hotels. The government provided food and non-food assistance, established temporary nurseries and schools, and issued tents to people who wished to stay close to their homes in order to protect them from looting (OCHA, 2008).

The international response to the Gërdec disaster was significant and included the provision of humanitarian, technical, and financial aid (see Table 12). Immediate relief included medical supplies and financial donations to hospitals, the Red Cross, and other health and emergency services, in addition to the deployment of doctors. Some states provided tents, food, clothing, and other supplies, while others organized the evacuation abroad of severely injured people. Germany, Italy, Macedonia, Sweden, and the United States provided expert assistance and equipment in support of UXO clearance. Various states also mobilized experts to assist Albanian police, investigators, and prosecutors. Long-term support from international donors included funding and assistance for ongoing UXO clearance operations and the reconstruction of public and private infrastructure, such as hospitals, houses, and schools.

Responsibility

The Gërdec explosion occurred during surplus ammunition disposal operations conducted by a private contractor hired by the Albanian MoD. Expert reports suggest that the contractor operated with little oversight and conducted demilitarization in unsafe working conditions. First, the factory was very small and inappropriate for the demilitarization of ammunition (*SETimes*, 2008). Second, local employees had not been adequately trained to

dismantle explosive ordnance and included children and elderly people who are alleged to have worked at the site (Zenegala, 2009). Third, the storage of propellants in the open air and in containers, and a lack of respect for safety distances, allowed a fire in one container to spread quickly to neighbouring containers, which resulted in the explosion.[71]

Table 12 International donor response during the Gërdec explosion and its immediate aftermath

Country	Description	Value in EUR
Austria	800 kg of medical supplies, dressing material, infusions liquid	
	Relief measures (projects had to be submitted to the Austrian government)	*200,000*
	Vorarlberg: rehabilitation of school buildings and nurseries	*20,000*
	Several private fundraising initiatives for relief and rehabilitation projects	*1,000–10,000*
Czech Republic	Medical supplies to Albanian Ministry of Health (MoH)	80,000
Denmark	Deployment of 22-person Danish Aid EOD relief team to the explosion site	
	Allocation of relief funds to the Albanian Red Cross	40,000
EU Commission	Donation to the Mother Teresa Hospital	950,000
	Donor pledge	*4,000,000*
France	Emergency tents and 9 tonnes of medical supplies/equipment (antibiotics, plasma, tents)	165,000
Germany	2,000 albumin transfusion units and 250 kg of dressings materials for the Albanian Red Cross	100,000
	EOD equipment for Albanian Mine Action Executive	
Greece	Medical evacuations to Greece	
	Medical supplies; 5 sets of EOD equipment for Albanian Mine Action Executive	
	Donation of various materials to the Albanian Red Cross	
International Red Cross Federation	Donation to the Albanian Red Cross	85,000
Italy	Medical supplies (2 respirators, 2 medical stands, 1 monitor, 4 electric syringes, and 1 ECG apparatus)	
	2 EOD experts	
	Medical evacuation of 6 injured persons to Italy	
	Italian NGOs collected and supplied food, clothes, and other relief items for distribution in the affected areas	
KFOR	300 blood units	

Macedonia	200 blood units	
	Medical supplies	
	EOD equipment	
Montenegro	Donation of various materials to the Albanian Red Cross	
Netherlands	Donation to the Disaster Relief Emergency Fund	40,000
OSCE	*Reconstruction of health clinic*	*15,000*
Romania	6 medical boxes	
	50 blood units	
Sweden	1 EOD expert	
Switzerland	Environmental analysis expertise (HAZMAT team)	
	538 kg (260 kg by UNDAC) of medical supplies, medical evacuation of 2 (3 by UNDAC) injured persons; transport and medical treatment for 2 (3 by UNDAC) injured persons	
	Support for housing and rehabilitation of public buildings (schools)	
Turkey	Transport and medical treatment for one injured person	
UN	UNDAC team assistance	
	WHO supported MoH	
	UNDP worked with Albanian Mine Action Executive	
	UNICEF provided fuel for the Community Mental Health teams	
	World Vision was contacted in response to the needs of women/ children	
UK	Funded a member of the recent UNDAC team post-Gërdec	
United States	USAID: provision of USD 1,000 worth of medical supplies to military hospital trauma centre within 3 hours of explosion	
	USAID: Donation for Red Cross (USD 50,000)	37,015
	European Command: 2 navy EOD specialists and a 10-person team	
	New Jersey National Guard needs assessment team	
	6 agents from the Bureau of Alcohol, Tobacco, Firearms and Explosives to assist police and prosecutors	
	Organized a meeting of NATO member country embassy staff to promote donor support for UXO clearance operations	
	US Dept of State contract with Armor Group for ordnance clean-up at the blast site (agreement signed, USD 2 million)	*1,480,600*
European Investment Bank	*Long-term loan financing to assist Albanian government in infrastructure reconstruction around Gërdec*	

Note: Text in italics indicates long-term support.

Sources: Adapted from Albania (2008); OCHA (2008); UNDAC (2008, p. 11)

Police immediately arrested five individuals after the explosion. The defence minister resigned several days after the explosion and the prime minister came under strong pressure from victims' families (*The New York Times*, 2008). Both were widely criticized for not having exercised better control over activities at the site. In March 2012, 19 former officials were given prison sentences of 1–18 years. Families expressed disappointment and claimed that top government officials had evaded justice (Likmeta, 2012; *The New York Times*, 2012). Following clean-up operations, Albanian authorities will stop all demilitarization activities at the Gërdec site, which will become a park or another type of green area.[72]

Lessons learned and the future of the site

The Gërdec incident clearly demonstrates that the Albanian government needs to exercise greater oversight over demilitarization activities. It is also clear that there is currently insufficient expertise among local companies to conduct demilitarization operations safely. That said, Albania has demilitarization capacity within the MoD and the AAF. With the assistance of external agencies, such as NSPA, which has received USD 4 million to date from the US Department of State's PM/WRA to modernize and manage an Albanian MoD demilitarization facility, and some support from other foreign donors, the MoD is improving its demilitarization infrastructure, security procedures, and personnel training.[73]

Estimated costs

Estimating the real costs of the Gërdec explosion is a challenging task. Politicians have reportedly attempted to conceal the real costs of the disaster. Available evidence, however, suggests a very large financial toll on the state budget.

Clean-up

Clean-up operations following the explosion initially focused on the clearance of surface UXO. This phase involved 392 personnel from AAF EOD teams; 16 deminers funded by Danish Church Aid; and two Swedish Rescue

Services Agency advisers (UNDAC, 2008, p. 8). These teams cleared 5,712 UXO items and debris from 660 exploded shells over 823,308 m² of land (ICBL, 2009, pp. 138–9). The second phase of the operation commenced in July 2008 and involved surface and subsurface[74] clearance of the military site and heavily contaminated private property. By the end of 2011, this operation had recovered 107,487 live shells and 89,181 other explosive items, from 270,260 m² of land. Clean-up operations are expected to end in 2012.[75]

The US Department of State's PM/WRA funded most of the UXO clearance, providing USD 6 million in 2010, a further USD 2 million in 2011, and a final allocation of USD 2,234,000 in 2012. The latter figure encompasses operations to clear a 35,000 m² area contaminated with fuses, which the AAF had originally intended to undertake independently; however, in view of the dangerous nature of the work and the extent of the task, Albania sought assistance from the PM/WRA's current grantee and contractors at the Gërdec explosion site. As of April 2012, however, budget considerations compelled the PM/WRA to return this immensely expensive undertaking to AAF custody to enable the United States and its grantee and contractors to focus on their original core humanitarian tasks in Gërdec.[76]

Wider socio-economic impacts and costs

The Gërdec disaster had significant socio-economic impacts. Immediately following the incident, the Albanian government and international organizations estimated the costs of rebuilding the area's infrastructure. As Box 3 indicates, these estimates varied widely.

Following the explosion, the government evacuated people to government-run facilities, although many evacuees were taken in by friends and family. It also provided some basic services, including onsite teaching for primary school students, transport of children to secondary schools in Tirana and Vore, and social activities for child evacuees. In addition, workers evacuated to Durrës were provided daily transport to their place of work (UNDAC, 2008, p. 9). The Albanian government allocated USD 520 per individual and a maximum of USD 2,080 per family in immediate financial aid, which amounted to a total of USD 1,620,320 (Albania, 2008; Zenelaga, 2009).

Box 3 Estimates of financial support required

These figures provide three different cost estimates. UNDAC provided the first estimate, which also included the second set of estimates provided by the Albanian MoD. The last two sets of estimates were provided by the Albanian MoD for mid- and long-term needs.

1. UNDAC estimates

Rebuilding of houses	EUR 15,000,000 (USD 20,296,500)
Rebuilding of schools	EUR 564,000 (USD 763,148)
Recovery of the health sector	EUR 91,000 (USD 123,132)
Reconstruction of power supply infrastructure	EUR 224,000 (USD 303,094)
Reconstruction of water-supply, roads, and other basic infrastructure	EUR 5,000,000 (USD 6,765,500)
Recovery of green environment and forests	EUR 332,000 (USD 449,229)
Proposed environmental actions (by UNEP)	EUR 9,200,000 (USD 12,448,520)
Decommissioning of ammunition	ca. EUR 50,000,000 (USD 67,655,000 = USD 677/tonne)
Total	**ca. EUR 80,000,000 (USD 109,000,000)**

2. Ministry of Interior (MoI) estimates

Education	USD 707,200
Health system	USD 114,400
Electricity infrastructure	USD 280,800
Infrastructure reconstruction (water, canal networks, roads)	USD 6,167,200
Environmental actions – Ministry of Environment (MoE)	USD 416,000
Total	**USD 7,685,600**

3. MoD estimates of mid- and long-term needs

Education	EUR 1,262,000 (USD 1,707,612)
Health	EUR 410,000 (USD 554,771)
Infrastructure	EUR 6,073,000 (USD 8,217,376)
Environment	EUR 1,400,000 (USD 1,894,340)
Agriculture	EUR 76,000 (USD 102,836)
MoI	EUR 4,927,000 (USD 6,666,724)
Social affairs (psycho-social support service)	EUR 10,000 (USD 13,531)
Total	**EUR 14,158,000 (USD 19,157,190)**

Sources: Albania (2008); UNDAC (2008, pp. 13, 45)

Table 13 Fact sheet on the Gërdec explosion

Date	15 March 2008
Time	12:00; explosions lasted for nearly 14 hours
What	Private ammunition demilitarization facility, Gërdec
Human costs	• 26 fatalities 300 injured (40 severely)
Material damage	• 9,000 tonnes of material 4,200 homes damaged, 400 homes completely destroyed
Other impact	• An area of 350 ha was contaminated with UXO (shells were scattered to 4 surrounding villages)
	• Durrës-Tirana highway was closed until the next day Flights to Tirana airport were suspended for 40 minutes The Defence Minister resigned UXO risk education had to be provided
Estimated costs Clean-up	• USD 10,234,000
Socio-economic	• USD 1,620,000 immediate financial help to displaced families USD 1,100,000 to families whose houses were rendered uninhabitable USD 16,000,000 to reconstruct/repair destroyed/damaged houses and infrastructure USD 74,800 compensation to workers USD 499,200 for 24 victims
Total	**At least USD 29,500,000**

Sources: Albania (2008); ICBL (2009, p. 134); *SETimes* (2008); Zenelaga (2009)

The government initially set aside USD 1.114 million to compensate families for material loss and to assist in repairs and rebuilding. This was far less than cost estimates for repairing and rebuilding housing, which ranged from USD 16 to USD 27.1 million. The Albanian government eventually allocated around USD 16 million for these purposes.[77]

Each worker received USD 520[78] in compensation for lost wages, which amounted to a total disbursement of around USD 74,880 (Albania, 2008). In addition, the government paid USD 20,800 in compensation to 24 victims, which suggests a total payout of USD 499,200 (Albania, 2008). Many individuals are reportedly dissatisfied with the level of government compensation.[79]

Despite initial surface clearance of the areas around Gërdec, NGOs and community activists report that still today civilians regularly discover unexploded ordnance (UXO)—notably in areas the Albanian authorities have declared to be clear of UXO. Children are most often at risk from UXO injury because they play in the fields and hills around their communities. Farmers have also reported discovering buried UXO while tilling their fields.[80] The government has had to organize and provide public education to the local population regarding UXO-related risks.

Conclusion

While respect for storage standards and best practices reduces the risk of an undesirable explosion to a minimum, there is no guarantee that an incident will not occur.

As this *Special Report* has shown, South-east Europe has faced a growing incidence of UEMS since 2006. When safety procedures and appropriate infrastructure development for regular stockpile disposal are lacking, the question is not *if* another accident will occur, but *when*. Ineffective stockpile management, coupled with the slow pace of surplus weapon and munitions stockpile destruction, will inevitably lead to further—and possibly more frequent—explosions.

The case studies illustrated in this *Special Report* provide evidence of the dangers that UEMS pose to societies. These incidents can have a devastating impact on surrounding populations, infrastructure, and the environment. Clean-up operations often last several years and these incidents can erode public trust in the authorities and the management of weapon and munitions sites. Most regional governments that have had to deal with UEMS events have limited financial and technical capacity to undertake subsurface and underwater UXO clearance operations; consequently, they have relied heavily on international expertise and funding support to address these challenges.

PSSM, including the destruction of large quantities of surplus and obsolete weapons and ammunition, can be resource-intensive in the short term. It nonetheless remains a far cheaper option than paying for the direct and indirect costs of unplanned weapon and munitions stockpile explosions that in most cases result from a failure to invest in sound PSSM.

The Gërdec explosion suggests that each tonne of exploded ammunition caused more than USD 3,000 damage. Comparing these costs to the demilitarization costs in Albania of USD 540–740 per tonne highlights the assertion that preventing this accident would have cost less than USD 6.6 million. Instead, the costs reached USD 29 million.

Annexes

Annexe 1 Destruction and demining projects in South-east Europe, from 2002 onwards

	Project name	Period	Funding source	Weapon and ammunition types/quantity	Budget
ALBANIA	PfP Albania II Project	January 2003 to September 2007	NSPA	11,651 tonnes of ammunition (lifespan of 4 years)	EUR 6,400,000 (USD 7,850,000)
	PfP Albania III Project	2008–2012	NSPA (some funding from Albanian government)	75,000 tonnes of various ordnance	EUR 35,800,000 (USD 53,000,000) overall budget (including transportation, administration costs, NSPA management team); EUR 8,500,000 from Albania
	NATO project	2011–2013	US Dept of State (PM/WRA)	Development of industrial demilitarization factory at ULP Mjekes to demilitarize 24,000 tonnes of ammunition	USD 10,000,000
BULGARIA	TEREM EAD	FY 2006	US Dept of State (PM/WRA)	76,000 tonnes of military SALW	USD 400,000
		2008	MoD	14,900 tonnes of ammunition	BGN 27,000,000 (USD 18,703,000)
		2012–2015	MoD	39,000 tonnes of ammunition	BGN 114,000,000 (USD 83,240,000)
			US Dept of State (PM/WRA) and Bulgaria	23,295 weapons, including 10,000 AK-47s and ammunition	USD 119,000
CROATIA		2008	Croatia MoD and Armed Forces of Croatia	25,000 arms and weapons	USD 100,000 from UNDP for further support
		2009	US Dept of State (PM/WRA)	929 MANPADS	USD 1,000,000

CROATIA		Future		19,000–20,000 tonnes current surplus. This might include: 200 tonnes white phosphorus, 3,000 tonnes of explosives, 20 mm–203 mm calibre ordnance	EUR 9,000,000 (USD 13,000,000)
	SEESAC, implemented by UNDP Croatia and Croatian Ministries of Interior and Defence	2011–2013	EU under EU Council Decision 2010/179/CFSP	9,435 weapons destroyed (by September 2011); goal is to destroy 30,000 weapons	EUR 1,600,000 (USD 2,222,720), shared with Serbia
MACEDONIA		FY 2009	US Dept of State (PM/WRA)	Clearance of 700 pieces of abandoned ordnance	USD 200,000
MONTENEGRO		2006	Bulgaria	destruction of 1,897 SALW	USD 7,588
	MONDEM		OSCE, UNDP	430 tonnes (870 tonnes remaining for phase II as soon as funding is received)	Phase I (ended in May 2010: EUR 763,428); Phase II: around 1,000 tonnes to be destroyed – budget around EUR 900,000
	MONDEM	2007–2010	OSCE, UNDP	927 tonnes of ammunition	USD 227,800 for small arms ammunition destruction in 2007; USD 652,500 for small arms ammunition destruction in 2008; USD 652,500 for demilitarization of medium- and heavy-calibre ammunition in 2008; USD 649,600 for demilitarization of naval and air large-calibre ammunition in 2009
	Technical Agreement	FY 2007 and 2008	US Dept of State (PM/WRA)	Destruction of 1,497.50 tonnes of SALW and ammunition, including 1,500 MANPADS (FY 2008).	USD 2,500,000
	Technical Agreement	FY 2011	US Dept of State (PM/WRA) via a grant to the ITF	Demilitarize and destroy 1,300 tonnes of conventional weapons (including small arms and light weapons) and ammunition	USD 1,750,000

	Project name	Period	Funding source	Weapon and ammunition types/ quantity	Budget
ROMANIA		2002	US Dept of State (PM/WRA)	200,000 small arms and light weapons (pistols, SMGs, mortars, grenade launchers), 1,281,524 pieces of 7.62 mm ammunition, 62,400,000 pieces of 7.92 mm ammunition	USD 4,800,000
SERBIA	SEESAC and UNDP	2003		20,859 SALW	About USD 6.00 per weapon
		2003–2009	US	Over 9,000 SA-7B/9M32M 'Strela' MANPADS	About USD 400 per missile
	For ITF	FY 2008	US Dept of State (PM/WRA)	1,404,819 APM destroyed (total amount from the beginning of the programme)	USD 2,000,000
	UXO clearance projects and demilitarization and destruction of ammunition	FY 2009	US Dept of State (PM/WRA)	Destroyed 129 UXO, 27 anti-tank mines, 35 APM, 3,700 MANPADS	USD 6,700,000
	SEESAC	2011–2013	EU under EU Council Decision 2010/179/CFSP	At least 11,715 SALW (under revision to increase caseload)	EUR 1,600,000 (USD 2,222,270), shared with Croatia

Note: FY means financial year.
Source: Lazarević (2012)

Annexe 2 Ammunition Depot Explosions in Bulgaria: Focus Group Discussion, Brief Moderator's Guide

Date: 18 June 2011

Target audience: Population of the **communities** affected by the ammunition depot explosions, if possible including people who worked at the depot, or members of their families.

Approximate focus group time: 90 minutes

I. Introduction (5 minutes)

Welcome to participants and self-introduction.

Explain the general purpose of the study and focus group discussion.

Explain the presence and purpose of the recording equipment and address the issue of confidentiality.

Outline general discussion guidelines and rules such as the importance of everyone speaking up and doing so one at a time.

Ask participants to introduce themselves (first name, age, occupation, number of years of residency in this community).

II. Main Discussion: Awareness, Reaction (20 minutes)

What do you know about the ammunition depot explosion that occurred in Chelopechene/Gorni Lom? Causes, other details?

Before the explosion, did you know that there was an ammunition depot nearby?

What were you doing when the explosion occurred? What was your reaction?

III. Main Discussion: Casualties, Damage (25 minutes)

Are you aware of any casualties among the local population/military personnel?

Did you, your family, friends, or neighbours suffer physical trauma as a result of the explosion?

Was your property (house, barn etc.) affected? Were your household animals affected? Other property?

Was farmland/pastureland owned by local residents contaminated as a result of the explosion? If so, for how long?

Who has been most affected (by demographic profile and socio-economic status/profession)? How?

Could children still go to school/nursery after the explosion?

What other impacts and costs did you face as a result of the explosion?

IV. Main Discussion: Government Response Measures, Responsibility, Consequences (25 minutes)

Were local officials available after the explosion?

What response measures did the authorities take? Were those measures sufficient?

Were roads/railways/bridges etc. closed? If so, for how long? How did that affect your mobility? Were you able to go to work/access your agricultural land that was not contaminated during that time?

(If applicable) Was medical assistance made available rapidly for the injured?

(If applicable) Were you and your family among the residents who were evacuated?

Were you evacuated after the explosion or do you know of someone who was evacuated? How was the evacuation organized? Transportation etc.?

(If applicable) When were you allowed to return home?

Who, if anyone, was found responsible for the explosion? In your opinion, who should be held responsible?

What was the effect of the explosion on your everyday life?

Did the explosion change the quality of your life in terms of security?

Have casualties been reported long after the explosion due to scattered unexploded ordnance?

V. Main Discussion: Government Assistance, Preventive Measures (10 minutes)

Did you receive any assistance/compensation from the authorities?

If so, for what? Compensation for lost life? Compensation for injuries/medical costs? Compensation for damaged or destroyed property/lost household animals/contaminated farmland and pastureland? Are security measures in place?

What help does the local population (victims of ammunition depot explosions) still need?

After the explosion, did the authorities introduce an emergency evacuation plan to respond to any further explosions? Do local residents know what to do/how to behave in the event of a new explosion? Have emergency-response training exercises taken place?

Have affected areas been cleared of debris and unexploded ordnance? By whom? How long did it take? Are there still areas that need to be cleaned up? Are they marked with signs to prevent people from approaching?

VI. Conclusion (5 minutes**)**

Closing remarks

Thank participants and close the discussion.

Annexe 3 Ammunition Depot Explosions in Serbia: Focus Group Discussion, Brief Moderator's Guide

Dates: 30 June 2011

Target audience: Population of the communities affected by the ammunition depot explosions, if possible including individuals or family members that worked at the depot.

Approximate duration of focus groups: 90 minutes

I. Introduction (5 minutes)

Welcome to participants and self-introduction.

Explain the general purpose of the study and focus group discussion.

Explain the presence and purpose of the recording equipment, and address the issue of confidentiality.

Outline general discussion guidelines and rules such as the importance of everyone speaking up and doing so one at a time.

Ask participants to introduce themselves (first name, age, occupation, number of years of residency in this community).

II. Main Discussion: Awareness, Reaction (20 minutes)

What do you know about the ammunition depot explosion that occurred in Paraćin/ Užice? Causes, other details?

Before the explosion, did you know that there was an ammunition depot nearby?

What were you doing when the explosion occurred? What was your reaction?

III. Main Discussion: Casualties, Damage (25 minutes)

Are you aware of any casualties among the local population/military personnel?

Did you, your family, friends, or neighbours suffer physical trauma as a result of the explosion?

Was your property (house, barn etc.) affected? Were your household animals affected? Other property?

Was farmland/ pastureland owned by local residents contaminated as the result of the explosion? If so, for how long?

Who has been most affected (by demographic profile and socio-economic status/ profession)? How?

Could children still go to school/nursery after the explosion?

What other impacts and costs did you face as a result of the explosion?

IV. Main Discussion: Government Response Measures, Responsibility, Consequences (25 minutes)

Were local officials available after the explosion?

What response measures did the authorities take? Were those measures sufficient?

Were roads/ railways/bridges etc. closed? If so, for how long? How did that affect your mobility? Were you able to go to work/access your agricultural land that was not contaminated during that time?

(If applicable) Was medical assistance made available rapidly for the injured?

(If applicable) Were you and you family among the residents who were evacuated?

Were you evacuated after the explosion or do you know of someone who was evacuated? How was the evacuation organized? Transportation etc.?

(If applicable) When were you allowed to return home?

Who, if anyone, was found responsible for the explosion? In your opinion, who should be held responsible?

What was the effect of the explosion on your everyday life?

Did the explosion change the quality of your life in terms of security?

Have casualties been reported long after the explosion due to scattered unexploded ordnance?

V. Main Discussion: Government Assistance, Preventive Measures (10 minutes**)**

Did you receive any assistance/compensation from the authorities?

If so, for what? Compensation for lost life? Compensation for injuries/medical costs? Compensation for damaged or destroyed property/lost household animals/contaminated farmland/pastureland? Are security measures in place?

What help does the local population (victims of ammunition depot explosions) still need?

After the explosion, did the authorities introduce an emergency/evacuation plan to respond to any further explosions? Do local residents know what to do/how to behave in the event of a new explosion? Have emergency-response training exercises taken place?

Have areas contaminated by debris and unexploded ordnance been cleared? By whom? How long did this take? Are there still areas that need to be cleaned up? Are they marked with signs to prevent people from approaching?

VI. Conclusion (5 minutes)

Closing remarks

Thank participants and close the discussion.

Endnotes

1 These include: Albania, BiH, Bulgaria, Croatia, Macedonia, Montenegro, Romania, Serbia, and Slovenia.

2 An **accident** is defined as: 'an undesired event, which results in harm' (UNODA, 2011b, para. 3.5, p.2). 'Harm' is defined as: 'physical injury or damage to the health of people, or damage to property or the environment' (UNODA, 2011b, para. 3.120, p. 14).

3 An **explosion** is defined as: 'a sudden release of energy producing a blast effect with the possible projection of fragments. Note 1: The term explosion encompasses fast combustion, deflagration and detonation' (UNODA, 2011b, para. 3.95, p. 11).

4 **Abandoned Explosive Ordnance** (AXO) is defined as: 'explosive ordnance that has not been used during an armed conflict, that has been left behind or dumped by a party to an armed conflict, and which is no longer under control of the party that left it behind or dumped it. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use' (UNODA, 2011b, para. 3.1, p. 1).

5 **Damaged munitions** refer to the physical or chemical deterioration of ammunition and explosives.

6 Munitions are considered **improperly stored** when storage generally does not follow accepted multilateral norms or guidelines, or existing national legislation and controls.

7 **Munitions** are defined here—and in common usage—as: weapons, ammunition, explosives, and components. A number of armed forces and ammunition specialists, however, use the term 'munitions' to refer solely to complete rounds of ammunition (Bevan and Wilkinson, 2008, p. xxvi). **Ammunition:** A complete device (for example, missile, shell, mine, demolition store) charged with explosives; propellants; pyrotechnics; initiating composition; or nuclear, biological, or chemical material for use in connection with offence, or defence, or training, or non-operational purposes, including those parts of weapons systems containing explosives (Bevan and Wilkinson, 2008, p. xix).

8 An **Explosives storage area** (ESA) is defined as: 'an area used for the storage of explosives and within which authorised ammunition or missile preparation, inspection and rectification operations may also be carried out' (UNODA, 2011b, para. 3.108, p. 12).

9 An **ammunition process [site]** is defined as: 'a building or area that contains or is intended to contain one or more of the following activities: maintenance, preparation, inspection, breakdown, renovation, test or repair of ammunition and explosives' (UNODA, 2011b, para. 3.12, p. 2).

10 As noted, better knowledge of UEMS incidents after 2001 might be attributable to the increased availability of relevant information. This does not mean that fewer explosions occurred prior to 2001, however.

11 A cost–benefit analysis model for use in the storage of small arms and light weapons and their ammunition was developed by the University of Bradford, the United Nations Institute for Disarmament Research (UNIDIR), and the South Eastern and Eastern Europe Clearinghouse for the Control of Small Arms and Light Weapons (SEESAC). The database for this

model allows states to calculate the actual annual costs involved in the storage of ammunition and weapons, and to compare them to benefits from potential surplus sales (Turner, 2006).

12 When calculating destruction costs, it should be noted that the costs and logistics involved in the destruction of weapons and ammunition in a demilitarization facility are not the same as those involved in the disposal of debris from an unplanned explosion or in the clearance of areas contaminated by warfare.

13 This is safe and feasible for certain types of depot (those exclusively used for the storage of weapons or small-calibre ammunition) on condition that the area between the storage and demilitarization sites is appropriately secured. Without that assurance, any demilitarization process undertaken at a weapons and munitions depot would be considered a dangerous risk that could trigger an incident. Author interview with Tom Van Beneden, Gabrovo, 13 April 2011; written correspondence with Adrian Wilkinson, 1 March 2012.

14 Author interview with Marin Ivanov, director of the Terem Kostenets weapons/ammunition production and disposal facility, Bulgaria, 12 April 2011.

15 For more information about South-east European demilitarization capacities, see Gobinet, 2012.

16 Author correspondence with John E. Stevens, PM/WRA, 2 May 2012.

17 It was not possible to confirm whether staff wages in Croatia were higher than in Serbia. Experts believe, however, that the 'real' costs per missile, including destruction, staff salaries, and transportation costs, should not exceed USD 100.

18 This included both Serbia and Montenegro, before they split into two separate countries after a referendum in 2006.

19 The armed forces have to authorize the re-use of this ammunition for themselves or to allow the demilitarization company to use this material for its own needs (meaning selling it to other customers).

In addition, not all small arms ammunition is authorized for civilian re-use (for example, for armour piercing). Author correspondence with Tom Van Beneden, NSPA, 28 March 2012.

20 Author correspondence with Adrian Wilkinson, 1 March 2012.

21 Author interview with Tom Van Beneden and Fermin Olivan, Gabrovo, Bulgaria, 14 April 2011.

22 An item that frequently remains forgotten in the process of surplus destruction is dunnage—the robust boxes and trunks, often made from wood, used to package weapons and ammunition. After their content is destroyed, they serve as burning material in developing countries, to reduce building heating costs. Uncontrolled incineration is not recommended as these items are often chemically treated and should be disposed of safely. Potentially, the boxes could serve to store and protect other items, for example in the agricultural sector; however, they are often marked with codes and lot numbers, which would need to be removed.

23 The price data for yellow brass in BiH was obtained through an interview conducted by the author.

24 Author interview with ammunition technical officers, AAF, May 2011.

25 Normally, steel is an alloy of iron and carbon. Iron–carbon alloys are known as 'steel' if their carbon content is less than two per cent, whereas they are considered to be pig iron if their carbon content exceeds two per cent. In this study, steel and iron are considered the same, as there may be a difference in the application of the term steel among countries.

26 Explosive Pentrit and Hal-20 are not included in the calculation, as no market prices are available for the region and the amounts are less significant than for other scrap material.

27 Author interviews with various stakeholders, spring 2012.

28 An SAF expert believes that about 20–30 per cent of the explosives will not detonate (interview with Nicola Bobić, Sarajevo, November 2010). Others estimate the non-detonation rate to be 30–40 per cent (written correspondence with Adrian Wilkinson, 1 March 2012).

29 For a more detailed description of the hazards that might exist after an unplanned explosion at munitions sites see SEESAC (2006, pp. 2–3), and UNODA (2011a, p. 3).

30 Written correspondence with Adrian Wilkinson, 1 March 2012.

31 The environmental impacts of contaminated ammunition at storage sites have started to gain more attention. Experts and armed forces want to understand better the toxic behaviour of ammunition and its components in the environment and in environmental receptors within water and soil (Temple and Hooper, 2011). NATO, for example, organized a symposium on munitions and propellant disposal and their impact on the environment. Some countries have also established assessments of the impact of their OB/OD activities at demilitarization sites in order to determine potential or actual soil contamination with heavy metals such as mercury, copper, zinc, and nickel, as well as possible groundwater pollution (Croatia, 2003).

32 This case study does not follow the same methodology as the previous two. No focus group discussions and interviews were held with the local population affected by the blast. The information and data provided in the following sections was collated from open sources, official reports, and interviews held with Albanian stakeholders during various meetings and workshops.

33 Author correspondence with Lt. Colonel Nikolay Nikolov, 3 August 2010.

34 The Small Arms Survey commissioned the Sofia-based Razum Institute to conduct focus group discussions and in-depth interviews with the population affected by these events. In order to understand impacts and government responses better, two focus group discussions were conducted in Chelopechene on 18 June 2011 and 18 in-depth interviews were held in Gorni Lom on 6 July 2011. Participants in the focus group discussions and interviewees were chosen according to criteria such as age, gender, and economic activity. All were living in communities affected by explosions at the ammunition sites. The discussions and interviews were based on guidelines for focus groups developed by the Small Arms Survey (see Annexe 2).

35 Author interviews with Bulgarian MoD and General Staff officials, Sofia, 11–15 April 2011.

36 Author correspondence with Bulgarian MoD and General Staff officials, Sofia, 12 April 2011.

37 Author correspondence with Bulgarian MoD and General Staff officials, Sofia, 12, 14 April 2011.

38 Interviewees who witnessed the explosion say it occurred at 18:30 on 3 February 2010.

39 Authorities claim the safety distance of the building was respected, but because the force of the blast was amplified by the detonation of 10 tonnes of ammonite (nine tonnes over the authorized quantity at a single storage site), it encompassed the APM storage area. Author interview with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

40 *Sofia News Agency* (SNA) stated that three men were injured in the ammunition factory explosion (SNA, 2010).

41 Author interview with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

42 Author interview with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

43 The tests were undertaken by an agency called 'Environment' under the auspices of the Ministry of the Environment and Water. Author correspondence with Lt. Colonel Nikolay Nikolov, 3 August 2010.

44 Author interview with Bulgarian MoD and General Staff officials, Sofia, 12 April 2011.

45 The head of the facility, a former professional soldier, reportedly evacuated all personnel from the area and issued a general warning. Author correspondence with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

46 Author interview with Bulgarian MoD and General Staff officials, Sofia, 12 April 2011.

47 Author interviews with US Embassy officials, Sofia, 11 and 15 April 2011, and with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

48 Another report says that 110,000 pieces of ordnance were found and removed (Kostadinov, 2009).

49 Author interview with Bulgarian MoD and General Staff officials, Sofia, 12 and 15 April 2011.

50 Author correspondence with Lt. Colonel Milanov of the Joint Operations Command, Bulgaria.

51 Lt. Colonel Nikolay Nikolov, Ljubljana, 2011.

52 Figures provided during the fifth RASR workshop in Durrës, Albania, 24 April 2012.

53 Author interview with US Embassy officials, Sofia, 11 and 15 April 2011, and with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

54 Author interview with Bulgarian MoD and General Staff officials, Sofia, 15 April 2011.

55 Author interview with Bulgarian MoD and General Staff officials, Sofia, 12 and 14 April 2011.

56 The Small Arms Survey commissioned the Belgrade Centre for Security Policy (BCSP) to conduct a focus group discussion and a series of in-depth interviews with members of the population affected by the two events. The focus group discussion was conducted in Paraćin on 30 June 2011. Its findings were complemented by their input from the eight interviews held on 30 June and 1 July 2011. Due to the sensitivity of the matter, focus group discussions were limited to Paraćin and the explosion in Užice was analysed during 16 interviews conducted on 11 and 12 July 2011. Focus group participants and interviewees were chosen according to criteria such as age, gender, and economic activity. They either lived in communities where homes and places of work were affected by their proximity to the scene of one of the two incidents or they had friends and relatives who worked at the ammunition site in question. Discussions and interviews were based on guidelines for focus group activities developed by the Small Arms Survey (see Annexe 3).

57 According to the Deputy Defence Minister of Serbia, 70 per cent of Serbia's storage capacity was destroyed by the NATO bombing. As a result, several tonnes of ammunition had to be stored in the open air. The MoD believes that it will succeed in storing all munitions in covered structures by the end of 2012. Author interview, 29 May 2011, Pula, Croatia.

58 This represents about 31 per cent of the total ordnance stored at the site (written correspondence with Petar Mihajlović, director of the Demining Centre of Serbia, 13 March 2012).

59 Work to replace windows was slow and glasscutters apparently inflated prices above those fixed by the government. Some individuals suggested that public funds may have been misused, too.

60 Written correspondence with Petar Mihajlović, director of the Demining Centre of Serbia, 13 March 2012.

61 Newspaper articles cited the head of the Serbian Civil Defence Headquarters as saying that about 450 members of the SAF and the MoD were involved in the operation (B92.net, 2008). Written correspondence with Petar Mihajlović, director of the Demining Centre of Serbia, 13 March 2012; B92.net, 2008; Jovanović, 2011.

62 Written correspondence with Petar Mihajlović, director of the Demining Centre of Serbia, 13 March 2012.

63 Written correspondence with Petar Mihajlović, director of the Demining Centre of Serbia, 13 March 2012.

64 Written correspondence with Petar Mihajlović, director of the Demining Centre of Serbia, 13 March 2012.

65 It is believed that the scholarships payments were made for one year and then ceased, although this could not be confirmed by the local partner.

66 Three families refused to accept this payment, as they deemed the amount too small.

67 The following case study does not follow the same methodology as the previous two. No focus group discussions and interviews were held with the local population affected by the blast. The information and data provided in the following sections are collated from open sources, official reports, and interviews held with Albanian stakeholders in meetings and workshops.

68 Albanian authorities initially estimated there were about 100,000 projectiles in a stockpile of some 3,000 tonnes of ammunition at the site (ITF, 2011). This number had to be adjusted as clean-up operations progressed.

69 The MoI has declared one additional person is missing (UNDAC, 2008, p. 4).

70 Author interview with AAF ammunitions technical officers, the MoD, and the Albanian General Staff, November 2010.

71 Author interview with ammunition technical officers from the AAF, the MoD, and the Albanian General Staff, November 2010.

72 Author interview with ammunition technical officers from the AAF, the MoD, and the Albanian General Staff, November 2010.

73 Author interview with various stakeholders, from November 2010 to August 2011.

74 Depending on the location and the ground, subsurface clearance involved team searches to a depth of 1.5 to 3 m and even up to 7 m, in some cases.

75 Author interview with various stakeholders, from November 2010 to December 2011.

76 Author correspondence with John E. Stevens, US Department of State's PM/WRA, 2 May 2012.

77 Other sources report the government estimated the cost of home repairs at EUR 17 million (USD 22.3 million) (Zenelaga, 2009); USD 18.75 million (ICBL, 2009, p. 134); and EUR 20 million (USD 27.1 million) (*SETimes*, 2009).

78 *The New York Times* reported that workers received USD 1,300 (*The New York Times*, 2008).

79 Author interview with AAF ammunition technical officers, Albanian MoD officials, and General Staff, November 2010.

80 Author correspondence with Hans Risser, UNDP programme specialist, 22 March 2011.

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