NATO Security through Science Series - C:
Environmental Security

Environmental Security and Public Safety

Edited by
Wolfgang Spyra
Michael Katzsch

Springer

This publication is supported by: The NATO Programme for Security through Science

Environmental Security and Public Safety

NATO Security through Science Series

This Series presents the results of scientific meetings supported under the NATO Programme for Security through Science (STS).

Meetings supported by the NATO STS Programme are in security-related priority areas of Defence Against Terrorism or Countering Other Threats to Security. The types of meeting supported are generally "Advanced Study Institutes" and "Advanced Research Workshops". The NATO STS Series collects together the results of these meetings. The meetings are co-organized by scientists from NATO countries and scientists from NATO's "Partner" or "Mediterranean Dialogue" countries. The observations and recommendations made at the meetings, as well as the contents of the volumes in the Series, reflect those of participants and contributors only; they should not necessarily be regarded as reflecting NATO views or policy.

Advanced Study Institutes (ASI) are high-level tutorial courses to convey the latest developments in a subject to an advanced-level audience

Advanced Research Workshops (ARW) are expert meetings where an intense but informal exchange of views at the frontiers of a subject aims at identifying directions for future action

Following a transformation of the programme in 2004 the Series has been re-named and re-organised. Recent volumes on topics not related to security, which result from meetings supported under the programme earlier, may be found in the NATO Science Series.

The Series is published by IOS Press, Amsterdam, and Springer, Dordrecht, in conjunction with the NATO Public Diplomacy Division.

Sub-Series

A. Chemistry and Biology	Springer
B. Physics and Biophysics	Springer
C. Environmental Security	Springer
D. Information and Communication Security	IOS Press
E. Human and Societal Dynamics	IOS Press

http://www.nato.int/science
http://www.springer.com
http://www.iospress.nl

Series C: Environmental Security

Environmental Security and Public Safety

Problems and Needs in Conversion Policy and Research after 15 Years of Conversion in Central and Eastern Europe

edited by

Wolfgang Spyra
Brandenburg University of Technology,
Chair of Chemical Engineering and Hazardous Wastes,
Cottbus, Germany

and

Michael Katzsch
Brandenburg University of Technology,
Chair of Chemical Engineering and Hazardous Wastes,
Cottbus, Germany

Springer

Published in cooperation with NATO Public Diplomacy Division

Proceedings of the NATO Advanced Research Workshop on
Environmental Security and Public Safety - Problems and Needs
in Conversion Policy and Research
after 15 Years of Conversion in Central & Eastern Europe
Cottbus, Germany, 8–12 October 2005

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN-10 1-4020-5643-5 (PB)
ISBN-13 978-1-4020-5643-7 (PB)
ISBN-10 1-4020-5642-7 (HB)
ISBN-13 978-1-4020-5642-0 (HB)
ISBN-10 1-4020-5644-3 (e-book)
ISBN-13 978-1-4020-5644-4 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

www.springer.com

Printed on acid-free paper

CONTENTS

PREFACE

The demilitarisation and conversion of military properties worldwide has been a topic of growing importance since the end of the cold war. The political changes taking place in the world have lead to a shift in the priorities of governments and thereby to an extreme reallocation of financial resources. Defence ministries, and therefore the armed forces themselves, have been forced to deal with these budget reductions.

The decision to reallocate financial resources did not come without risk. An important aspect of these changes was the redefinition of the armed forces. There no longer existed an opponent against whom one needed to be armed and who required that one be constantly engaged in the improvement and development of one's capabilities. The implications of this include the diminishment of military potential, the reduction of troop numbers, the closure of bases and the modification and storage of weapons and equipment such that they do not find their way into civilian hands. These changes continue to the present day.

One of the most important challenges posed by these changes, namely social instability, appears to have been successfully met. When individuals trained as soldiers are released to an employment market incapable of absorbing this immense potential, social instability, dissatisfaction and stress will inevitably arise. The period following the significant changes has shown that a number of very different paths exist leading to generally stable political and social situations.

The new political responsibilities also include the task of containing and controlling military potential. This applies to national governments as well as the international community as a whole.

With the dismantling of military potential and the dissolution of military contingents, landscapes must also be released from military use.

For the first time, and in some cases following centuries of military usage, it was possible for civilian experts to examine and study these areas for hazards, dangers to health and safety, and risks to environmental goods such as soil, water and the atmosphere.

The experts identified unexploded and discarded munitions of many different types on troop training areas, fuels floating on groundwater below airfields, radioactive contamination of soils, among other serious contamination issues.

A transition to a new use follows the handover of areas formerly used by military forces. With almost no exception, the conversion of an area results in the opening of access to the general public. When under military control, these areas were accessed only by experts, namely trained soldiers responsible for their actions. It can be assumed that following conversion, untrained civilians will enter and make use of the property and these individuals will be unaware of the risks associated with their activities. Acute injuries—including deaths—and long-term damages to the ecosystem can be expected.

For this reason, the responsibility to mitigate the risks associated with these hazards borne by the general public and to ensure that these risks are equal to what is considered to be normal in the context of everyday life.

Political responsibility does not end with the closure of military bases, but rather requires the remediation of hazards and the securing of the properties. These measures require financial resources generally allocated to other commitments of the state towards the society. As a result, private and commercial interests become of greater importance and their valuation of new use for the landscape become critical. With the incorporation of commercial components, those aspects of remediation with significant influence on the value of a property, such as acute hazards, will become more important.

The problems encountered during conversion activities are as diverse as the uses that took place on these lands. Some hazards are like hot spots, limited to a single location, while others occupy almost unimaginable dimensions, such as the contamination of the upper layer of ground water aquifers or the contamination of soils, whereby the number and types of contaminants make any cultivation impossible and pose a threat to human health.

- This workshop had the goal of concerning itself with questions of conversion, which have commercial and economic factors as motivations for action. This workshop provided examples of conversion activities, successful implementations of re-use strategies, and made clear that private industry, NGOs and government bodies are capable of not only discussing conversion, but also transforming this discussion into action. To engage in discussions of the challenges of conversion within a dynamic set of conditions, to question one's own assumptions and standpoint, and to take on new challenges were the components of the workshop.
- The programme of the workshop showed that both co-directors developed an agenda that included very important and currently heavily discussed topics and that documented the expertise of the participants.

We would like to extend our thanks to NATO who, in the framework of the program Science for Peace, generously supported this workshop. This workshop brought together scholars, scientists and military personal from 14 countries with the goal of examining the practical and technological options available to mitigate the hazards associated with former military facilities.

The workshop belongs to one of the few forums in which currently running remediation programs could be showcased.

The spectrum of countries from which the participants came represented very differing situations and challenges.

There were countries in which

- the first steps in the conversion of military facilities was in initial stages
- conversion projects were in the planning phases
- conversion projects were running
- conversion projects had been successfully executed.

On the path to a more peaceful geo-political situation, the following texts serve as hopeful examples of what trans-national idea sharing and co-operation can achieve. For emerging nations, it is precisely such co-operation that ensures continued academic and technological development.

LIST OF CONTRIBUTORS

Ahlman, Juhani
Plancenter Ltd.
Majasuontie 773 A
16200 Artjärvi
Finland

Babievsky, Kirill
Russian Academy of Science
Institute of Organoelement
Compounds RAS Vavilov St.
Moscow
Russia

Döring, Alexander
Consulting Engineers Döring
Prenzlauer Promenade 190
13189 Berlin
Germany

Fricke, Günther
Dresdner Sprengschule GmbH
Heidenschanze 6–8
01189 Dresden
Germany

Galitchi, Sergiu
Investment, Innovation and Modern
Technologies Center Moldova
Puskin 22, nr. 239 A
MD2001 Chisinau
Moldova

Gramatikov, Plamen S.
Southwestern University "Neofit
Rilsky", Department of Physics
66 Ivan Mihailov Blvd.
2700 Blagoevgrad
Bulgaria

Jarmalaviciute, Neringa
Senior Executive Kaunas City
Municipality Administration
Laisves av. 96
44251 Kaunas
Lithuania

Katzsch, Michael
Brandenburg University of
Technology
Chair of Chemical Engineering and
Hazardous Wastes
Postfach 10 13 44
D-03013 Cottbus
Germany

King, Chris
Department of Geography and
Environmental Engineering
United States Military Academy
West Point N.Y. 10996
USA

Lazarescu, Mihaela
National Research and Development
Institute for Env. Protection
Spl. Indepentei 294. Sect 6
Bucharest 78
Romania

Neffe, Slawomir
Military Academy
Kaliskiego Street 2
00-908 Warsaw
Poland

Rekker, Andres
HQ Estonian Defence Forces
Narva Road 8
EE0001 Tallinn
Estonia

Silhankova, Vladimira
University of Pardubice
Studenska 95
53210 Pardubice
Czech Republic

Spyra, Wolfgang
Brandenburg University of Technology
Chair of Chemical Engineering and Hazardous Wastes
Postfach 10 13 44
D-03013 Cottbus
Germany

Tynybekov, Azamat
Kyrghyz Russia Slavonik University and NGO
Inter Science Center
Kievskaj Str. 44
Bishkek 720000
Kyrghyz Republic

Werners, Ingo
Foundation Forest for Saxony
Floßplatz 13
D-04107 Leipzig
Germany

Winkelmann, Kay
Brandenburg University of Technology
Chair of Chemical Engineering and Hazardous Wastes
Postfach 10 13 44
D-03013 Cottbus
Germany

Zlobenko, Borys
Ukraine Ministry of Emergencies and
Affairs of Population Protection
Palladin Ave., 34-A
03142 Kiev
Ukraine

POTENTIAL HAZARDS CAUSED BY FORMER MILITARY TRAINING AREAS IN THE DAYS OF TERRORISM

Dipl. Eng. Alexander Döring
General Manager of Ingenierbüro Döring GmbH Engineering Consultants, Berlin and member of the Board of the Authority Center for Conversion and Evacuation of Weapon e.V., (KOMZET e.V.)

Abstract. Since the reunification of Germany and the withdrawal of the last Russian troops, Brandenburg has developed into a centre for the conversion industry. The reasons for this are primarily historical. For more than a century, large areas (for example more than 2300 km^2 of military training areas) of the land have been used for military purposes. Dangerous military waste continues to hinder economic development and endanger the public security in some areas.

Most of these areas are easily accessible to the public. Both conventional and chemical ammunition can be found in these terrains.

This paper will introduce the Armed Forces Training-Centre in the Döberitzer Heide area as an example of the problems and risks of the contamination with unexploded ordinance (UXO).

1. Introduction

The *Financial Times Germany* reported on September 15, 2003 on a new quality of Nazi terror in Germany. The German police arrested nine people in Munich. Homemade explosion-bodies were found together with 14 kg of explosives in their apartments.

Also in September of 2003, the daily *Berliner Morgenpost* reported of a group of individuals who collected TNT in eastern Brandenburg.

A search of the German Internet revealed:

- 688 sites with “home made bombs” somewhere in their title
- 118 sites in connection with “ammunition-collection”
- approximately 1200 sites searching for “we need TNT”
- 98,000 sites with the title “we need old grenades”
- 16,800 with the input “we need grenades”.

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 1–8.

TABLE I. Explosive masses of typical munitions found in Brandenburg.

Munition	Explosive mass
82 mm mortar grenade	0.4 kg
100 mm Russian grenade	1.73 kg
152 mm Russian grenade	4.4 kg
10.5 cm German grenade	1.7 kg
Russian anti-tank mine TM-62	7.2 kg

In 2005, the well known German TV program “monito” discussed a German terror-group which collected old ammunition to recover the explosives.

Table I lists the explosive masses of a number of typical ammunitions found in this region.

Large quantities of these munitions may be found in our forests today, more than sixty years after the end of World War II. The risk to those collecting the ammunition is nearly zero.

2. Initial Position

As an example of professional risk-management, the project for the removal of ammunition from an armed forces training grounds near Berlin, StOÜbPl Berlin, will be introduced.

The training area, located in the south of the former training area Döberitzer Heide, has been used as a military ground since 1713. Between 1914 and 1918 it served as an army testing ground for looted ammunition and was used by the Emperor Wilhelm Institute for chemical weapons testing.

After the end of World War I, chemical ammunition was dismantled on the grounds. In the 1930s, the grounds were utilised for tank training. After 1945, the Red Army used the grounds very intensively. In the area, the destruction of chemicals was one of the many activities undertaken. The systematic examination of environmental contaminations began in 1996. During the period 1999–2003, the systematic removal of chemical weapons took place. Today, the grounds have been restored and are free from ammunition in accordance with Bundeswehr rules and regulations.

Because of its proximity to the provincial capital Potsdam and the metropolis Berlin, the Döberitzer Heide represents a popular recreation area. The terrain may be accessed by two federal roads and numerous footpaths. Beyond the potentially serious hazard to residents, armed forces members

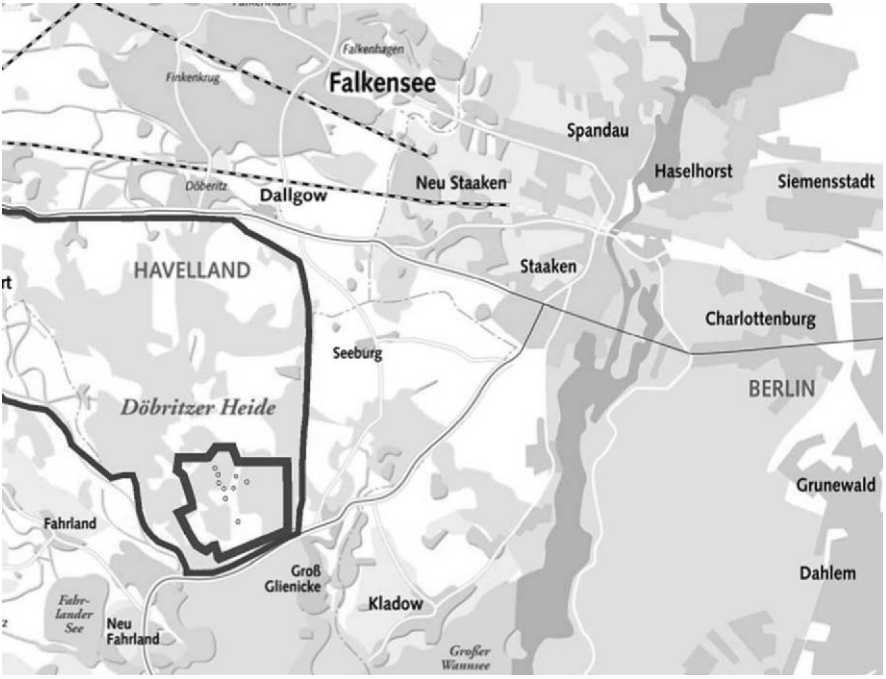


Figure 1. Location of the Döberitzer Heide and the StOÜbPl Berlin.

and visitors, the relatively freely available ammunition constitutes a high risk because of its easy access by criminal and terrorist elements.

In connection with the planned civilian utilisation of the Döberitzer Heide and for the protection of those who would make use of the grounds, the following tasks had to be carried out:

- protection of terrain against illegal access to ammunition and weapons
- planning and realisation of an extensive evacuation of the surrounding resident areas
- preparation of procedures in the case of an accident.

In the area of the Döberitzer Heide, several hundred tons of UXO were recovered in the last few years, including chemical weapons. Approximately 75% of the identified ammunition was found within 40 cm of the surface, easily obtainable without any serious technical efforts.

The authorities in charge do not comprehend the high UXO debit, entry as a security problem, but rather primarily as a matter of responsibility and funding.

TABLE II. Chrachteristsics of the management issue at StOÜbPl Berlin.

Area of the Döberitzer Heide	*ca.* 5000 ha
Area StOÜbPl Berlin	*ca.* 550 ha
Munitions contaminated surface-size	*ca.* 240 ha
Distance to Berlin Zoologischer Garten	25 km
Distance to Potsdam	12 km
Distance to the nearest village	*ca.* 400 m
More definitely security radius	*ca.* 400 m
Number of participating communities	9
Number of participating districts	2
Number of participating authorities	22

3. Results of the Security Analysis

In the area of the Döberitzer Heide, 46,677 kg of German ammunition and 4640 kg ammunition from the Allied Forces were recovered from a surface of 637,400 m^2.

The quantity, variety and dangerousness of the UXO must be mentioned. Approximately 25–40% of the ammunition was detected at depths close to the surface (0–50 cm). Even incendiary bombs were found near to the surface. These begin to burn immediately upon first contact with the atmosphere. Those areas in the Döberitzer Heide which have not been cleaned remain threatened by surface-fires caused by conventional ammunition or by the explosions of ammunition filled with chemical combat agents.

Standard fire-fighting procedures in this terrain include all measures which need to be taken against the release of chemical ammunition, as these may be hazardous to the fire fighters themselves and to residents of the surroundings.

The danger zone for chemical combat materials was determined on the basis of the nomogram in fig. 2 on page 5. The calculated security radii are depicted in fig. 3 on page 6.

Based on the pre-examination results and previous findings, it was necessary to define intensified project safety measures. The appropriate authorities developed a project structure as is depicted in fig. 4 on page 7.

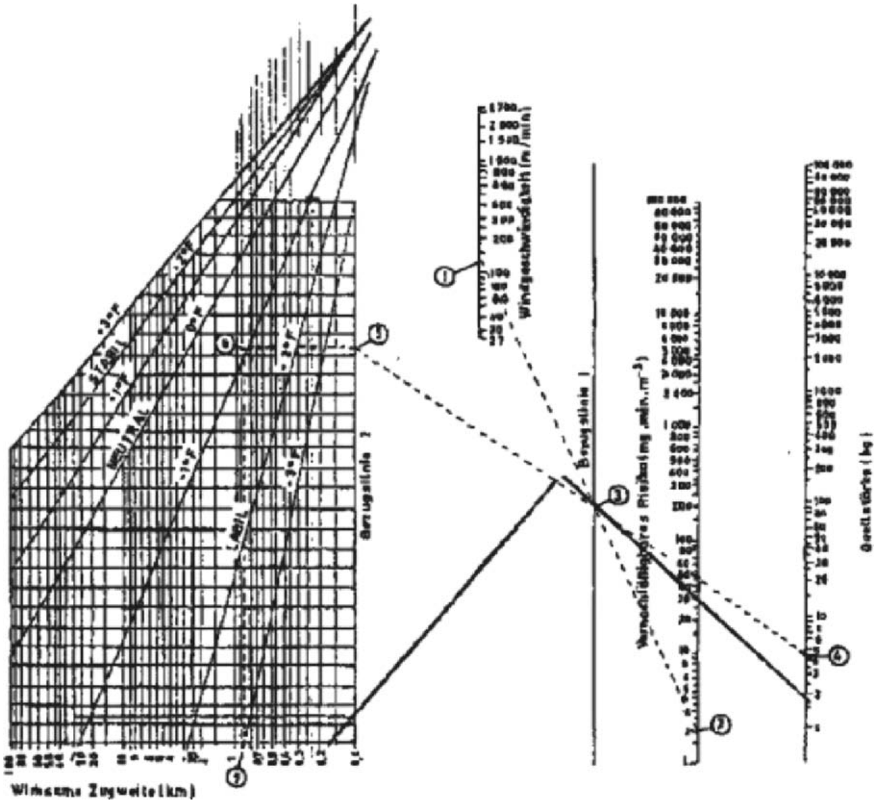


Figure 2. Nomogram depicting safe distances from explosive hazards.

4. Technical Objects

Technical objects are shown in fig. 5 on page 7.

5. System of Safety Organisation

The organisational structure for security is shown in fig. 6 on page 8.

6. Results

In total, the surfaces of 11 areas were cleaned. 86,922 pieces of ammunition were removed, 252,258 kg of ammunition fragments and ammunition scrap were found, 18,898 m^3 of garbage was picked up additionally and disposed of. During this operation 196 chemical subsection bodies were found.

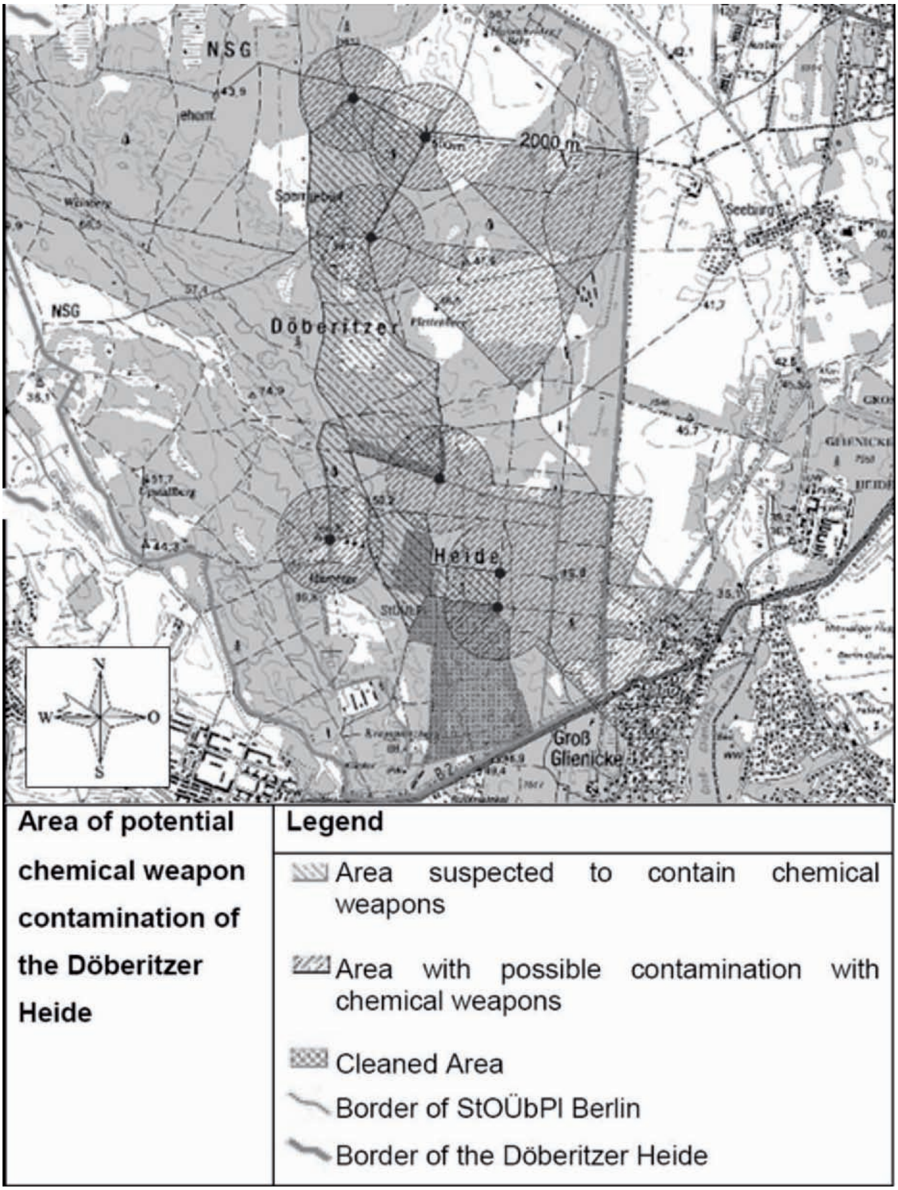


Figure 3. Map of the Döberitzer Heide.

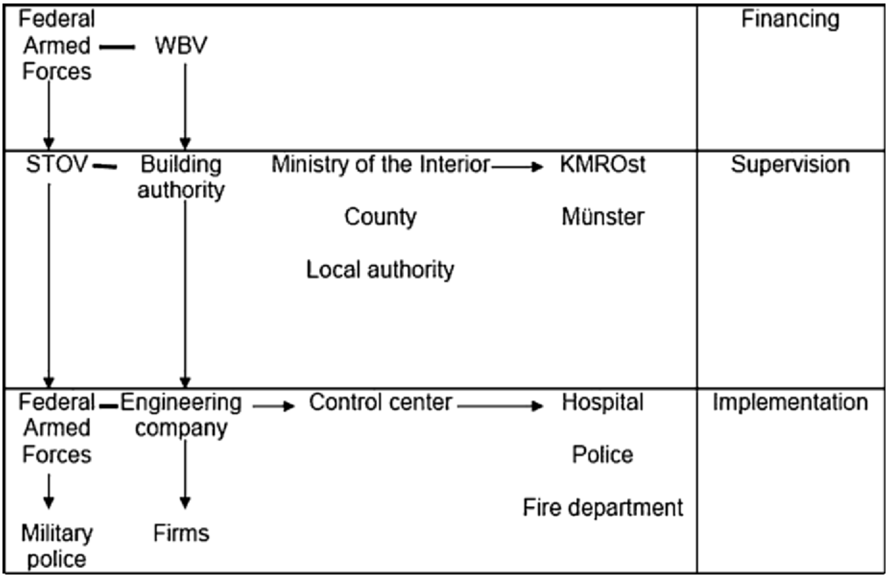


Figure 4. Project structure.

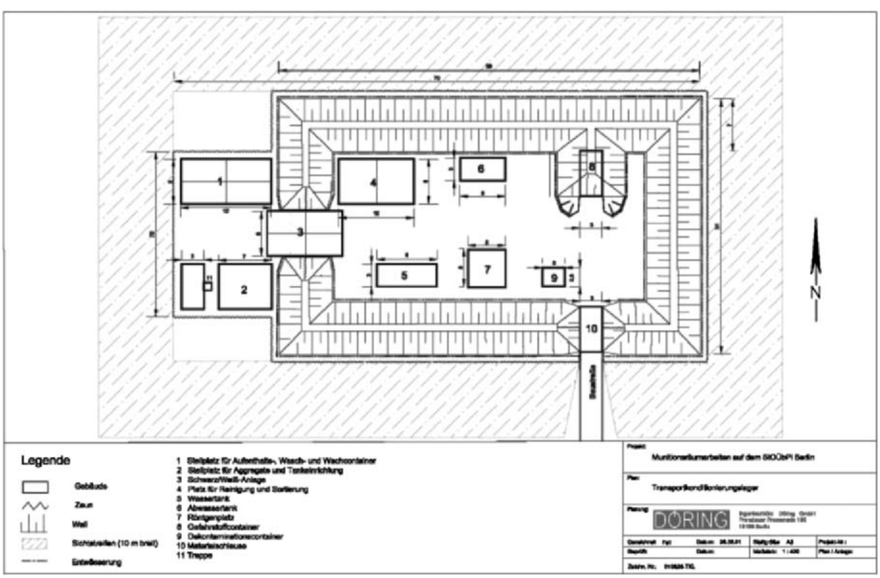


Figure 5. Technical objects.

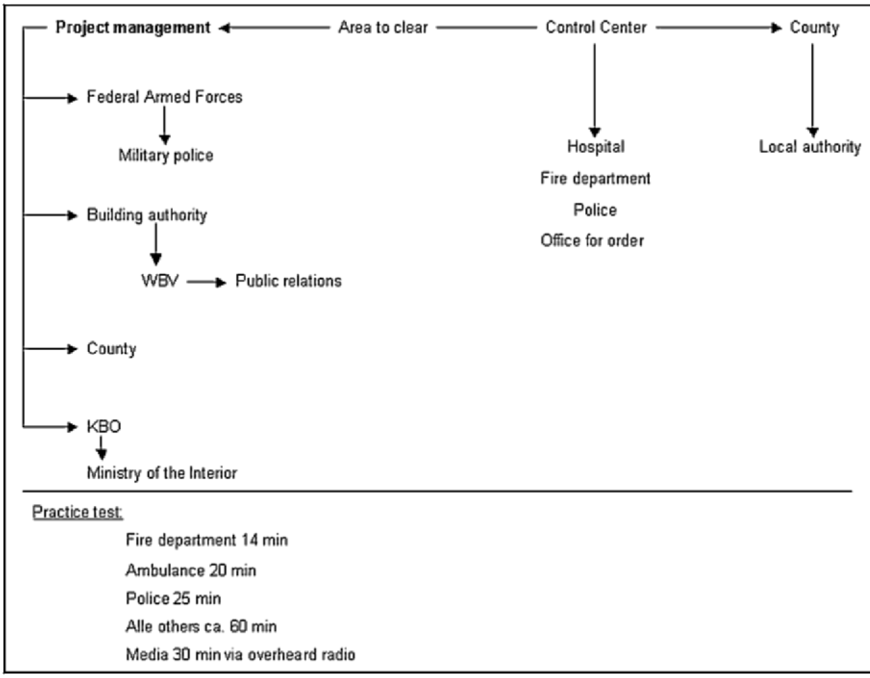


Figure 6. Organisational structure for security.

7. Conclusion

The complete decontamination of an area this size, so strongly contaminated with UXO, is technically, organisationally and financially impractical.

The only effective protection against the illegal removal of UXO by criminal or terrorist elements is the cleansing of a terrain. UXO may be collected and disposed of with controllable risks. Its destruction must be prepared meticulously and must to be carried out in close cooperation with civilian emergency authorities.

MILITARY SECTOR AND ENVIRONMENTAL PROTECTION IN ESTONIA: CHALLENGES FROM 1991 TO TODAY

Andres Rekker
1st Lieutenant, Senior NBC-Defence Staff officer
Operation branch J 3/7 (operations and training)
Joint Headquarter of the Estonian Defence Forces

1. Interesting Facts About Estonia

Estonia is located in Northern Europe, on the eastern coast of the Baltic Sea, thus lying in the northern part of the temperate zone and in the transition zone between maritime and continental climates. The capital and the largest town of Estonia is Tallinn.

With an area of 45,227 km^2, Estonia is larger than Denmark, the Netherlands, and Switzerland. Estonia stretches 350 km from east to west and 240 km from north to south. Conversely, Estonia's population ranks amongst the smallest in the world: as of 2005, an estimated 1.4 million people live in Estonia—a density of only thirty people per square kilometre.

Estonia's neighbours are Russia to the east, Latvia to the south, Sweden to the west and Finland to the north. Its land border is 645 km long, with half of it running along rivers and lakes. Estonia's mainland neighbours are Russia and Latvia. Estonia is a seafront country: the length of coastline (3800 km) is about six times longer than the terrestrial borderline.

Sea islands form one tenth and lakes about one twentieth of Estonia's territory. There are more than 1500 islands, 1000 lakes (five percent of Estonian territory), 7000 rivers and streams in Estonia; bogs and wooded swamplands of different types cover over one fifth of the country.

According to the constitution of the Republic of Estonia, supreme power belongs to the people, who exercise it via the legislative body, the *Riigikogu*. All important state-related questions pass through the Riigikogu. In addition to approving legislation, the Riigikogu appoints high officials, including the Chief of the Defence Forces. The Riigikogu also ratifies significant foreign agreements that impose military and proprietary obligations, brings about

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 9–26.

changes in law, approves the budget presented by the government as law and monitors the executive power, and so on.

For a small country like Estonia, political-geographic location is important in terms of, above all, what the great powers surrounding it are. For Estonia, such great powers have been mainly Germany and Russia, but also Sweden during its period of ascendancy in Europe. The first foreign military base was established in 1030 when the Kievan prince, Jaroslav the Wise, raided Tarbatu and built his own fort in this place, which was known by the name of *Jurjev*. Estonians retook the castle in 1061.

2. Overview: Estonian Defence Forces and Defence Policy

As Estonia is geographically situated on the border between different civilisations, it has been subjected to wars throughout the centuries. Having realised that in the current geopolitical situation, a small country can only maintain its democracy and independence by way of integration into the Western European security and economic space, Estonia's objectives have been to join NATO and the European Union. As Estonia wishes to be not only a consumer of security, but also a producer, a defence system has been developed in Estonia since it regained its independence in 1991.

The concept of Estonian national defence is set out in those legal documents that prescribe the building of Estonia's national defence system as a system of total defence, where military action taken is based on the principles of territorial defence.

The main terms and principles of national defence are set out in the defence concept. Estonia's "national defence is an inseparable component of guaranteeing national security, anticipating the establishment and maintenance, in peacetime, of a regulated system of forces and resources necessary for armed defence of the state, and its application in the event of an aggression against the Republic of Estonia" (Guidelines of the National Defence Policy of Estonia).

Besides guaranteeing military security, Estonia's defence structure must be prepared to assist the population in the event of a natural disaster, epidemic or major technological accident, and to support civil institutions and organisations in the elimination of the consequences of a catastrophe.

The Supreme Consul of the Estonian Republic decided to establish the Estonian Defence Forces on September 3, 1991, re-establishing Estonian Defence Forces for the first time after the Soviet occupation. At the same time, the armed forces of the former Soviet Union (Russian Federation) remained in the territory of the Republic of Estonia. The Ministry of Defence was re-established in April of 1992.

The armed forces consist of the Defence Forces and the National Defence League. Further, there exist militarily organised agencies and units under the Ministry of Internal Affairs which are transferred to the subordination of the Commander-in-Chief of the Armed Forces during wartime, as per the War-Time National Defence Act.

The Estonian Defence Forces consist of a regular component (divided into three services: Army, Air Force and Navy), military educational institutions and a voluntary military organisation: the Defence League. The average size of the Estonian Regular Defence Forces in peacetime is roughly 3800 (3300 Army, 300 Navy, and 200 Air Force) persons, of whom about 1500 are conscripts. The voluntary Defence League has also about 8700 members, with affiliated organisations a further 17,400. The planned size of the operational (wartime) structure is 16,000 personnel.

The Army is the main arm of the Defence Forces. The Army development priorities include the capability to participate in missions outside the national territory and the capability to perform operations to protect the territory of Estonia, also in co-operation with allies. During peacetime, base military units in the Army are battalions and battalion-sized units (mostly training centres for conscripts). During wartime they will be formed into tactical brigades.

The Air Force is responsible for all air operations in Estonia. The main goals were to gain the control over Estonian airspace and to provide air defence for strategic objects. The Air force consists of three units today: the Air Force Staff, the Air Force Base, and the Air Surveillance Wing.

The Navy is responsible for protecting the territorial waters of the Republic of Estonia. In the case of a crisis, the Navy must be ready to defend sea approaches, harbour areas, marine lines of communication and to co-operate with coalition units. The Navy includes units of patrol ships, and units of minesweepers and coast guard necessary to ensure the security of maritime communications lines and to establish and clear mine barriers, as well as a naval base.

According to legislation, the Defence League is a voluntary military national defence organisation and part of the Defence Forces. The Defence League possesses arms and engages in military exercises, fulfilling the tasks given to it by the law. The organisation is divided into fifteen regional units whose areas of responsibility coincide mostly with the borders of Estonian counties. The main goal of the Defence League is, on the basis of the citizens' free will and initiative, to enhance the readiness of the nation to defend the independence of Estonia and its constitutional order.

3. The Ministry of Defence and Defence Forces' Environmental Aspects

Estonian Defence Forces are an integral part of the society and they have to follow the current legislation. The Peacetime National Defence Act regulates the activities of the Ministry of Defence and Defence Forces in peacetime and proceeding from the latter, the Ministry of Defence and the Defence Forces are obliged to follow legislation which concerns the protection of the environment.

The past fifteen years has seen the level of environmental awareness of the Estonian Defence Forces increase from zero to an appreciable level.

Since 1999, the Defence Forces have officers responsible for environmental protection. In a new Defence Forces regulation from 1999, each unit commander is responsible for environmental security and protection.

The Estonian Defence Forces Environmental Policy Act was established in 2001 for the Defence Forces. Order 522 of the Supreme Commander from June 28, 2001 and the Ministry of Defence Order from June 20, 2001 ratify the Environmental Policy Act for the Defence Forces. This is based on the act related to the Protection of Nature in Estonia and Defence law, and other acts and NATO Standards. The Ministry of Defence has ratified NATO STANAG 7141 EP "Joint NATO Doctrine for Environmental Protections During NATO-led Operations and Training".

In 2004, and in cooperation with the Estonian Nature Fund, an environmental plan for the Ministry of Defence for the time period 2004–2015 was prepared.

In the Republic of Estonia, national environmental laws and lower legal acts were first passed in 1988 with a law for the protection of Estonian nature and the regulation of environmental protection. The (civilian and military) environmental regulations concerning the Defence Forces specifically regulate training activities and the establishing of dislocation sites and their exploitation. In addition to the above-mentioned, the Republic of Estonia has ratified several international nature protection conventions relevant to the development of the Defence Forces. In case of an environmental damage under the liability of the Defence Forces deemed to have been a deliberate act or the result of negligence, the Defence Forces will hold the perpetrators materially responsible.

In planning their activities, the Defence Forces of the Republic of Estonia must proceed from the possibility of minimising damage to the environment, taking care of nature and preserving the diversity of nature, while at the same time taking into consideration the obligations and needs of national defence.

One of tasks by Statutes of the Ministry of Defence (MoD) is to manage, co-ordinate and organise environmental protection in its sphere of administration (paragraph 10-6). In order to carry out this function, the Ministry of Defence established the post of environmental expert under the State Secretary in the autumn 1994. It is the obligation of this expert to coordinate and carry out inspections, and to create conditions for the organisations in the legal sphere of the Ministry of Defence to fulfil the current environmental legislation and economically utilise natural resources. After the reformation of the structure of the MoD in 1997, this function has been the responsibility of the Real Estate and Construction Department, which plans and arranges construction design, the subsequent public procurements and construction contracting in the Ministry's area of responsibility. It also ensures conformity with the environmental requirements.

After the second reformation in 2004, environmental responsibilities fell to the Department of Infrastructure. The main task of the Department of Infrastructure (DoI) related to the environment is the coordination of environmental protection activities of the MoD sphere of administration. In order to perform these tasks, the DoI shall prepare the environmental protection plan of the MoD sphere of administration and the necessary standard documents, and coordinate the environmental protection activities of the MoD sphere of administration while performing the requisite supervision.

Since a reformation in the summer of 2005, the environmental responsibilities are divided between the Land Forces' Department of Staff Operations and Planning (G3/5) and the Department of Logistics (G4). Land Forces' staff is responsible for environmental training in the Defence Forces. The Logistic Centre is a section dealing with the environmental planning of the Defence Forces' properties, mostly in the training areas and everyday environmental questions at training centres.

In the Defence Forces from 1997–2000 was leading department General Staff operation and training department (J3/7). After establishing Army Staff 2000 leading Environmental work for all three Services Army Staff under Engineer and NBC-Defence Department. Since a reformation in the summer of 2005, the environmental responsibilities are divided between the Land Forces' Department of Staff Operations and Planning (G3/5) and the Department of Logistics (G4). Land Forces' staff are responsible for environmental training in the Defence Forces. The Logistic Centre is a section dealing with the environmental planning of the Defence Forces' properties, mostly in the training areas and everyday environmental questions at training centres.

After the establishment of Army Staff 2000 the leading Environmental protection work for all three services (Army, Navy and Air Force) was directed to the Army Staff Engineer and NBC-Defence Department. Previously, between 1997–2000, the environmental leading department was General Staff Operation and training department (J3/7).

TABLE I. Extent of Soviet military bases in the Baltic states

State	Estonia	Latvia	Lithuania
Military bases (number)	1565	*unknown*	227
Surface (hectares)	87,000	100,000	67,762
Proportion of the whole territory (%)	1.9	1.5	1

4. Historical Background

Estonian experience in hosting large numbers of non-Estonian military forces is extensive: Peter the Great established the Russian military bases in Estonia in the latter part of the seventeenth century. During Word War II, Germany seized many of those bases for its own use, until the Soviets retook the region and maintained a significant military presence in Estonia.

The concentration of former Soviet Union military troops in the Baltic states—Estonia, Latvia and Lithuania—was directly influenced by the Baltic region's strategic position at the western border of the former USSR. The extent of Soviet bases in these states is summarised in tab. I.

Most of the sites once occupied by the military units of the former Soviet Union and Russian Federation were contaminated with oil products, chemicals, demolished buildings and domestic waste.

Former Soviet Union and Russian Federation troops withdrew from Estonia on 31 August, 1994. A systematic environmental inventory was started in 1992. As a result of the cooperation between the Ministry of Defence and Ministry of Environment it has become clear that 1565 military objects, including fourteen major air bases, three military ports and three training areas, collectively covering 87,000 hectares or 1.9% of Estonia's territory, remained from the occupying Soviet forces. The most militarised county was Harju County, where nearly half of the military sites were located (546 objects and 48,040 hectares). The most militarised city was Tallinn, the capital of Estonia, with its 291 military sites. Because many military constructions built by the Soviets are low in construction quality and far from central settlements, they are unsuitable for civil purposes and must be demolished.

The Estonian Ministry of Environment initiated the project "Assessment and liquidation of damage caused to the environment by the Army of the former Soviet Union". The project was carried out between 1992 and 1995. The inventory of former Soviet military sites was carried out according to a methodology introduced through a joint project with the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety.

As a result of the investigations, it was revealed that twenty sites were extremely polluted, the majority of which were air bases, large fuel depots, harbours, and small areas used as rocket bases. One hundred fifty-five sites, including harbours, fuel depots rocket bases, had an average level pollution and were littered with dangerous substances. Two hundred eighty sites had minor pollution and approximately 300 sites were less dangerous and less polluted. Thus more than half of the former abandoned Soviet sites were, to some extent, polluted. The total extent and load of different kinds of pollution have roughly been estimated as follows: hydrocarbon contamination: 4100 ha (5% of the military territory); iron, steel and non-ferrous material debris: 158,000 tons; domestic waste: 52,000 tons on 3000 ha; and 2800 tons of chemical contamination.

The Russian Navy left behind more than fifty warships, including a Whiskey class submarine sunken into in Estonian coastal waters. The number of wrecks is highest in the two harbours of Tallinn-Miinisadam (Mine Harbour) and Lennusadam (Seaplane Harbour) (nineteen ships).

As a result of the investigations, the loss caused to the nature of Estonia has been estimated to be in the area of €3.6 billion. The likelihood of receiving compensation from the state responsible for these damages is extremely limited.

5. Principle Environmental Protection Tasks of the Defence Forces and Ministry of Defence

The Estonian Ministry of Defence uses approximately one hundred military sites from the armed forces of the former Soviet Union, representing 7% of the total former Soviet military abandoned sites and covering approximately 25,000 hectares. The majority of these objects are sites provide the units of the Defence League, located all throughout Estonia, with the necessary buildings and training areas (the Central Training Area covers approximately half of the territory: 12,000 ha).

Taking into consideration that the units of the Defence Ministry and the Defence Forces were forced to start using the abandoned sites of the armed forces of the former Soviet Union prior to any cleaning operations, the main priority should be to find, localise and avoid any pollution. Because the MoD lacks experience and faces a shortage of environmental specialists and infrastructure, the work is carried out in cooperation with the Environmental Ministry and cooperation forms with other NATO and Partnership for Peace countries. At the present time there are going on joint projects with several countries (Denmark, Finland, Germany, Latvia, Lithuania, Sweden, Norway, and USA).

The discussed military objects are divided according to the main pollution type as follows:

1. Former Soviet ammunition and weapon maintenance facility: (The state joint-stock company E-ARSENAL, belongs today to the MoD) chemically polluted waters from galvanic and other lines of production contain heavy metals and cyanides, soils contaminated with sewerage and the groundwater polluted with oil products, emission of toxic substances while painting, solid wastes.
2. Fuel and oil storage depots: soil and groundwater contain oil products.
3. Naval Base Mine Harbour: soil and groundwater polluted with oil products, ships' sewage and chemical pollution and garbage on the shores and in the waters, hazardous wastes and substances, UXOs.
4. Ämari air bases: soil and water polluted with fuel, hazardous wastes and other substances.
5. Training areas: soil erosion, unexploded ammunition, abandoned and unusable equipment and targets, hazardous wastes and other substances.
6. Garrisons: polluted soil, groundwater and construction waste.

The main environmental task is to identify, localise and finally liquidate environmental pollution on the formerly occupied properties, as well as prevent any further pollution. Today, the above mentioned task has been almost fully carried out (*ca.* 90%). The largest environmental problems are found at the Ämari Airfield and in the Naval Base Mine harbour.

6. Two Case Studies

6.1. ENVIRONMENTAL RISK ASSESSMENT OF THE FORMER SOVIET AIRBASE AT ÄMARI

Between 1998 and 2003, employees from FOA in Umeå worked intensively on an environmental military defence project in Estonia. The project was financed by the Baltic Billion (Östersjömiljarden) and the Swedish armed forces on behalf of the Swedish government. The Ämari Air Base is a former Soviet air base located in Vasalemma parish, approximately 25 km southwest of Tallinn. Since 1952, the long-term and continuous contamination of the environment with different oil products, such as aviation and diesel fuels, gasoline and other fuel and lubricating oils has taken place in the Ämari-Vasalemma region. The soil, surface water and groundwater have been contaminated. This contamination is very complicated and heterogeneous due to the large number of factors affecting the distribution of oil products in the environment. Heavily contaminated soil affects the contamination of waters by oil products. At the same time, the reverse of this process can also occur: heavily contaminated water can contaminate the soil. The largest sources of contamination were the military properties of the Soviet Union, most importantly the Ämari airfield and its fuel management facilities.

The aim of this project was to develop a risk assessment, hydro-geological models and methods for the remediation of soil and groundwater contaminated by military activities. In this case, a former Soviet military airbase in Ämari, close to Tallinn, has been contaminated, mainly by aviation fuel. The contaminated groundwater reaches private wells and the Vasalemma River, which has an outlet to the Baltic Sea. It is therefore not only urgent and important for Estonia and other Baltic states to solve the leakage and contamination problem, but for all countries in the Baltic region.

6.2. ENVIRONMENTAL RISK ASSESSMENT OF THE FORMER SOVIET NAVAL BASE IN MINE HARBOUR

Tallinn Mine Harbour was built before World War I for the Russian navy. From this time onwards, Mine Harbour has been a naval base. Tallinn Mine Harbour was the base for Soviet military ships and it was last Soviet military base in Estonia. Since 1994, Mine Harbour has belonged to the Defence Forces of the Estonian Republic. As all previous military bases and objects in Estonia, there was environmental pollution both of the land (inert and hazardous waste) and of the harbour (half-sunken and sunken ships). Situated in the eastern part of the harbour is a boiler house with fuel tanks and unused storage facilities. This area was cleared of thirteen vessels while the Paldiski North Harbour was cleared of four vessels between 1994 and 1997 in cooperation with a Norwegian company. The wrecks of ships littered most of the pier line and oil was constantly leaking into the water from these vessels. Due to the security regulations of the Soviet Military, there is nearly no information about the previous possible environmental accidents that caused the pollution. The only information available describes an accident on the nearby railway in 1992, when approximately twenty tons of liquid fuel was spilled, followed by observations of polluted soil and drainage water. Between 1993 and 1999 there have been five studies to investigate the present environmental status of Mine Harbour.

The following studies have been made about the environmental state of Mine Harbour:

- In 1993, the Estonian Building Institute performed a mainly visual inventory of possible environmental damages caused by Soviet Armed Forces. As the observations were made without laboratory analyses, it was not possible to confirm the soil pollution. This study covered mainly the inventory of small local landfill in the harbour area. A number of cable incineration sites were also found. The total extent of the soil pollution was estimated to be 3415 m^2. The total quantity of waste was estimated to be 1421 tons (806 tons of mineral demolition waste, 569 tons of metal scrap).

- In 1994, AS Ecoman (a private environmental company) undertook an environmental investigation of the harbour. The investigation concluded an oil spill could result if the sunken ships were to be raised.
- In 1995, the Estonian Environmental Research Centre investigated the presence of oil products in the drainage systems of harbour. The investigation had been ordered by the Estonian Navy. Oil products were found in the northern branch of the drainage system.
- In 1996, Geoestonia made a geodetic investigation on the territory of harbour with the main purpose being the specification of technical drinking water and sewage well parameters.
- In 1996, AS Maves made hydro-geological investigation of the area, but the goal and results of the investigations are missing.
- In 1999, AS EcoPro made environmental pollution investigations in the area of the boiler house and fuel storages.
- In 2002, the Swedish Armed Forces made undertook environmental pollution investigations on the full territory of the Mine Harbour.

According to the latest investigation, twenty-seven polluted locations on the boiler house and fuel tanks area have been identified. The soil pollution was estimated by taking soil samples from a depth of 1 m with a hand auger and analysing soil samples in the laboratory. Volumes of oil products were calculated according to the measurements. The following contaminants were identified in the studied areas:

- soil pollution with heavy metals (lead): 20 m^3
- soil pollution with oil products: 250 m^3
- paint waste: 1.59 t
- old batteries: 15 t
- oil waste: up to 1200 t
- approximately twenty five fuel tanks of varying sizes
- one hundred forty 200łbarrels with solid oil and paint wastes.

7. Plans and Medium-term Goals

The Estonian government had a membership action plan for NATO Membership for the period 1999–2004. In accordance with this plan, an Annual National Programme was published annually over this period. Chapter 2.2.9 of the programme discusses environmental protection. The Estonian Defence Forces have further a number of medium term goals:

- To raise environmental awareness among Estonian Defence Forces personnel and to develop corresponding educational programs for the personnel
- To conduct a study in cooperation with the Ministry of Environment on the conditions and level of pollution in military installations in order to prevent the future contamination of the installations
- To conduct an ecological study of military installations with potentially high environmental risks: Ämari Airbase, Mine Harbour and the Central Training Area.

8. Current Situation and Implementation of Plans

The activities in the area of environmental protection have two main goals:

- to carry out the clean-up of the former soviet military bases in cooperation with civilian organisations, foreign companies and partners
- to increase environmental awareness within the Estonian Defence Forces and implement the principles of environmental protection in the forces.

The Estonian Defence Forces intend to localise the above-mentioned environmental pollution and to avoid further pollution; to this end, it will be necessary to apply the following measures:

1. The development of extensive cooperation between the Estonian Ministries of Environment and Defence and the respective ministries of other NATO and Partnership for Peace countries will be very important. This will be especially important given their extensive experience in the conversion of military sites.
2. The planning of environmental activities and aims in the legal sphere of the MoD must proceed on the basis of national environmental policies, laws and norms.
3. The field of usage and intensity of an object at the present moment and in the future will need to be determined. Infrastructure needed to prevent

environmental pollution (sewage and oil collectors, waste depositories, etc.) must be developed.

4. The developing the armed forces must consider the environment and the careful exploitation of natural resources (the Law of Economical Development).
5. Pollution and environmental damage caused by military training must be mitigated (special equipment is required) and minimised, preventing damages to fauna and flora or the minimising such damage.
6. Noise and air pollution are to be mitigated at air bases and during training.
7. Abandoned garbage must be removed from garrisons, making proper deposition sites in order to avoid further pollution.
8. Materials and equipment are to be used and stored in environmentally safe manners.
9. The technical condition of motorised vehicles, ships and aircraft, and their correspondence to the established standards will minimise oil and fuel leakages and gaseous emissions.
10. The safe handling and storage of chemical waste produced during the training of defence forces will mitigate contamination.
11. Unexploded ammunition will be removed from training areas.
12. The electromagnetic radiation flow emitted from radar radio stations during usage will be controlled, ensuring that levels do not exceed what is deemed as safe for the population and nature.

Up to the present time, the MoD and the Defence Forces have carried out the following major pollution liquidation activities:

- In cooperation with a Norwegian private company, sunken Soviet ships were removed from the Paldiski North Harbour (four vessels) and the Tallinn Mine Harbour (thirteen vessels). The wrecks of ships littered most of the pier line and oil was constantly leaking into water from these vessels.
- In cooperation with the Swedish Royal Navy, German Bundesmarine, and the Latvian and Lithuanian Navies, the Estonian Navy has cleaned the waters and fairways of unexploded ammunition and other explosives.
- The engineering service of the Defence Forces has destroyed explosives left by the armed forces of the Russian Federation and Word War II-era munitions on the island of Naissaare, in Astangu explosive storage depots, on the Paldiski Peninsula and from the Utsali Training Area. These activities are following a multi-year plan.

- According to a fuel efficiency development plan, the majority of fuel tanks of the larger military units have been substituted with up-to-date container tanks.
- In cooperation with U.S. Department of Defence, the U.S. Environmental Protection Agency (USEPA), and the Finnish Armed Forces, a new central training area for Estonian Defence Forces was established with an environmental management safety plan.
- A reconstruction plan for the Tallinn Mine Harbour and Ämari Air Base is being developed in cooperation and with the assistance of military experts from the Sweden and the U.S.
- A joint Swedish-Estonian defence sector environmental plan is being developed. As well, Estonia, Georgia and Sweden are jointly developing a Georgian military environmental system.

9. Regional Cooperation: The Riga Initiative

Sustainable development and security in the Baltic Region are mutually conditional and call for international cooperation between Baltic Sea countries. There is already close cooperation between three Baltic states on the basis of a partnership between the defence forces of the Baltic Sea region states within various structures and with diverse objectives. Sustainable development in the Baltic Region is not a primary task of the defence forces, but is governed by international agreements and NATO/EU regulations and is directed at protecting the Baltic Sea.

Military/environmental cooperation has been determined up to now by bilateral projects between various countries, with various aims and focusing on number of areas. However, there is still considerable room for improvement as far as exchange of information and coordination are concerned.

As a forum to discuss the improvement of environmental/military activities among the Baltic Sea region countries and the necessity for establishing a cooperative framework in the Baltic Sea region, the Latvian Ministry of Defence organised the first Baltic Environmental/Military Cooperation Conference in Riga, Latvia on 20–22 August, 2002. This international forum concluded that work on a Baltic Sea regional defence environmental cooperation strategy should be started. The aim of the work is to improve cooperation in the Baltic Sea region.

In order to facilitate continuous discussions and the work of the Riga Initiative, each participating country, namely Denmark, Estonia, Finland, Georgia, Germany, Latvia, Lithuania, Norway, Poland, Romania, the Russian Federation, Sweden, the United Kingdom and the United States, appointed a

Ministry of Defence point of contact. Each individual country is responsible for its decisions and conduct in terms of defence environmental practices.

It is clear that military/environmental cooperation in the Baltic Sea region is essential not only for environmental stability, but also for regional stability at the social and political levels.

10. Environmental Training in the Armed Forces

The most important task is to raise the environmental awareness of the conscript, NCO and officers. The states belonging to NATO and Partnership for Peace countries from Scandinavia have developed a solid environmental training system. Many Estonian officers and NCOs participate in different environmental protection courses abroad. Estonian Defence Forces engage in environmental training with and under leading Swedish and US colleagues and with Latvian and Lithuanian defence forces.

The first environmental course for Estonian military officers and NCOs was organised by the Maryland National Guard in 1997 in Tallinn. The Maryland National Guard is a counterpart to the Estonian Defence League.

Since 1998, the EPA Region 5, together with the NBC Defence School from Sweden and the Swedish Defence Research Institute (FOA), has conducted environmental training for military personnel from the Baltic countries at the Nemeciene Civil Defence and Environmental Training Centre, Lithuania. After joining Estonia, Latvia and Lithuania had joined NATO and the EU, the USA and Sweden ceased their sponsoring of the project and it was ended. Today, responsibility for these courses is held largely by Estonia, Latvia and Lithuania, who have offered supported by providing lecturers and teachers. One international course for military environmental specialists was planned for December 2005.

The handbook *Environmental Protection in Defence Forces* was published in 2002. This book is an adaptation of Swedish handbook *Handbok miljö för Försvarsmarkten* (H. Miljö) to Estonian laws and Estonian Defence Forces structure. After publishing this book in the Estonian language, Sweden produced a Latvian adoption in cooperation with the Latvian MoD. This book is considered to be very good, and remains the principle training manual for senior NCOs and conscripts. A second edition is planned for the near future.

The main elements of environmental education are environmental awareness, specific environmental procedures and measures, and supervisory responsibilities.

Environmental awareness consists of:

- environmental protection [water resources protection, air and atmosphere quality protection, vegetation and soil protection (including forests)];

- noise abatement;
- landscape quality protection;
- habitat and natural resources protection;
- material and waste management and pollution prevention);
- resource conservation
- heritage protection (natural and man-made) and resource protection in the context of sustainable development (energy conservation, reduction of the use of non-renewable resources and waste minimisation and recycling);
- environmental policy (domestic environmental policy, host nation's environmental policy, NATO and EU environmental policy, and multilateral environmental agreements).

Specific environmental procedures are related to procedures or measures of a specific nature designed to ensure environmental protection during the performance of duties. These procedures often require more detailed environmental education, generally given to small groups of personnel. Such duties include construction engineering, aircraft and vehicle maintenance, and waste and fuel handling at sea.

Supervisory responsibilities are an area of particular concern to commanders and their nominated supervisory staff. Environmental supervision is generally an additional task for staff, as most units or training centres do not have full-time environmental protection staff. The need for professional environmental expertise may require ready access to specialised experts or advisors. Particular attention will have to be given to environmental policy and guidance, risk management and planning.

Environmental education should be incorporated into existing training programmes. Opportunities include:

- Individual training: Basic training courses, junior officer courses, and NCO courses, covering the basics of environmental awareness, procedures and supervisory material
- Collective training: Provides the opportunity for initiatives such as the presentation of standing orders for exercises and training areas, waste handling and pollution prevention.
- Continual training: environmental knowledge and training will need to be continually updated, refresher training provided as legislation and working practices develop.

In Estonia, environmental protection skills and qualification demands differ according to command level:

- Conscript (soldiers, junior NCOs)
- COY, Plt. commanders, senior NCOs
- Specialist officers and NCOs
- Base, unit commanders, staff officers
- General staff, A/N/AF staff officers, civil servants in the MoD
- Minister of Defence, supreme commander, CoS, CaA, CoN, CoAF
- Environmental officer or specialist.

Routine environmental training of the Estonian Defence Forces:

- Conscript training:
  - soldier's basic course: 1 hour
  - soldier's speciality course: 1 hour
  - training at the section and platoon level: environmental protection instruction and on the job training during exercises
  - Junior NCO course: environmental protection instruction and on the job training during exercises
- NCO School (Senior NCO training):
  - environmental protection instruction and on the job training during exercises
  - Estonian National Defence College (officer training)
  - environmental protection course (40 hours) for logistical and border guard officers (since 2001)
  - environmental protection instruction and on the job training during exercises for all specialities.

Plans for future are in the environmental training are as follows:

- negotiations with German Armed Forces regarding future cooperation in NBC-protection and environmental protection training
- including the environmental protection course in senior NCO curricula at the NCO Academy and Estonian National Defence College (for all officer candidates) in 2005–2006
- continued participation in NATO Environmental Protection training working group from 2005 onwards
- continued participation in NATO Environmental Protection working group from 2003 onwards
- continued participation in the EU Military Environmental Protection working group from 2004 onwards.

11. Summary

The Supreme Consul of the Estonian Republic established the Estonian Defence Forces on 3 September, 1991, re-establishing these forces for the first time after Soviet occupation. At the same time, the former Soviet Union (Russian Federation) Armed Forces remained in the territory of the Republic of Estonia. The Ministry of Defence was re-established in April of 1992.

The period between 1992 and 1994 saw the transfer of Soviet military bases to the Estonian Defence Forces and the relocation of occupational forces to the Russia Federation. The armed forces of the Soviet Union had used 1565 military bases, including fourteen major air bases, three military ports and three training areas, totalling some 87,000 hectares and covering 2% of the country's territory. Today, the Estonian Defence Forces use only a fraction of the Soviet military installations, the remainder being used by the public or have been privatised.

In 1995, the Estonian Ministry of Environment initiated and carried out a project entitled "Assessment and liquidation of damage caused to the environment by former Soviet Union Army". This assessment estimated that the total environmental damage caused to the Estonian environment is approximately € 3.6 billion.

In the third quarter of 1994, the Estonian military sector established a post for an environmental expert at the MoD. From this date onwards, environmental thinking became familiar to the military sector. The Defence Forces have had two importants milestones in the area of the environmental protection: officers first became responsible for environmental protection in 1999 when in the Defence Forces Internal regulation first briefly mentioned environmental protection, and in 2001 when the Estonian Defence Forces Environmental Policy Act for Defence Forces was established. The past fifteen years have seen significant progress, as the level of environmental thinking in the defence forces has increased from a negligible to an appreciable level.

The environmental protection activities have two main goals. The first of these is the clean-up of former Soviet military bases currently being used by Estonian defence forces and the acquisition of new and environmentally friendly facilities. The second goal is to increase the environmental awareness of military personnel and implement principles of environmental protection, and establish environmental training systems for all levels of military and civilian staff in the Defence Forces.

References

Raukas, A. (ed.) (1999) *Endise Nõukogude Liidu sõjaväe jääkreostus ja selle likvideerimine /Past pollution of the formal SU Army in Estonia and its liquidation*, Tallinn, Estonia, Ministry of Environment.

CONVERSION IN AN ENVIRONMENTAL AND SAFETY CONTEXT: THE ROLES OF ACTORS AND THE DOUBLE IMPACT PROBLEM—A FINNISH PERSPECTIVE OF A TRANSNATIONAL ISSUE

Juhani Ahlman
Plancenter Ltd. Finland

Roland Vogt
Conversion Commissioner in the Brandenburg State Ministry of Economics, Representative of the CONVERNET Lead Partner

Dr. Jürgen Neumüller and Dipl.-Ing. Sven Friedrich
Infrastruktur & Umwelt, CONVERNET Project Coordinator

Abstract. Even in countries that were not occupied by the Red Army, safety and contamination problems have arisen. National defence forces are responsible for a number of environmental problems, including the spilling of fuels and the deposition of lead bullets and undetonated projectiles on shooting ranges. In cases like Finland, where the Ministry of Defence (MoD) is responsible for clean-up measures, the so-called "double-impact" phenomenon can arise. The MoD may considers it too difficult to restore a former military site and solves the problem by simply holding the facilities empty. As long as this occurs, the region cannot benefit from the civilian re-use of the former military property.

Here, the Finnish conversion process profits from the multinational CONVERNET network where 21 partners from the Baltic Sea Region have united to help one another find new, meaningful uses for properties vacated by the military. The lead partner of CONVERNET is the Brandenburg State Government. Products such as the Conversion Handbook for the Baltic Sea Region inspired partners and additional institutions to continue and extend the network after 2005 as CONVERNET II within the EU-INTERREGIIIB Programme.

1. Introduction

The German-Russian war philosopher Klausewitz's famous citation states that "War is merely the continuation of politics by other means." Today you could formulate a new one: "War is an environmental disaster."

But what kind of relation is prevailing between the environment and peacetime military activities?

Following the withdrawal of the Red Army from Eastern Europe, it became clear that an important part of the conversion process was the cleaning

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 27–35.

of contaminated soil and the discharging of explosives. Step by step, while significant base closures took place in Scandinavia, it was realised that this is the case with the national defence forces as well, if at a much smaller scale. The conclusion is that even the maintenance of military readiness and training can be quite harmful, if not disastrous.

2. Conversion and Safety Issues in Finland

Considering the safety issues in Finland, the enormous cleaning work after World War II cannot be forgotten. Particularly the vast area of Lapland was a stage for thousands of detonation accidents, faced both by the de-mining personnel and civilian residents returning home from the evacuation regions. Although lethal casualties have not been recently reported, mines and other explosives remain to be found even today.

Finland was never occupied in the usual sense (Helsinki, London and Stockholm were the only capitals in Europe free throughout the war), and it is for this reason that most conversion problems are caused by the domestic defence forces. The exceptions are—besides the German mine fields in the North—undiscovered aerial bombs and the naval base at Porkkala (30 km west of Helsinki), leased by the Russians until 1956. This base remains in use by the Finnish navy, and small problems continue to occur regularly, even if not dissimilar to domestic military sites.

Before the 1990s, the only safety problem considered, beyond explosive objects, was the retired heavy artillery pieces—mostly coastal artillery—left in place by the MoD due to the high expenses associated with removal. These guns are constructed in deep rocky holes which can be dangerous for both children and other trespassers. The best solution for this problem has been to donate the guns to a municipality or a heritage preservation society. The donation must consider aspects of safety, responsibility and liability. This example involving the heavy guns—the situation is also known in Sweden—is mentioned here only to show how different the safety aspect of the conversion questions we are facing can be.

3. The Double-Impact Question

In a democratic society, the decision to undertake conversion is in the hands of politicians, even if the facts and reasons behind reducing the volume of military activity are varying.

There can be pure military reasons—changes in the doctrine, surroundings, technique, economic factors (which are usually hidden behind less dangerous issues) and—as is often the case in Finland—changes in the need for facilities, for instance due to a reduction in the number of conscripts caused by a diminishing birth rate.

Decisions to decommission or convert military facilities are made at the cabinet or ministerial level and based on changes in national defence strategy. Such conversion activities share similarities at the local level: resistance to the base closure. The armed forces enjoy a relatively high level of support from the general public in Scandinavia and local and regional authorities are often unsupportive of plans to close bases. Local military authorities are often unconvinced of the rationale to close bases, even if these sentiments are not publicly voiced. These factors contribute to the double-impact problem, though it is not the local military authorities who are to blame. Rather the cause lies with the human psyche and its resistance to change. The realities of closure and decommissioning can be an emotionally trying experience for staff and other involved parties.

It must be recognised that the double impact phenomenon can be a result of real circumstances and not only exist virtually in the heads of those negatively affected by conversion. This observation diminishes feelings of accusation or blame. That being the case, the phenomenon, in its simplicity, is as follows.

The first impact is also the best known. A reduction of military employment causes a decline in local tax revenues, fewer options for secondary employment—the service sector and logistics—and as a result a decline in public services, traffic connections, and so on. These are negative events in a very concrete way, but very often the local authorities give as much attention to the image and heritage issues. The rhetoric is that "this region has always been vital for national defence, and now the local people are losing their firm belief in national defence and security."

The local attitude that closure wounds patriotism should be seen as an opportunity rather than as a threat. Otherwise it strengthens the negative impact—the second one—of conversion in the safety context. This means that local military authorities, even together with civil authorities, ignore the possibilities which the vacant facilities and former military infrastructure can offer. Entering the situation with a negative attitude, local authorities may fail to notice the opportunities and possibilities (e.g. storage or another passive activity) inherent in the abandoned military facilities. The safety aspect must always be considered. Warehouses for explosives in particular need a safety buffer which cannot be used for activities.

Safety in this context can mean any kind of problem. There may be dubieties or investigations concerning soil contamination. The defence forces may imply that the base can be used, *e. g.* for warehousing, without an expensive clean-up, which is a responsibility of the user. Old shooting ranges are a typical safety problem and are a typical reason for blocking re-use plans. The soil can be contaminated by heavy metals, but often this is in a very limited zone. As well, there can be non-detonated projectiles. This can obstruct any civil use even if the defence forces no longer need the range.

We know that the safety and environmental issues are among the most remarkable obstacles for a successful conversion. We can develop new, cheaper cleaning methods and better investigative techniques to solve this problem. Also important, however, is the human factor, such as a dubious mind, conservative attitudes, and even hidden agendas. These can build unnecessary barriers between the withdrawal of military facilities and the development of new civil activities trying to renovate the affected region.

4. Lessons Learned: Finnish Base Closing Case Studies

There are some safety issues to be considered with every base closing, even if some are quite insignificant. The MoD has nevertheless learned a lesson, and now there are examinations going on even at sites in continued military use. There are more than ten bases open today and several million Euros are needed for cleaning. The cases vary from gasoline leakages to unexploded munitions, but no scandalous cases have been exposed.

That is why these examples are not very harsh cases—there may be no such cases in Finland—but they have some interesting features, even in the double-impact context.

Oulu, Year of closure: 1999 The garrison at Oulu consisted of two separate military sites. One was near to the city centre, the other being ten kilometres away in a suburb.

The town planning and economic pressures against the city garrison were obvious, and perhaps this is why safety issues did not become important prior to conversion. Even if no party had any clear expectations of the continuation of military use, the local headquarters remained at the site. The closure of a military hospital faced significant resistance, but this was not related to safety issues.

In contrast, the suburban part of the garrison became a typical example of our topic. Most problematic has been the shooting range for heavy guns. The range uses tens of hectares in a place which could be used for civilian housing, but has instead remained an obstacle for planning of the range to the present day, causing disputes between the city and the Ministry of Defence. This situation has perhaps been aggravated by the continuation of warehousing on the site, although a large, separate storage area for explosives not in contravention of the original closure agreement continues to prevent the civilian use of a large area. The original plans for the decommissioning of the site did not include plans for the continued use of the shooting range. In addition, the Ministry of Defence has indicated that the removal of the projectiles is cost-prohibitive, or at least not realistic given the current financial situation.

The Oulu case is not a meaningless one, as the city is one of the most important growth centres in Scandinavia.

Hanko, Year of closure: 2000 Hanko is a small town but an important port, with daily fast-ferry connections to Lübeck. The closed base—a pier and depot terminal for connections to a fortified island—borders the harbour and the city centre. The location contains a number of impressive granite buildings, yet has been empty since its closure because of PCP soil contamination. The city considered it to be a matter of common sense that the owner, in this case the state, would have cleaned the site immediately. Unfortunately the property manager of the state is saying, that the cleaning up is easiest to do under the re-use construction work, not now. But what is interesting in this case, and unusual to some, is that the MoD is obviously not responsible for the contamination. The site was purchased in the early of 1970s from a bankrupt landowner. The former owner was involved with paints and chemicals and is no longer available to fulfil his responsibilities. You may notice that this case is not a unique one, nor only an accident. When the MoD needed estates or facilities, this kind of property was very frequently considered for purchase. For instance, a similar conversion case occurred in Porvoo, although the city was more vigorous in fulfilling its responsibilities, though not prior to purchase.

The former ferry terminal in Hanko, including the contaminated yard behind the building, remains a stalemate between the city and state. The terminal is shown in fig. 1.

Elimäki, Koria, Year of closure: 1994 Koria is an interesting combination of both successful and problematic conversion cases. The time and place for shut down was a difficult one, there as there was no existing growth in the region. In any event, the site has natural attraction given the river and landscape. But the River Kymi has also been a curse for garrison conversion efforts. This is because the explosives would not be there without the spectacular river, among the three largest in Finland.

Small mines and projectiles numbering in the tens of thousands were thrown into the water after World War II when the base commander became concerned regarding ammunition restrictions determined by the Allies. The commander anticipated that only a few hours would be needed to dispose of the weapons. Figures 2 and 3 show some examples of the discarded munitions.

Figure 1. Former ferry terminal of Hanko.

Figure 2. Unexploded mines in river.

Figure 3. Unexploded ordinance in river.

The large aerial bombs have a totally different history. The Russians had attempted to destroy the Koria train bridge, but failed, because the tracks from East are turning slightly just before the river, causing the pilot to misjudge his approach. The result was several undetonated bombs remaining in the soft river clay.

But the Koria story has a happy ending: the MoD has been recovering the ammunition for several years, and the final steps are already in sight. Even the heavy Russian bombs were lifted and detonated in September 2005. Concerning our topic, this ammunition problem has had a certain affect on the speed of conversion. Even double-impact could be seen in a small scale because the small part of the former garrison is still in use on the opposite bank of the river. This was not mentioned in the original closure decision, but there are said to be several reasons for this exception, one of these being that a cleaning program was to be performed in the river. But we must admit that this small base has not posed an obstacle for any conversion implementations on the opposite site of the river. Figure 4 depicts a conversion procedure.

5. The Swedish Explosive Disposal Initiative

In Finland, munitions disposal and discharge expertise does not exist outside the MoD. The situation in Sweden is not very different from in Finland, but because Sweden has made bolder conversion decisions, there are even

Figure 4. A small munitions discharge explosion in the Kymi River.

more training fields and shooting ranges to be cleaned up. It is also possible that Sweden has had more resources to fire projectiles. In any event, Sweden has made a number of unofficial requests to cooperate with the clean-up of unexploded ordinance.

The idea was that the defence forces are perhaps unable to independently furnish their experts with the most modern equipment. Even the quality of the expertise would benefit from the opportunities bilateral cooperation would offer. The agenda—to the best of our knowledge—was otherwise quite open. Even a private enterprise—perhaps partly owned by the public authorities—is one possibility. In any event, some kind of public-private partnership could be the right solution and would be very interesting in this international context. It must be recognised that this kind of expertise would find immense markets in the formerly Soviet countries and in Russia.

Unfortunately this initiative has not gained any attention in Finland, perhaps due to the established situation in this sector. As yet no largest projects have been initiated. The latest news from Sweden indicates that the resources are even limited there today. Choosing a wait-and-see strategy for conversion is one expression of double-impact.

6. Profiting from Transnational Experience—Finland in CONVERNET, a Conversion Network for the Baltic Sea Region

The Finnish conversion process profits from knowledge available in the Baltic Sea Region provided by the transnational CONVERNET network. The network consists of twenty-one member states, united to help one another find new, meaningful uses for sites and properties vacated by the military and to encourage and inspire others who are not members of this network to solve their conversion problems. In the handbook, the network partners recommend continuation and extension of the conversion network work. The goals should be:

- Exchange of experience.
- Pave the way for business relationships in the conversion sector including professional advice.
- Introduce "spill-over" effects: in other words, municipalities and states with an edge in conversion expertise should make a special effort to pass on their conversion know-how to less advantaged partners. An application for the project CONVERNET II has been submitted to the eighth session of the INTERREG IIIB Baltic Sea Region Programme. Twenty-seven partners want to continue conversion networking in the Baltic Sea Region, amongst them partners from Russia and Belarus.

STRATEGIC SECURITY ENVIRONMENT AND THE TRANSITION OF THE BULGARIAN ARMED FORCES

Assoc. Prof. Plamen S. Gramatikov, Ph.D., M.Sc., M.Eng.
Neofit Rilsky South-western University, 2700-Blagoevgrad, Bulgaria

Abstract. For the defence system of the Republic of Bulgaria the major transformation trends have been identified as a result of a strategic defence review (SDR) prepared in 2003–2004. The most important conclusions of the SDR, including the reduction of unit numbers, a modernisation plan, and the long-term vision for development of the Bulgarian Armed Forces (AF) up to 2015 and the full professionalisation of the AF by the end of 2010, are presented in this work. Data regarding the destruction of warheads and motors of twenty-four Soviet CC-23 rockets and sixty-seven "Scud" and "Frog" rockets, as well as the conversion of some military bases in Bulgaria are also discussed in this paper.

1. Introduction

At the beginning of the twenty-first century, "transformation" is the key word both for NATO as a whole and for the member states. The transformation of NATO is being undertaken parallel to the latest round of expansion.

Now NATO is a political-military Alliance of twenty-six states. The military contributions of the seven new members of the organisation amount to approximately 190 soldiers and are mainly land forces, the majority of which are Romanian and Bulgarian. With the membership of these countries from Central and Eastern Europe the security and stability zone is enlarged and opportunities for prosperity of their societies are being established.

Bulgaria joined NATO with all the positive characteristics of a country that has much to offer the alliance. On the one hand Bulgaria is located between Europe and Asia, between the East and West and the North and the South. Bulgaria is close to the regions that are of strategic interest to NATO—the Middle East, the Caucasus, Central Asia and the Caspian region, North Africa and the Mediterranean. Together with Romania, Bulgaria strengthens the southern and central flank of NATO and enhances the organisation's approach to the Black Sea.

On the other hand this country has a unique historic experience and economic perspective. Bulgaria proved its political maturity and established itself

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 37–49.

as a factor of stability on the issue of the Balkans being firmly determined and having concrete initiatives for more security and prosperity in the region. Bulgaria joined NATO with its partnerships and the capacities of a number of regional initiatives—the Multinational Peace Forces of South Eastern Europe, BLACKSEAFOR and others.

2. The Bulgarian Perspective as a new NATO Member

For Bulgaria, a formal NATO member as of the spring of 2004, the need for a complex re-assessment of the state of defence and armed forces and the setting of guidelines for their long-term development in conformity with the new security environment and the available defence resources has required the conducting of a strategic defence review (SDR).

The SDR process was launched with a resolution of the Defence Council at the Ministry of Defence (MoD) on January 8, 2003. The MoD has elaborated a concept and established the necessary organisation to conduct the SDR. The respective inter-agency bodies—Interdepartmental Council and Interdepartmental Expert Working Group—have been constituted by virtue of Resolution 262 of the Council of Ministers on April 22, 2003 for the management and conduct of the SDR. For the purpose of the SDR, twenty-one working groups have been set up in the MoD, integrating the civilian and military expertise of the MoD and the General Staff of the Bulgarian Armed Forces (BAF).

In order to facilitate and promote the SDR process, experts from the Administration of the President, the National Assembly, the Council of Ministers, members of the academic community and civil society have been invited. Parallel to this, a series of seminars and round tables with representatives of the executive, the legislature and experts from NGOs, as well as consultations with representatives of NATO, its member states and the US European Command, have been conducted.

One of the most important conclusions resulting from the SDR was that a smaller number of fully-manned, interoperable, well-equipped and trained units would generate more efficient combat capabilities. Bulgaria's forces have been largely equipped with outdated equipment and armaments. Identifying the number and type of forces needed to serve its responsibilities to NATO and planning the modernisation of the forces represents a serious challenge.

The SDR was conducted in three main stages. Its fundamental principles and parameters were outlined in the first stage, the policy framework, adopted with Resolution 650 of the Council of Ministers, dated September 15, 2003. The policy framework sets the political requirements of the SDR on the basis of national security and defence interests and objectives. The framework also determines the parameters that serve as a basis for the elaboration of defence planning assumptions in the context of future requirements and the capabilities needed to meet them. The policy framework was adopted by the National Assembly on March 25, 2004.

Planning assumptions were adopted in the second stage following a resolution by the Interdepartmental Council. This stage further develops the defence missions into specific tasks, determines the necessary operational capabilities, as well as performs a costing of structural alternatives.

Conclusions and recommendations of the review were summarised in the SDR Results Report adopted by the Interdepartmental Council on April 29, 2004. The report includes a Long-term Vision for Development of the Armed Forces–2015. SDR results and recommendations shall be reflected in the new National Security Strategy and National Military Strategy as well as in the respective doctrines and concepts for the Armed Forces. The SDR report was adopted in Resolution 465 of the Council of Ministers, dated May 31, 2004, and was submitted to the National Assembly.

In a broader sense, the SDR supports the process of aligning defence capabilities with twenty-first century risks and threats and national security commitments. It is a tool to succeed in our efforts to build and maintain an effective and affordable defence system, as well as a steady political, expert and public consensus on national defence policy and strategy.

3. Transition and Modernisation of the Bulgarian Defence Forces

In terms of functions, the BAF must be reduced by up to 40,000 soldiers and will be divided into three parts:

1. Active forces
2. Support elements
3. Forces with a lower level of readiness.

This structure takes into account the new tendencies to optimise the command structures in NATO's armed forces and to increase the percentage of usable forces. The attention is focused on the forces capable of deployment, allocated for participation in joint operations outside the territory of the country. These forces are with the highest level of equipment and personnel.

During the course of the SDR the need to improve the leadership and management of forces on the strategic and operational level was identified. As a result, a comprehensive review of the existing administrative and leadership practices at the MoD and the General Staff (GS) of the BAF has been made. The goal of the review was to establish conditions for efficient and effective

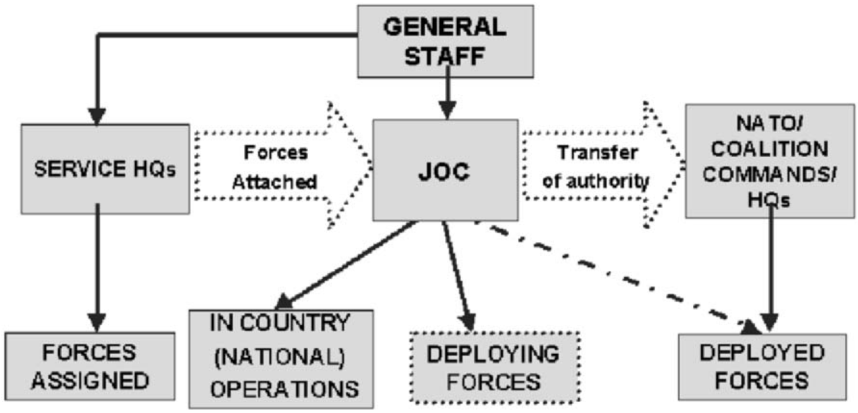


Figure 1. JOC operational vision of the BAF.

management of the BAF through the elimination of duplication and excess structures and the optimisation of existing personnel.

In order to achieve an efficient operational command and control of the BAF, a Joint Operational Command (JOC) was established as a body that would implement the principle of a joint AF. The JOC does the planning and operational command of troops from the AF when participating in operations in and outside of the country (fig. 1 on page 40).

In order to achieve a balance between capabilities and resources at the Ministry of Defence, the establishment of a system for the management of BAF development has been started. As a result, the forces will be provided with capabilities for achieving national goals and tasks in the sphere of defence and security. The system incorporates three complex subsystems:

1. System for the necessary operational capabilities
2. Integrated system for defence resources management
3. System for acquisition.

The system for the necessary operational capabilities identifies the requirements and priorities needed to achieve the necessary operational capabilities stemming from national documents and tasks in the sphere of defence and security.

The integrated system for defence resources management identifies the necessary defence resources and when they could be used to achieve the defined and prioritised operational capabilities.

The system for acquisition identifies the best way to achieve the necessary operational capabilities. Thus the planning cycle between development and requirements, management of resources and acquisition of defence products would be closed.

The need to create usable and efficient forces was one of the reasons to start the process of full professionalisation of the BAF. At the end of 2003, professional soldiers in the BAF amounted to 37% of the forces. According to current plans, both the Air Force and the Navy would be 100% professional by the end of 2006 while the Land Forces (LF) would be 100% professional by the end of 2010. At the moment (2005) professional soldiers in the BAF amounted already to 58%.

An important element in the process of total transformation of the BAF is their modernisation. The aim is to plan and implement that modernisation so as to provide for a technological build-up of the priority capabilities. In order to achieve that goal, the government adopted eleven priority modernisation projects in late May of 2004.

4. Long-term Vision for Development of the Armed Forces–2015

All issues important for Bulgaria and its defence were addressed in the conclusions and recommendations of the SDR. Subsequently, the SDR has been created and the National Assembly adopted a Long-term Vision for the Development of the Forces and Assets–2015. The plan defines the major parameters and trends of development of the BAF aimed at establishing forces that are capable and well equipped, able to meet Bulgaria's new requirements in the current security environment. This vision is the basis for the Plan for the Build-up and Modernisation of the BAF by 2015 currently in preparation at the MoD. The plan will come with the detailed parameters of the vision, including a concrete time-frame and responsible bodies.

This vision has been developed in line with the declared commitment of the Government of the Republic of Bulgaria to keep the annual defence expenditures within 2.6% of the GDP for the period 2005–2007. The relative share of annual defence expenditures are forecast to be within the same range for the period 2007–2015.

The fundamental points of the vision are:

- Finances: There is no realistic possibility to increase the budget of the BAF. Additional resources required for new capital investment ought to be provided mainly through the reduction of maintenance costs for specific operational capabilities not expected to be necessary in the future, or through achieving a maximum efficiency in defence resource spending.
- The modernisation, as an essential element of transformation of the BAF, will require allocation of substantial resources amounting up to 20–25% of the annual defence expenditures in the coming decade. When realising the modernisation and rearmament of its forces, Bulgaria will

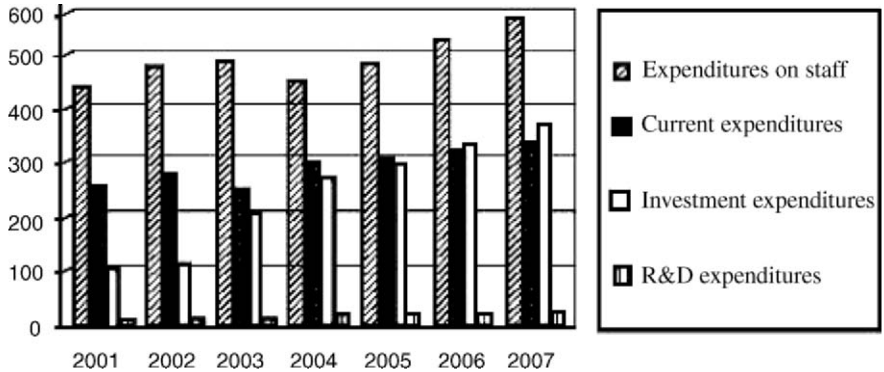


Figure 2. Expenditures of the BAF on basic sectors (in millions of BGL).

look for alternatives both by relying on traditional partnerships and establishing new partnerships so as to guarantee an optimum effect of the forces' capabilities. Expenditures for defence on basic sectors are shown in fig. 2 on page 42.

– Forces: Elements of the BAF that do not have the necessary level of training and do not maintain the required state of readiness represent a financial burden to Bulgaria. Despite the tendency to build a fully professional armed forces, the recruitment of conscripts shall continue.

– Programmes for development: While drafting specific programmes for development, proposals on separate programme modules should be elaborated following a prototype structure that may include:

  1. missions
  2. required operational capabilities
  3. operational concept
  4. planning scenarios
  5. force requirements.

– Public support: In an open society, the state security and defence policy requires broad political, expert and public support. The defence capabilities must be perceived as being composed of the following major components:

  1. information support
  2. command and control
  3. training for combat use
  4. deployment outside the country
  5. execution of missions

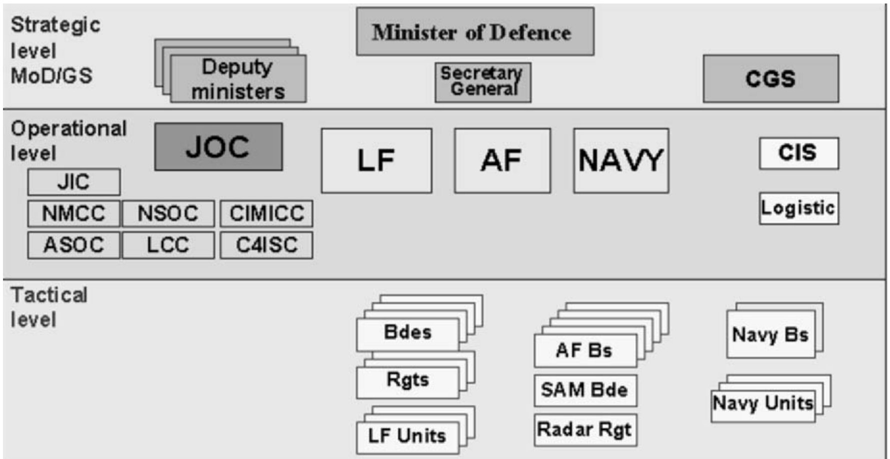


Figure 3. Joint Vision Model of the Bulgarian Armed Forces.

6. protection of forces
7. logistics.

The functional structure of the Armed Forces of the Republic of Bulgaria shall consist of:

– Active forces: a package of modularly structured deployable forces that could be used across the full spectrum of NATO-led operations. The normal formation readiness cycle of the deployable forces must include training and operational readiness stages.

– A small package of highly capable and quickly deployable forces able to contribute to national security in peacetime, and are in particular able to counter potential asymmetric threats.

– Support elements and forces of lower readiness, including on-location forces for logistic and maintenance support, bases, depots, and so on.

The leadership of defence and the AF of the Republic of Bulgaria is carried out by the National Assembly, the President and the Council of Ministers in conformity with the national constitution and legislation.

The new structures and capabilities of the AF, proposed by this vision, can be effectively managed by a three-level command structure as seen in fig. 3, comprising of:

1. strategic level
2. operational level
3. tactical level.

On the strategic level the Ministry of Defence is the main body charged with the implementation of the government's defence policy. The Ministry of Defence is an integrated leadership module, which combines both civilian and military expertise and functions on the principles of civilian control over the BAF.

The operational level of the BAF's command structure shall comprise a Joint Operational Command (JOC) as an instrument for implementation of the principle of jointness. The JOC shall execute the planning and operational management of units from the BAF during their participation in operations both inside the country and abroad. Integral parts of JOC shall be the following: the National Military Command Centre, Air Sovereignty Operational Centre, Naval Surveillance Operations Centre, Logistics Centre, the Civil–Military Co-ordination Centre, and so on.

The tactical level of the BAF command structure comprises units (air base, naval base and brigade), and sub-units, which are directly subordinate to the services Headquarters (HQ) in matters of training and to the JOC in matters of participation in operations. The alternatives of the major tactical units and sub-units are mechanised battalions which shall comprise a combination of both "active" and "reserve" companies. The former shall be manned and equipped to no less than 90% and the latter manned to over 50% and equipped to 100%. These forces have the highest level of manning and equipment, with an overall ratio of no less than 2:1 in favour of their "active" components.

The vision's time frame provides for the AF to maintain and develop units and infrastructure is as follows:

- The *land forces* shall comprise of two mechanised brigades, one light infantry brigade, one SOF brigade, one artillery unit, one engineer, and one logistics regiment, units for combat support and combat service support, as well as a system of training centres and ranges.
- The *Air Force* shall maintain the following air bases: one fighter base; one helicopter base; one transport/air-lift base; one flight training base and in case of a need for aircraft repositioning, one forward operations base. The system of ground based air-defence units shall consist of one surface-to-air (SAM) brigade and one radar regiment. An infrastructure for combat training and combat support shall also be maintained.
- Along with the decommissioning of surplus armaments and equipment, the *Navy* shall reduce its structures to two naval bases, with the respective combat support, combat service support and training elements.

5. Conversion of Military Bases in Bulgaria

Modern realities in the field of defence and the state of federal finances have induced many governments to close large numbers of military bases. This tendency brings with it a number of consequences. Some of these are short-term and negative, but the majority have positive effects in the medium to long term.

The residents and business of regions subject to conversion should search for prospective ways of clearing former military objects and their further use. The main problem is the cleaning of the environment, and a paramount task becomes the reorientation of the economic activities of the population. Among other considerations, the economic impact on settlements hosting military facilities must be considered in plans to retire these facilities, especially in cases where the military is the sole large employer. Some military bases can be adapted to civilian use, including for example schools, universities, centres of public health services, parks and reserves, and prisons. This approach can create new workplaces, diversify the local economy and stabilise the situation of the local population. The benefits from the conversion projects of military bases will likely be essential, though a real evaluation can come only after twenty years.

A number of experimental projects, such as in Romania (Fundulea and Mangalia) and Bulgaria (Dalgopol, Razgrad, Simitli and Sliven), promote the development of a strategic approach to military base closures and the reorganisation of military objects in these countries. Other potential experimental projects are discussed with the interested countries.

The project "Conversion of Military Objects in South-east Europe" is an economic management initiative of the Department of Political Questions and Safety Policy of NATO. Its purpose is to help the partner-states to reduce to a minimum negative consequence of military base closures while maximising the benefits. It also promotes an expansion of regional cooperation between countries, facilitating information interchange between them. This project is intended for countries such as Albania, Bulgaria, Moldova, Romania; and the Former Yugoslav Republics (FYR) of Croation, Macedonia, Montenegro and Serbia.

The NATO Expert Commission for Advising and Making Recommendations to National Bodies was created. Further, this body will assist them with the search for new and productive use variants for military bases subject to conversion for civilian use.

In the coming years, more than 600 military bases and military facilities will be closed in Bulgaria. The disbanding of a part of the motorised infantry and the closing of a bauxite mine in the town of Simitli in south western Bulgaria has increased the rate of unemployment to 70%. NATO assists in the realisation of a conversion project, which will establish a fire service, an emergency medical aid service, and a campaign for recycling plastic. This project has been approved by the PHARE Program of the EU with support from NATO. For the realisation of the feasibility report, three European companies have already been invited.

6. Destruction of the Soviet Rocket Complexes in Bulgaria

According to an agreement between Bulgaria and NATO, Soviet rocket complexes, consisting of twenty-four CC-23 rockets with combat cassette heads of 64 kg. of TNT equivalent, and sixty-seven "Scud" and "Frog" warheads were destroyed in the country during the period 10/09/2002–31/10/2002.

The combat cassette heads of the CC-23 rockets were destroyed underwater in 2.4 m deep trenches in the Zmeyovo military range. The method was suggested by a scientific team from the Bulgarian Academy of Sciences (BAS). According to the opinion of the Ivan Yuhnovski, president of the Bulgarian Academy of Sciences, Bulgaria is a very densely populated country, where distances between settlements are approximately 3.8 km. For this reason, any combustion-based methods were unacceptable. The liquid fuel of the CC-23 rockets was transported to Romania by the American firm CDI.

The warheads, fuel and engines of sixty-seven rockets "Scud" and "Frog" were destroyed at the same place. Approximately 1500 components or pieces of these rockets were destroyed in the Terem military plant in Veliko Turnovo.

The destruction of the combat parts of the rocket complexes contributed to the health and safety of the human population and the environment. All short-term obstacles were overcome. During the destruction process, four workers were slightly injured.

The international community has estimated that Bulgaria destroyed five times more rocket complexes in just one third the time other states had required for similar arms. The operation goal achievement was supported by an active media policy and purposeful civil-military cooperation, such that protests of NGOs against the destruction remained slight.

7. Phoenix Operation of the BAF

The use of the armed forces for non-military purposes is an example of conversion. Such was case was the PHOENIX operation of the BAF for support to the state and local authorities after the torrential rains in July and August of 2005. These rains caused the flooding of towns, villages and agricultural areas. As a result, a state of emergency was declared in a number of municipalities in the country. A great number of bridges, road and railway sections and houses were ruined. Thousands of citizens need to be evacuated.

Yet in the first hours of the disaster the General Staff of the BAF undertook decisive steps for rendering assistance to the population in the disaster-struck regions. In the period from the 5th of August to the start of the PHOENIX operation more than 1000 servicemen with 157 pieces of equipment from seventeen military units were involved in disaster relief activities.

On August 13 and 14, 2005, twenty-six engineer and reconnaissance teams from the Land Forces and eight teams from the Military Epidemiology Centre conducted reconnaissance of the flooded areas to determine the scale of the damages. The basic efforts were concentrated on Sofia Field, the Rivers Iskar, Maritza, Lesnovska, Tundzha and Vit, and in the regions of the towns of Shoumen, Smolyan and Velingrad. Two thousand kilometres of roads and 11,130 km^2 of river beds and their adjacent dams were reconnoitred. The status of one hundred fourteen engineer installations was described. It was observed that 9700 m of dams, 4150 m of roadways and fifty-one bridges had been destroyed; 7290 m of roads have been blocked by landslides.

The main efforts were concentrated on:

- reconstruction of dams along riversides
- clearance of river beds, dikes, cascades, and irrigation canals
- roads reconstruction
- building of temporary bridges, clearance of landslides
- building of temporary wooden houses
- rendering of support in the epidemic prevention activities.

The BAF participated with:

- seventeen tactical engineer modules adequately manned and equipped with wide spectrum of reconstruction equipment
- two modules for building of prefabricated houses
- two bridge-building modules
- two emergency recovery modules
- eight stand-by sanitary teams
- eight teams for disinfection and pest extermination
- one helicopter for reconnaissance and surveillance.

These forces consisted of approximately nine hundred personnel and one hundred fifty pieces of equipment.

The main tasks performed by the Bulgarian Armed Forces were the following:

- fortifying of dams: 7000 m
- river bed clearance: 6000 m
- roadway clearance: 7000 m

The operation was executed in four stages within the period 22 August to 31 October, 2005:

- First Stage: *Activation*. Formation of the modules and teams and their deployment to the respective locations.
- Second Stage: *Recovery*. Recovery of dams, clearance of river beds, landslides and roads.
- Third Stage: *Construction*. Construction of temporary bridges, road sections and wooden houses.
- Fourth Stage: *Deactivation*. Redeployment of the task teams to their permanent locations and disbanding of the teams.

8. Conclusions

Bulgaria is a reliable partner in the collective fight against non-military threats and challenges to security: organised crime; trafficking of goods, drugs and weapons; illegal trans-border traffic of people, money laundering and others. Further, Bulgaria offers NATO its active foreign policy, good neighbourly relations and traditional relations with a number of countries from Asia and Africa.

During the PHOENIX Operation, planning and execution were made with a wide use of the experience of the Bulgarian Armed Forces gathered during previous disaster relief activities in the country and during the participation of the Bulgarian military in UN and NATO missions in Kosovo, Bosnia and Herzegovina, Iraq and Afghanistan.

The challenge for Bulgaria, as a new member the alliance, is to successfully integrate into the alliance. This integration requires the internal transformation of the Bulgarian defence system; and a new philosophy, strategy and culture in the defence realm.

References

Republic of Bulgaria, Ministry of Defence, *Long-term vision for development of the Armed forces–2015*, Sofia, Bulgaria.

Republic of Bulgaria, Ministry of Defence (2000) *The Concept for ecological defence and environmental protection in the Bulgarian Armed Forces*, Sofia, Bulgaria.

Republic of Bulgaria, Ministry of Defence (2002) *White paper on defence.*, Policy Framework, Sofia, Bulgaria.

Republic of Bulgaria, Ministry of Defence (2004)a *Plan for modernisation of the Defence forces of the Republic of Bulgaria 2002—2015*, Sofia, Bulgaria.

Republic of Bulgaria, Ministry of Defence (2004)b *Strategic defence review of the Republic of Bulgaria*, Policy Framework, Sofia, Bulgaria.

Svinarov, N. (2004)a The challenges to the new NATO members: The Bulgarian perspective, Speaking notes, ECSS G. C. Marshall, Garmish Partenkirchen.

Svinarov, N. (2004)b The strategic security environment and the challenges to military education, Speaking notes, G. S. Rakovski Defence College.

Svinarov, N. (2004)c Transition of the Bulgarian defence forces. The impact of crisis: Management and civil-military relations, Speaking notes, NATO School, Oberamergau.

RESPONSIBILITIES OF OWNERS OF FORMER MILITARY SITES IN GERMANY

Wolfgang Spyra, Ph.D.
Brandenburg University of Technology Cottbus

Abstract. The legal framework regarding the placement of liability following an accident or other impact emanating from a property is extremely import in the context of the remediation of military wastes. Because in Germany a very significant liability lies with a property owner, liability law must be considered in any discussion of the reuse of lands once subjected to bombardment or upon which military activities had taken place. Because airports have historically been the location of both military activities and heavy bombardment, these lands must be given priority with regards to munitions clearing, remediation, and conversion.

1. Introduction: Responsibilities on Sites with Hazards

The ownership of land and soil be represented in different manners within a society. In some forms of society, the individual, in a physical or legal sense, cannot own land or soil. Instead, ownership lies with the state or the society.

In other societies, anyone can own land, including the state, a body of public law, a citizen, a legal person such as a firm, etc. Models lying somewhere between these extremes are also conceivable. What remains unclear is how property law is to be applied to upwards to the atmosphere and, in the opposite direction, downwards into the soil. This questions appears initially to be hypothetical, but its relevance is quickly apparent when at issue is not the utility of use by an owner, but rather liability in the case of an accident.

Who may make use of land and soil, and in what manner, is decided by the laws of a country. This approach to the protection of a society's interests can vary greatly.

Every property owner in the Federal Republic of Germany must ensure that no third party is harmed by his property. This is not applied absolutely, as every member of a society taking active part in the society accepts a certain everyday risk. This general risk is most easily described by the simple example of how every individual venturing into the public transport system accepts that an accident is possible. In this case it is fully immaterial whether—in the

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 51–58.

sense of an everyday risk—the accident is the fault of another individual or of the individual himself.

The individual property owner carries a certain responsibility to the greater society. All negative forces originating within the property cannot be permitted to leave the property. Thus, for example, commercial wastes can be stored on public lands only with the appropriate permit. The negative impacts must be contained on the property until their proper removal has been approved. The permits for such removal are often only granted for very special cases. The importance of the matter to the property owner plays no part in the decision to approval the removal of wastes. Instead, it is the welfare of the community that is considered.

In Germany, the harms emanating from a property that can can be suffered by the greater community consist of two types: harm from an action and a harm resulting from the contamination of the property. So-called "interferer with third-party acts" (*Handlungsstörer*) and "disturber of the public order" (*Zustandsstörer*) are discussed in this context. When a person damages the environment through his actions, *Handlungsstörer* is the relevant term. The disruption is no longer taking place. A situation involving a *Zustandsstörer* is more complex. Pollution of the soil with contaminations can take place such that flows of contaminants negatively impact neighbouring properties. If the contamination involves, for example, a fuel line leaking kerosene over a period of many years, creating a large spill and leading to the contamination of a neighbouring property via flowing ground water, the case would involve a *Zustandsstörer* and the property owner would be responsible for the remediation of the pollution.

The responsibility of the property owner to the community is often very difficult to fulfil. An example of this are the troop training areas. On the one hand, the affected areas are very large: some are as large as $100\,km^2$. On the other hand, affected are often wooded areas protected under special conditions.

Every citizen is permitted by law to use the forest for recreational purposes. These include the collection of mushrooms and berries.

The granting of these access rights to the citizens forces the property owner to limit any hazards to the public found on the property. This also implies that in the case of a forest once used for military training, the risks faced by a user of the forest must be similar to those risks normally encountered when accessing a forest. The risks of tripping over a root in a forest and injuring oneself, accidentally stepping into a badger's den, or becoming infected with a tapeworm, are normal risks accepted by those entering wooded areas. If a forest had been used as a troop training area and would be subsequently opened for public usage, the forest must be free of additional risks. The citizen must be prepared for the hazards that the forest, with its positive and negative attributes, contains. The citizen should not, however, be expected to anticipate that he will be injured or killed by munitions left on the troop training area. The particular circumstances leading to the deposition of unexploded ordinance, whether it was simply forgotten, was a dud, was not found or not collected, are not important.

In the case of hazardous military wastes, there is a further important particularity. German legislation is such that in certain cases, the government is given a monopoly on action. If, for example, a cholera epidemic were to occur, the state has the duty to protect the citizens from the threat with any means necessary to neutralise the threat. In this way, the state has regulated explosives such that it can influence their handling when it is deemed necessary. Resulting from the deposition of munitions from two wars on land and in the water, munitions are generally found during construction activities. Owing to the hazards posed by these munitions, they are properly disposed of by trained government specialists or their agents. These hazards are assessed as being so great that an acute risk to human life is attributed to the munitions. An acute risk to human health or life means that an incident can occur, regardless of the circumstances, immediately and at a time that even a specialist will be overwhelmed.

There exist thus two bases for action. The first is environmental law and the second criminal law.

2. Hazards of Unexploded Ordnance

Normally a discussion of protected goods will be centred on the contamination of water, soils and air by chemicals. This is the disturbance, endangerment or degradation of abiotic goods. When speaking of the disturbance, endangerment or degradation of humans, animals or plants—all organisms—we are speaking of biotic goods. The disturbance, endangerment or degradation of an environmental good results from a chemical insofar as this chemical produces reactions in the good. After an investigation, the risk is describable. In rare cases, the properties of a chemical can lead to acute hazards.

The situation with military hazardous wastes must be basically and essentially approached in a different matter. Military ordinance and ammunition are specifically designed to hinder or fully disrupt the ability of humans to act. The impairment felt by a opponent may range from the disablement of his ability to fight, to his death.

Additionally, the intention of the use of military equipment is to make military equipment or high-valued civilian objects such as water or electricity facilities unusable.

During the preparation of a risk assessment for military hazardous wastes, the assumption of a maximum risk must be made from the beginning. Only following the concrete inspection of the site is it possible to identify the hazards of the situation.

Before one can begin to deal with the chemical and biological effects of military wastes, one must first be identify what the possible effects of the munitions under the particular conditions are. When munitions are found, it must be assumed that they could function as they were originally designed. Because the storage conditions of found ammunition are unknown, the a priori assumption must be made that handling is extremely dangerous. A munition can be activated at a time or moment that is impossible t predict. Injuries can be caused by the projectile, shrapnel, or by released pressure when the munition is conventional in nature. Special munitions such as incendiary bombs or grenades, or smoke bombs can lead to injuries through other avenues.

For reasons of security and because of the risks described above, found munitions are transported to a secure location. The defusing or detonation of munitions will take place in such a secure location, for example, on a detonation square. Prior to the transportation of found munitions to a detonation site, the transportability of the objects must be confirmed. Pyrotechnical specialists (EOD), who additionally have received a federal mandate, are certified to undertake this task. Other individuals who attempt to transport found munitions make themselves liable to prosecution. It is entirely possible that the transportability of a munition cannot be confirmed. If this is the case, the destruction of the munition on-site may be required at great cost.

The pollution of soils and water, and especially of groundwater, at military locations has, until now, received no attention. Only with shifts in the political landscape and the subsequent reduction in military capabilities has it been possible for civilian experts to investigate the contamination of sites used by armed forces. Experience has now shown that the contamination of the soil and groundwater of military airports with aviation fuels is to be expected. We have also experienced that troop training areas are contaminated with munitions left behind due to malfunctions (duds).

In summary, a number of important realisations have been made: the hazards to be expected on a property are related to its historic uses. The problem encountered with former military properties is that the historic uses are generally unknown. Military operations are most often secret. It was only learned decades later that allied forces used Germany training areas to prepare for special foreign missions.

Munitions contain components intended for specialised functions. Often these are chemical such as explosives: initiating explosives, boosters, main charges, tracers, incendiary and hazing compounds, among many others. When, due to erosion, these chemicals are released into the environment, they pollute like other chemicals. The nature and extent of the environmental contamination must naturally be investigated in each individual case. The contamination is dependant on the characteristics of the chemical and of the conditions of the environment into which the contaminant is released.

The fundamental characteristics and behaviours of these chemicals used for military purposes are known and are often grounds for great concern.

Two examples: when munitions containing white phosphorous corrode such that the chemicals come in contact with atmospheric oxygen, the phosphorus can begin to burn and thereby develop those characteristics intended for the ammunition. Other flammable materials could be ignited, such as houses, forests, industrial facilities, etc. A consequence of this realisations is that forests fires on military training areas may no longer attended to directly by fire departments on the location of the fires. Exploding munitions pose dangers for fire fighters from which they cannot be protected.

Munitions also contain explosives. Many types of munitions contain the compound trinitrotoluol—also known by the acronym TNT. This explosive is generally degraded in nature by micro-organisms. Dinitrtoluol—DNT— and nitrosamine, or many other compounds, can be the products of degradation. When these characteristics of these compounds, Dinitrtoluol for example, are studied, it can very fortunately be concluded that the chemicals have lost the brisance of TNT. The bad news is that this substance and nitrosamine are both carcinogenic in humans.

If the releasing of the risks can be contained within a detonation square suitable for the disposal of military hazardous wastes, it would be a major victory for the environment. Until now, these locations have been chosen and designed to protect human lives and health. If one were to consider environmental goods as similarly worthy of protection, the geological characteristics of a site, or special mitigation measures, would be critical for the protection of abiotic natural goods.

3. Hazard Situation on Airfields

The hazard situation of German airports is especially acute. This lies in the history of these sites. The German aerospace industries developed very successfully. A very successful period in civil aviation began with the founding of Lufthansa. Airports were constructed suitable for use by both civilian and military aircraft and for civilian and military purposes. With the onset of the wars, namely the First and Second World Wars, the military usage of the facilities was given priority. Given the importance of the airports for the German military, they were also priority targets for bombardment by the Allied forces. Bombardment, the demolition of airports by German forces, and arson were the results of these concentrated assaults. In such situations, the protection of the natural environment receives no attention whatsoever.

Following the war, the clearance of combat debris and the handling of war damages was urgent. The commissioning of airports following the wars was of increasingly economic importance. The fire fighting forces available faced incredible challenges with regards to the disposal of war debris and munitions. This is shown by the statistics of war debris clearance. In part, debris were buried and these have become the inherited wastes we are faced with today: aircraft wreckages, tanks and munitions of all kinds were disposed of in this manner.

After the political changes of the 1990's, our perception of these issues has shown great cause for alarm. Airports in Germany, whether now in use for civilian or military purposes, have not been thoroughly checked for the hazards posed by munitions discarded at these sites.

The areas of Berlin and Brandenburg in which one must anticipate the presence of military wastes include not only airports, but other areas as well. All airports must be considered to be at risk for containing large quantities of munitions so long as no systematic clearing exercises or investigations have been undertaken.

Investigations have shown that the geological conditions of Berlin and Brandenburg have led to the contamination of soils and waters by aircraft fuels. In many areas of these regions, the groundwater has characteristics that lead the spilled kerosene to float on the top of the groundwater. Restoration has been initiated in many places, but the complete is not remediation of this issue is not in sight at this time.

3.1. BERLIN-TEGEL AIRPORT

The Berlin-Tegel Airport is partially located on the Berlin-Jungferheide imperial troop training grounds. Munitions of the imperial era from the munition testing grounds are still found here on occasion. Grenades filled with substances with physical properties similar to those of gun powder are found. As a general rule, these duds pose little risk but do indicate that the area has not been complete investigated for the presence of military wastes. Because the area has been only partially used for the construction of the airport, these finds are of principally of importance for military historians.

With the expansion of the Berlin-Tegel Airport to an international airport, steps to clear the soil of munitions were naturally undertaken. However, these measures were not not comprehensive and did not take into account the full implications of working with bombs. It is notable in all cases that the risk appreciation and perception posed by these munitions has shifted in the past decades. Pyrotechnical specialists who served during war-time assess risks differently than the newer generations of specialists.

The systematic clearing of airport grounds, including the documentation of the treated areas, has begun. These areas include both the civilian and military portions of the airport. It has been realised that different proprietors do not always face the same consequences for the needed hazard reduction measures.

Munitions capable of causing great damages, including large-calibre shells, continue to be found at this airport. However, it is currently foreseeable that the risks associated with these munitions will be completely eliminated.

3.2. SCHÖNEFELD AIRPORT

This airport also has a remarkable history that brought it much attention during the Second World War. The airport was heavily bombarded from the air and its military importance was thereby greatly reduced, indeed eliminated.

The hazardous products to be found on this type of property must be assumed to be of a greater variety than simply the large munitions. Because armament production facilities, such as the Henschel factories for aircraft construction, were also located here, it must be assumed that products beyond what would be expected from bombardment are to be found and disposed of. This is is documented in a newspaper article from 2003 where the discovery of a bomb was documented.

The realisations to be gained from these observations lead to the conclusion that a historical-use analysis should be undertaken for airports. This analysis should begin with the first documented use of an area, and should then include all known uses and activities having taken place there. Each use, with the subsequent environmental effects, should be documented. Given that it may not be known with certainty what the environmental effects of certain activities were, it may not be possible to correlate environmental effects with historical land uses. At this point, it is necessary to refer to reference catalogues with recommendations of how a historic land use analysis should be undertaken.

4. Conclusions

Unexploded ordinance pose a special threat in many areas of Berlin and Brandenburg, those these hazards are neither immediately evident, nor necessarily dramatic. That many authorities and the public remain perhaps unaware of the seriousness of buried munitions in this region does not lessen the necessity to continue research and studies of areas at high-risk of containing explosive and chemical hazards. The remediation of these hazards is expensive, difficult, dangerous and time-consuming, yet must remain a goal for the foreseeable future.

RISK ASSESSMENT FOR THE FORMER MILITARY TRAINING AREA "DÖBERITZER HEIDE"

Michael Katzsch
Research Assistant
Brandenburg University of Technology Cottbus

1. Introduction

The end of the initiated dramatic political changes across the globe that would lead to demilitarisation world-wide. This demilitarisation, and the associated reduction in troop numbers, is closely associated with the opening of lands once used for military purposes. Through this demilitarisation and after the end of the Cold War in 1989, more than 8000 areas with a total area of more than one million hectares used for military purposes were opened world-wide (BMfUNR, 1997). Because of the unique geographic and political situation of Germany, significant military forces were concentrated here for decades during the Cold War, occupying a correspondingly significant area. In Germany alone, some 3860 km^2 of land formerly used by military forces were opened (BMfUNR, 1997). Due to the very large area of land previously used by the military, the State of Brandenburg has had a particularly important role to play in this process. Some 2300 km^2 of the state's area was used for military purposes in 1989, accounting for *ca.* eight percent of the state. Between 1990 and 1994, the year in which the western group of the Soviet military (WGT) was completely withdrawn from the state, approximately 1600 km^2 were removed from military use (LB, 2001). Since that time, great efforts have been made to convert these areas such that they will be once again suitable for civilian use. However, the rehabilitation of lands used for decades by the armed forces harbours numerous problems. Beyond the conflicting interests of potential users, the availability of an area for particular uses is the limiting factor. The availability of former troop training areas for civilian uses is generally heavily limited by the presence of military wastes. The decades-long training, proving and testing of military equipment has lead

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 59–70.

TABLE I. Succession of users of the Döberitzer Heide troop training area.

Time period	User
1780–1892	Prussian forces
1892–1919	Reichswehr, Kaiser-Wilhelm-Institute
1920–1933	Ammunition delaboration, small-scale military exercises
1933–1945	Wehrmacht
1945–1994	Soviet troops

to the extensive contamination of areas with both military-specific and non-specific pollutants and hazards. Because of the length and intensity of the military uses, the distribution of these hazards cannot be completely predicted (Spyra, 2004).

Military-specific contaminants include combat agents, equipment and fuels. Contaminants that are not military-specific encountered in these areas include, for example, fuels and lubricants, solvents and solid wastes. From a modern perspective, these are the products of the careless handling and storage of environmentally hazardous materials (Möschwitzer and Haas, 1994).

The hazards posed by combat materials found on military areas, strongly related to the type of military activities formerly taking place, cannot be mitigated in the short or medium term due to technical factors. This has the result that areas decommissioned from military use cannot be used for civilian uses, and that the general public must be restricted from entry into these areas.

2. Case Study

An example of a troop training area is the Döberitzer Heide found west of Berlin. The area was used for military purposes between 1753 and 1991. The troop training area itself was formally designated for use by the emperor's regimental guard in 1894. The area would be subsequently used by the Reichswehr, the Wehrmacht and by Soviet troops. TableI shows the succession in which the area was use.

Since the withdrawal of Soviet troops in 1991 (Heinze, 1998), the grounds have been closed to the public due to contamination by combat materials and products and their protected status of the grounds under environmental law.

In the context of munitions clearance activities, a shell body was found on October 19, 1995 that gave rise to the suspicion that chemical weapons had been used (SMBDLB, 2003). During the subsequent examination of the shell body, this suspicion was confirmed. During further clearance activities between 1995 and 2003, additional munitions containing chemical weapons would be excavated. Some of these were found systematically buried with as many as 400 shell bodies (1996). The shells that have been found originate from the First World War era and are from a variety of nations. Those shells containing chemical weapons are predominately from the German army (*ca.* 550 pieces), while additional shells can be attributed to the English, French and Italian forces (*ca.* 40 pieces) (SMBDLB, 2003). As of August 2003, a total of *ca.* 550 hectares of the southern area of the Döberitzer Heide have been cleared of combat materials and munitions. This is because the German armed forces plan to continue to use the area as a training ground. The clearance of the entire area of munitions, given the associated costs of such an exercise, does not appear to be a realistic goal at the moment.

The study area is comprised of the entire area of the Döberitzer Heide used as a troop training area between 1894 and 1991, including those areas used only temporarily.

The extents of the study area were defined by researching the bounds of the activities in all periods of use of the training area.

3. Problem Description

Based on the decades-long military usage of the training area, the verified finds of munitions, combat agent munitions and the systematic burial of combat agent munitions, it must be expected that further contaminations are to be expected on those areas of the training area that have yet to be examined. The clearance of the entire area of the Döberitzer Heide is not yet realistic, given the great costs of such a project. In the context of hazard mitigation, the priority clearance of hot spots of munition contamination should be undertaken to minimise the dangers associated with this area.

The basis for a prioritised clearance of heavily contaminated areas should be a map describing areas suspected to contain munitions. This map should assign contamination classifications to the entire area of the Döberitzer Heide.

4. Data Sources and Tools

The preparation of a contamination risk map requires the use of varied historic and contemporary data sources. The description of the history of the former troop training area was prepared by with the information collected by a comprehensive search of information archived in Germany, Great Britain and the United States. The results of this research included 64 historic and contemporary maps, two aerial photo plans and approximately 410 aerial photos. Overflights of the Döberitzer Heide with thermal cameras took place in 1998 and 2003.

Additionaly, the area was overflown with a digital modular camera in June of 2003. This yieled high-resolution images (10 cm per pixel) for the analysis, corresponding to the most modern technology available.

This broad spectrum of data were utilised in a multi-temporal analysis, undertaken using a geographical information system (GIS), to produce a contamination risk map of the area and to identify areas likely to contain buried munitions. The multi-temporal analysis was focused on the investigation of uses and the spatial variation of these uses through the history of the training area. Based on the spatial distribution of uses and the changes in these uses through time, areas suspected to contain buried munitions were identified. The use of a geographical information system as a tool for analysis and documentation was an essential aspect of the project. GIS allows the development, allocation, analysis, calculation, documentation, management and visualisation of complex spatial information. This complexity arises when a large variety of data sources with heterogeneous temporal and spatial characteristics are used together, a variety of data formats will be involved. Additionally, a GIS will ensure that uncomplicated expansion of the dataset and the actualisation of a multi-temporal analysis through the inclusion of new information.

5. Data Preparation

The multi-temporal analysis of the Döberitzer Heide for the preparation of a munitions contamination risk map and for the identification of areas suspected to contained buried munitions was based on the derivation of combat agent risks and burial likelihood from the uses of the Döberitzer Heide and the changes of these uses through time. Additionally, the results of munitions clearance activities were considered.

The multi-temporal analysis of the use of the training area must include information from both historic and contemporary maps and aerial photographs. The survey and description of the usage structure was carried out in the *GIS Döberitzer Heide*.

The spatial structures were digitised from the maps and aerial photographs. This implies that the use structures were represented using the basic geometric forms of polygons, polylines and points. The outlines of the spatial objects were traced and saved as vector data.

The digitisation process necessitated the prior definition and systematisation of use classifications.

TABLE II. Differentiation of time periods for base-data for the *GIS Döberitzer Heide*.

Period	Time frame	Description
1	1888–1912	Pre-WW I
2	1924–1931	Post-WW I
3	1932–1938	Third Reich
4	1939–1945	Period of the Second World War
5	1949–1954	Post-war period
6	1964–1986	Period of Soviet use
7	1992–1993	Period immediately following the withdrawal of the WGT
8	1996–2003	Chemical agent clearance in the souther section of the Döberitzer Heide, current state

The available maps and aerial photographs contain a wide variety of temporal snap-shots and spatial data, which, in consideration of the relevance to the project, the information content and efficiency, required restriction.

Initially, the temporal stages were aggregated into periods. The definition of the periods was undertaken with consideration of the available data and the historical conditions. This consideration of historical events is critical, as the historical eras accompany changes in the use of the training area. A single period encompasses information describing the use of the training area from a number of actual dates. The merging of spatial data from different dates can lead to the loss of information. For this reason, time periods were defined such that, when possible, years in which structural changes in use were expected were boundary years between periods. In was in this manner ensured that the comparison of time periods would make changes in usage patterns detectable.

Table II contains the time periods defined for the project. For each time period, a model of the use patterns were constructed in the GIS. During the digitisation of the use patters of a time period, data from all data sources from within this period were considered. The most recent changes in the use patterns which took place in a time period were given higher weighting during digitisation. If changes in use patterns were identified within a period, these were noted in the attribute table of the effected use, such that this information could be considered during the multi-temporal analysis.

Beyond temporal systemisation of the use patters, these patterns also required thematic classification. The thematic classification needed to be appropriate to the analysis algorithms which were to be utilised. The characteristics of the spacial objects relevant to the analysis of spatial usage patterns and for the assessment of temporal patterns of munitions contamination must be

TABLE III. Differentiation of time periods for base-data for the *GIS Döberitzer Heide*.

Class	Definition
UXO-free (confirmed)	The "confirmed free" includes those areas documented to have been cleared of munitions during clearance activities. Copies of the certification and documentation of these clearance activities is stored at the Chair of Chemical Engineering and Hazardous Wastes.
UXO contamination unlikely	Areas deemed unlikely of containing contaminants based on historic land-use patterns.
UXO contamination likely	Areas deemed likely of containing contaminants based on historic land-use patterns.
Insufficient data	Areas classified under "insufficient data" include all areas of the training area for which no conclusion regarding contamination can be made due to insufficient data.

considered during the definition of the use pattern definition. Additionally, the use patterns must be detectable in the base data.

6. Classification of UXO Contamination

The goal of the classification is the differentiation of the area of the Döberitzer Heide with regards to local contamination with munitions. The classification is meant to act as the information basis for the planning of traffic routes and other developments to take place on the property. These developments and the future uses of the property must be planned with the consideration of local contamination with combat agents. The classification of areas is made with four classes, as defined in tab. III.

The zone "UXO-free (confirmed)" is represented on the risk map following the execution of the multi-temporal analysis. The southern part of the Döberitzer Heide is the region used by the German Federal Armed Forces and has recently been cleared of combat agents and munitions. Clearance also took place in preparation for the construction of a network of hiking trails in the northern area in 2000. The analysis was, however, tested on areas in which clearance had been undertaken and to verify the results of the analysis. Additionally, the results of the munitions clearance activities were compared with the classification. The zone "UXO contamination likely" includes areas within the target area of a shooting range, insofar as these areas had not be decontaminated.

The areas classified as “contamination unlikely” includes areas such as tank tracks from the period of WGT use, which, based on the continuous and long-term mechanical disturbances identified, can be considered to be at very low risk of containing munitions contamination. Unconsidered remain those areas in which the destruction of munitions took place. These areas are considered separately.

Areas classified as “insufficient data” include areas where holes in the data (such as clouds on aerial photographs) or difficulties in identifying the land-use patterns make the drawing of conclusions regarding contamination impossible.

7. Assessment of Individual Land Use Structures with Respect to their Effect on Local UXO Contamination

Necessary for the assessment of the munitions contamination of an area is an appraisal of the impact of military land use types on local contamination with munitions. One the one hand, the influence of single land use on the contamination of a location must be considered and weighted, while on the other hand, the influence of changes in land use through time, in the sense of the sequence of uses at the site, is an important factor in the determination of contamination risk.

The influence of the individual land uses on munitions contamination will be discussed below. It will be attempted to classify the influence of each use type on munitions contamination into three groups, namely:

- increases
- no change, and
- reduction of local contamination.

This classification schedule over-simplifies the impact of land use types on the local contamination. However, the multi-temporal analysis requires that there exist clear boundaries between the class of land use and their influence on contamination with munitions.

The differentiability and selectability of areas based on those attributes relevant to munitions contamination is a key aspect of the intersection analysis and the sequential assessment of contamination risk to follow. For this reason, it was not possible to avoid the simplification of the data.

The target areas of shooting ranges and shooting galleries heavily increases the contamination of a site given the significant deposition of munitions.

Additionally, wetlands (fens) and open water bodies were classified as contaminated. Wetlands and water bodies were historically often used for the disposal of munitions. This was the case when 69 light gas mines were found in the mud of a pond in the Döberitzer Heide during clearance activities taking place in June of 2003 (SMBDLB, 2003).

Land use types not directly effected by local contamination by munitions include forests and open areas. Open areas are to be differentiated from areas with open soil. Open areas are covered with grasses and shrubs and do not contain indicators of recent mechanical disturbance.

No direct indication of the deposition of munitions could be identified for these areas. These areas often lay fallow and underwent no mechanical disturbance. Indicators for the deposition of munitions could be found where these areas bordered other land use types.

Where forests are located adjacent to tank tracks, roadways, training locations or agricultural areas, the forests perimeters may have served for the disposal of munition bodies not directly related to the use identified with the forest. The demarcation and differentiation of forest edges in the vicinity of tank tracks and other such areas is very possible, though the definition of the width of a forest perimeter requires definition. Once this width has been defined, forest edges can be spatially identified and the increased risk of contamination considered in the analyses.

The firing positions of firing ranges, areas with bare soils and the areas where agriculture was practised are all considered to reduce the risk of local contamination. The firing positions of firing ranges were heavily frequented by troops and it is therefore concluded and assumed that the health and safety of the soldiers would have necessitated that no significant deposition of munitions into the soil would have taken place. It is to be expected that unusable munitions would have been removed from these areas.

Areas with soils open due to heavy mechanical disturbance can similarly be classified locally as free of munitions. These areas include, among others, roadways, tank tracks and training positions. Had, for example, a hand grenade become visible on track used by tanks, it can be assumed that it would have been moved to the edge of the track in order to avoid an accident during the exercise. This assumption also holds for roadways and paths.

Areas used for agriculture within the troop training area also belong to the class of areas associated with a reduced risk of local contamination with munitions. The working of a field with ploughs and other agricultural implements leads to the persistent mixing of the upper horizons of the soil. Munitions observed in this context were also generally removed.

Land use types considered in the multi-temporal analysis and the associated impacts on the local contamination with munitions are summarised and presented below:

- Increase
  - firing range (target area)
  - small arms shooting range
  - wetland edges
  - water bodies
- No effect
  - forests
  - grasslands, shrublands
- Decrease
  - firing positions
  - agricultural areas
  - open soil (tank tracks, etc.)

8. Assessment of the Dynamics of Individual Land-use Structures with Respect to their Effect on Local UXO Contamination

Beyond the impact of single land uses on the munitions contamination of an area, the influence of the use dynamics through time must also be examined. To this end, all possible original use/new use combinations were identified and evaluated.

The matrix shown in tab. IV describes the change in local munitions contamination given the original land use of period x and the new use of period $x + 1$ for all possible land use combinations. This matrix representation also reveals not only sequence of uses that would be expected, but rather all possible sequences. The inclusion of unexpected sequences, such as the changing of a land cover from an open water body to a open soil, was for the sake of completeness.

The term “open soil” included, as was described above, roadways, tank tracks and training positions.

It can be derived from the matrix that areas used as target areas or shooting ranges in time period x and used as tank tracks (open soil) in time period $x+1$ would be categorised as being at low risk of contamination with munitions.

On the basis of this assessment rule, both the changes in the expected contamination of a site or area caused by a change in land use and the change in the expected contamination in the case of no change in land use can be assessed. For the multi-temporal analysis of the contamination of the entire area, this assessment rule must be automated using an algorithm. The manual calculation of the changes in contamination for the entire area of the Döberitzer Heide for all time periods would not be possible.

TABLE IV. Matrix for the assessment of the impact of land use changes on local contamination with munitions.

		period $x + 1$								
		Firing range (target area)	Firing position	Small arms shooting range	Wetland edge	Forest	Water body	Agriculture	Open soil	Grassland, shrubland
period x	Firing range (target area)	+	−	+	+	**0**	+	−	−	**0**
	Firing position	+	−	+	+	**0**	+	−	−	**0**
	Small arms shooting range	+	−	+	+	**0**	+	−	−	**0**
	Wetland edge	+	−	+	+	**0**	+	−	+	**0**
	Forest	+	−	+	+	**0**	+	−	−	**0**
	Water body	+	−	+	+	**0**	+	−	−	**0**
	Agriculture	+	**0**	+	+	**0**	+	−	**0**	**0**
	Open soil	+	**0**	+	+	**0**	+	−	−	**0**
	Grassland, shrubland	+	−	**0**	+	**0**	+	−	−	**0**

9. Development of an Algorithm for Multi-temporal Analysis and Assessment of UXO Contamination

The results of the assessment of munitions contamination across the entire area of the Döberitzer Heide, based on the analysis of the interconnection of the temporal land-use changes, resulted in the creation of FeatureClass (data class) amalgamating data for each use type within every time period. The land use types with identical impacts on local contamination were aggregated into a single object. This object was made selectable with the help of an identification code attribute.

A FeatureClass consisting of three polygons was created for each time period. Each polygon defined one of the three groups of use types for a single time period that characterised the changes in the contamination of an area.

With the spatial differentiation of changes taking place witin time periods, an algorithm can be developed for the multi-temporal analysis of use type changes for the assessment of the current state of contamination.

The initial situation of munitions contamination of the area was after time period 1 (1888–1912). The area classified as “UXO contamination unlikely” was comprised of areas with land use types from which no contamination is expected and those areas having undergone clearance activities. The area classified as being “UXO contamination likely” includes those areas in which use types associated with munitions depositions were undertaken in time period 1.

In time period 2 (1924–1931), the state of contamination of the training area was altered by the changes in land use. The impact of the land use activities in the second time period on the munitions contamination was once again calculated using the amalgamated land use types. As mentioned above, this amalgamation resulted in the grouping of use types into three categories based on their influences on contamination levels. This influence was synchronised with the state of munition contamination calculated for the first time period. Additionally, the region which did not experience any change in contamination during the second time period was combined with the region in which changes in contamination were recorded. The resulting product was a map of the munitions contaminations after the second period, in which the contamination which took place during the second period and the changes in contamination (changes in activities effecting contamination) were considered.

When one repeats this algorithm up to the seventh time period, one acquires a contamination map that reflects the current level of munition contamination of the troop training area Döberitzer Heide. This map reflects the impacts of the land use changes of the training area on contamination levels.

10. Conclusions

The GIS-based multi-temporal analysis of historic and contemporary aerial photographs and maps is well suited for the development of a map describing areas suspected to contain munitions in the former troop training area of Döberitzer Heide.

Based on the available spatial data, a geographical information system can be used with a the developed assessment algorithm to perform multi-temporal analysis of land use types to asses the current state of munitions contamination.

The use of a geographical information system is an essential aspect of the implementation of this algorithm. The system allows the digitisation of the spatial objects based on various raster data, the merging of land use types with an identical impact on local munitions contamination, and also the the complex over-laying of areas in the context of the assessment algorithm. All preliminary and final analyses are saved within the *GIS Döberitzer Heide*, and remain available for the rapid and simple updating of the map describing areas suspected to contain munitions, should new data become available.

The four classifications of “UXO-free (confirmed)”, “UXO contamination unlikely”, “UXO contamination likely” and “insufficient data” can be integrated into the planning process of the future uses of this property. The *GIS Döberitzer Heide* offers a solid basis for the future management of this property. The basis of this management must include the continuous actualisation of the system.

References

BMfUNR (1997) Nachnutzung vormals militärisch genutzter Liegenschaften, Study, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.

Heinze, A. (1998) *Truppenübungsplatz Döberitz*, Swarzedz, Poland, Durowski.

LB (2001) Zehn Jahre Konversion im Land Brandenburg, Report, Land Brandenburg.

Möschwitzer, G. and Haas, R. (1994) Militärische Altlasten und ihre Folgen, In W. Hermanns (ed.), *Ökologische Altlasten in der kommunalen Praxis– Aufgaben der Kommunalpolitik Band 11*, Cologne, Deutscher Gemeindeverlag.

SMBDLB (2003), Personal communication from the Brandenburg State Service for Munitions Clearance.

Spyra, W. (2004) Geografische Informationssysteme für das Liegenschafts- und Konversionsmanagement ehemaliger Truppenübungsplätze, BTU Cottbus Lehrstuhl Altlasten.

MOBILE SYSTEMS FOR CHEMICAL WEAPONS DEMILITARISATION: RECOVERY, IDENTIFICATION AND DISPOSAL

Kirill Babievsky (babievsk@mail.ru)
Institute of Organoelement Compounds, Russian Academy of Sciences

Evgenii Aleksandrov (aleksandrov@center.chph.ras.ru)
Institute of Biochemical Physics, Russian Academy of Sciences

Abstract. The Chemical Weapons Convention (CWC) classifies chemical agents into different classes according to the risks they pose to the object and purpose of the Convention. This includes the destruction of stockpiled materials, as well as of old and abandoned agents and remnants.

Today, although it has been more than eighty years since the end of World War I, old chemical weapons munitions and remnants still pose a serious danger to mankind and the environment in many countries.

The discovery and disposal of old chemical weapons is an ongoing and unpredictable process. For the most part, these weapons are obsolete or leaking and pose a real threat to the nearby environs. With regard to the technologies used to destroy old chemical munitions or remnants, the most common approach is a time-consuming and hazardous procedure.

It is important to note that the possibility of the use of new technologies is much higher at small-scale disposal sites, in comparison to large-scale and continuously operating facilities designed for the destruction of chemical weapons stockpiles.

An efficient regime to ensure the safety of the population at large requires a well organised system of ecological monitoring, where systems assessments and evaluations, based on information and data specific to the region in question, play critical roles.

1. Introduction

The Chemical Weapons Convention (CWC), which was signed in 1993 and entered into force in 1997, places the duty on its member states to both declare and destroy any chemical weapons they own or possess or that are found at any location under their jurisdiction or control or that they have abandoned on the territory of another state party. Of major concern to the CWC are stockpiled chemical weapons (CW), which, by definition, are weapons produced and stockpiled since 1946. For chemical weapons from prior to

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 71–80.

1946, the Convention defines a category of "old chemical weapons (OCW)" (OCPW, 1994).

It is necessary to note that the process of safely and efficiently disposing of chemical weapons and toxic precursors is recognised as one of the highest priced and most dangerous components of disarmament. It is challenging in terms of the technical and organisational operations involved (Hart, 2000).

The CWC divides chemical weapons into different classes according to the risk they pose to the object and purpose of the Convention. This includes the destruction of stockpiled materials, as well as of old and abandoned agents and remnants.

It is possible to say now, with a high level of confidence, that the technology and expertise necessary for disposal of chemical agents and munitions do exist, and several countries have (in some cases) destroyed a significant amount of chemical arms. The United States is at present successfully realising a programme for the disposal of stockpiled chemical weapons that have long ago exhausted their warranty shelf time. In the case of the Russian Federation, the liquidation of chemical weapons, stockpiled in seven storage locations, may incur costs in excess of six billion dollars. The sharp deterioration of the financial and economic situation in 1998 has already brought about disruption of obligations to the CWC. Although uncertainty remains about some aspects of the Russian chemical weapons disposal programme, a comprehensive destruction act has been signed into law and the CW disposal process is successfully proceeding.

The effective and safe disposal of old and abandoned CW munitions is in closely related to the potential hazard posed by such weapons to the local population and environment. The general public underestimates the hazards posed by such chemical weapons, to a great extent, due to an insufficient knowledge of their states of storage. This is despite the high effectiveness of the weapons in comparison with conventional weapons, as was demonstrated by their influence on the course of fighting in World War I.

2. Size and Hazard

The total amount of chemical agents produced by chemical industries of the belligerent parties during World War I, was more than 130,000 tons (A.M., 1937) with the majority of these deadly weapons (an estimated 90%) being used on the battlefield. It caused one million casualties where more than 10% being fatal. According to a recent OPCW publication, records suggest that 20–30% of the chemical munitions used failed to function and remain concealed on European lands or in waters in non-exploded shells.

After World War I, chemical weapons research establishments were consolidated and the lessons of the gas war assimilated. Much of the surplus agents remained on the inventory of the victors, and were subsequently successfully forgotten.

Today, although it has been more than ninety years since the end of World War I, old CW munitions still pose a serious danger to mankind and the environment in many European countries, such as Belgium (near the Flemish town of Yprés), France, Germany, Italy, the Netherlands, and Poland. An exceptionally dramatic scenario of CW-stock disposal occurred in 1916 at the so-called "Gasplatz Breloh", a site located four kilometres from the centre of Munster in the northern region of Germany (Staginnus, 1994).

Following the end of World War I, transportation of large amounts of bulk and filled-in chemical agents were prepared for dumping at sea. However, in a powerful explosion on October 24, 1919, the whole infrastructure and a train, consisting of tank wagons with toxic chemical agents and numerous wagons containing CW munitions, exploded. This explosion and the subsequent dispersion of agents covered several square kilometres and caused heavy contamination with mustard and arsenic agents. During the following years and up to 1925, the whole area was decontaminated only superficially by the removal of shells from the surface of the ground.

Recently, the residents of Washington State in the US received a real lesson in the problem of hastily abandoned CW stocks. It happened when construction workers unearthed a dump of World War I-era chemical weapons in Spring Valley on the premises of the former American University Experimental Station (Argetsinger and Vogel, 2001). The first remnants of chemical weapons and mortar shells with lewisite and mustard gas were discovered during a 1993 excavation. The Aberdeen Proving Ground specialists confirmed the presence of chemical mortar rounds and 75 mm artillery shells, some of which were still intact. The US government has spent millions of dollars investigating and clearing up this area, but the task is far from complete.

According an Associated Press publication (Unknown, 1999), the Spring Valley site in Washington's north-western corner is one of thousands of former defence sites the Army Corps of Engineers is investigating nationwide.

Old chemical weapons have been discovered at the former Imperial Japanese Army depots in China and at a construction site in the Ethiopian town of Ambalaghe.

During World War II, the military research and development centres of leading industrial countries continued to create both new chemical agents and CW production facilities with annual capacity many times greater than before.

As is known from post-war publications in the Soviet newspaper *Red Star*, a German storehouse of chemical munitions was discovered and safely disposed of by Soviet military chemists in western Belarus. A considerable quantity of chemical weapons remnants was left by the Wehrmacht within Germany during WW II, as well as within Austria, Belgium, Italy, Poland and Slovenia, among others (Argetsinger and Vogel, 2001). It is significant to note that after the CWC entered into force and declarations of weapons deposits became obligatory, numerous publications on the finding of abandoned and forgotten storehouses of chemical weapons have been produced in many countries.

3. Approaches to Disposal

As a result of the extensive production, transfer and storage of chemical weapons during the World Wars I and II, the problem of old and abandoned chemical weapons now confronts many countries.

The discovery and disposal of old chemical weapons is an ongoing and unpredictable process. For the most part, these weapons are obsolete, leaking and pose a real threat to the nearby environs. With regard to the technologies used to destroy old chemical munitions or remnants, the general approach is a time- consuming and hazardous procedure.

It is important to note that the possibility of the use of new technologies is high at small-scale disposal sites when compared to large-scale and continuously operating facilities designed for the destruction of chemical weapons stockpiles (Manley, 2001).

Today, the CVC state parties have so far declared roughly fifty sites as containing old or abandoned chemical weapons; most of them have received OPCW inspections. Some countries had successfully carried out destruction programs for old chemical weapons even before the entry into force of the CWC.

In Indonesia, for example, experts had by 1979 completed the destruction by simple incineration of the bulk of mustard gas stockpiles produced by the Dutch in the 1940s.

In Russia, one of the first steps to solve the problem of CW disposal was the creation of a mobile facility (named “KUASI”) for the destruction of organophosphorus super-toxic agents which make up as much as 80% of the huge Russian chemical arsenal. According to this early model of disposal technology, a two-stage detoxification approach was applied. During the first stage, the nerve agents were disposed of with the use of triethanolamine (for sarin or soman), and with the use of an orthophosphorus acid solution in ethyleneglycol (for V-gases). The resulting reaction mass with a reduced toxicity was incinerated in a special furnace during the second stage.

The chemical munition destruction process was carried out with the original "two step" technology and in a periodic mode in a mobile complex. In this way the double barriers of safety have been achieved and the completeness of detoxification has been guaranteed.

In 1980, the facility was put into service by the Soviet Army. From 1980 to 1987 more than four thousand units of chemical munitions had been successively disposed without any harm to the involved personnel or the environment. On this basis, a prototype industrial facility for the destruction of chemical weapons was created near to the city of Chapaevsk, comprising of four disassembly lines for chemical artillery shells and rockets. The Chapaevsk facility was constructed very quickly and without delays, but was not put into operation as the political, economic and social changes in the Russian Federation have forced a "freeze" until the present time.

In the United States, the destruction of CW munitions is covered by the National Non-Stockpile Chemical Materiel Project. There are 229 suspected chemical warfare materiel burial sites at 99 locations spread across 38 states, the District of Columbia, and the US Virgin Islands. The total estimated cost of the Project is more than fifteen billion US Dollars and rising.

Mobile CW destruction systems (similar to the KUASI) are being developed for this purpose. The first mobile system, MMD-1, is undergoing testing before it becomes operational at Dugway Proving Ground (Manley, 2001).

The US is also developing a transportable explosive destruction system (EDS). The EDS Phase 1 has been designed by Sandia National Laboratories to treat chemical munitions under three scenarios:

1. at chemical munitions recovery locations where transportation of munitions is deemed to be unsafe
2. at chemical munitions storage locations where a previously recovered chemical munition is determined to be unsafe for continued storage
3. at locations where the quantities of old chemical weapons do not justify the use of other destruction systems.

Some years ago, Poland completed its programme for the destruction of the adamsite chemical agent. According to the published data, 9320 kg of adamsite were safely decomposed by reduction with phosphorous acid. The technology was found to be efficient, relatively inexpensive, and safe (Neffe and Wiki, 2001).

The old chemical warfare disposal site near Civitaveccia (Italy) consists of a mustard gas/phenyldichloroarsine mixture and adamsite destruction plants. At these modern facilities the mustard gas mixtures are destroyed by liquid phase oxidation with hydrogen peroxide, followed by neutralization with lime.

One of the most spectacular examples of old chemical weapons destruction is an experience of the disposal of 16,000 badly corroded M6 hand grenades at the British Ammunition Depot in Wulfen, Germany. Grenades had been deposited (perhaps by the US army) in the ground, and contained a mixture of adamsite and agent CN. The planned destruction was done in 1977 by specialists of Dr. Kohler GmbH using "Pyrocat" technology (Katzung, 1998).

It should be noted that a special feature of the Pyrocat is the ability to recycle arsenic. This process was realised in the mobile mode and can be recommended for the safe destruction of small stockpiles of munitions containing arsenic and sulphur CW agents.

4. Realisation of Safety

Following from the text of the CWC, each state-participant defines in which manner it will dispose a chemical weapon found on its territory. It is necessary to bear in mind that flooding, burial and incineration are banned methods for disposal. However, these methods have been used throughout Europe and in the US (Neffe and Wiki, 2001). According to the agreement, countries are at liberty to choose the technologies and processes used in the inconvertible destruction of a CW. The Convention requires that the destruction of CW conform fully to national standards regarding the safety of surrounding populations and the environment. Having been deposited throughout the territories of many countries during and between two world wars, old and forgotten stores depositions of chemical munitions represent a real danger to society and the environment.

5. Risk Assessment of CW Disposal

Some notion of the scale of the hazard associated with the disposal of toxic chemical compounds is implied by typical industrial accidents occurring at industrial chemical plants.

There have been different empirical and semi-empirical models proposed to estimate the consequences of different types of accidental events:

- fire
- explosion
- toxic leakage and dispersion.

These models have been developed on the basis of past experience and pilot studies and have been validated under specific conditions. An analysis of the potential hazard posed by the CW agent storage and disposal facilities has been carried out at Udmurtia State University in the framework of projects of Green Cross International (Kolodkin, 1988).

This group undertook the project, which includes the creation of the information database on the storage and disposal of objects and the collection and systematisation of properties of the CW agents, the creation of mathematical models of the origin of the sources of hazards, the adaptation of the models of dispersion of toxic substances in the environment, and the creation of a computer forecasting system.

The group made some predictions of the effects of various accident scenarios for objects in the Kurgan district of the Russian Federation. The analysis showed that those accidents involving fire at the storage and disposal facility posed the greatest risk of toxic impact to the population. These scenarios account for approximately 90% of the total level of the accident hazards. Unfortunately, direct losses will not exhaust the list of possible accident consequences. It is the biological and medical implications of such accidents for the wider surroundings which must be given special consideration.

An efficient regime to ensure the safety of the population at large requires a well organised system of ecological monitoring, where regional systems assessments and evaluations, based on information and data specific to the region in question, play critical roles. System assessments on the local level are, at present, based on the integrated approach and must satisfy the following requirements:

- The collection of comparable information on objects;
- The collection of information in a real or quasi-real time scale for expected operations, and under exceptional conditions;
- The observation and collection of baseline conditions and parameters for each study location;
- The documentation of methodological principles to ensure the comparability of data across sources;
- The collection of generalised data for the construction of making a database.

The crucial issues of the disposal are the technologies and the resulting by-products. It must therefore be stated that disposal and conversion remain key problems in many countries and thus pose severe threats to environmental security. Information useful for the description of technologies and wastes are listed below. Types of secondary wastes include:

- spent filtration carbon
- contaminated protective suits
- contaminated wood and other non-metal solid wastes
- contaminated metal wastes
- contaminated liquid wastes.

Disposal technology information, if available, for each of the applicable secondary wastes:

- secondary waste being considered (*e. g.* spent filtration carbon, protective suits, etc.)
- disposal technology type (*e. g.* evaporator, metal part furnace, rotary kiln, incinerator, plasma arc converter, immobiliser, etc.)
- type(s) of contaminant chemical agent destroyed (HD, HT, DA, DC, VX, sarin, soman, lewisite, etc.)
- operating temperature
- operating pressure
- reaction medium (*e. g.* O_2, air, N_2, etc.)
- use of secondary oxidizer/combustor (*e. g.* , secondary combustor)
- final destination of residues (*e. g.* landfill)
- system capacity (*e. g.* pilot, demonstration or commercial-scale, etc.)
- system status (*e. g.* operated, operating, under construction, being designed, etc.)
- technical concerns (*e. g.* safety, environmental, control, cost, etc.).

6. New Projects

One of the first steps in the destruction of obsolete stockpiles of highly toxic substances is accessing the object and exposing the chemicals for further processing. A large range of options are available in this respect and treatment can be undertaken in a number of ways:

- Thermal technologies use the heat to decompose the chemicals;
- A variety of reactor designs are available for this purpose including the fuel-fired incinerators, plasma torch, molten media, and radiation;
- Chemical treatment involving the addition of reagents to detoxify the chemical substances, sometimes making use of catalysis or activators.

In all cases, the residues and effluents resultant from the destruction process must be treated further to meet environmental standards. For an assessment of technologies of disposal, four groups of basic criteria should be chosen which reflect the main requirements of such technologies. These are technological and ecological safety, efficiency, and cost effectiveness. Further, each group of criteria should include individual criteria estimating separate properties both of the method of toxicant destruction and the technical system which applies the method.

The proposed project contains design documentation for a versatile mobile platform to be used mainly in the processing of highly toxic substances and secondary reactant masses or wastes, and their transportation to disposal sites where conditions for subsequent degradation of pollutants must be ensured. Based on preliminary analyses, alcoholysis and silanolysis in alkaline media, high temperature reduction by ammonia, and biotechnoloical destruction of toxic substances and wastes are selected for experimental testing and subsequent use.

7. Conclusions

The final analysis of the influence of technogenic factors demonstrates that most dangers are bound not only to wastes of the nuclear industry or chemical enterprises, but also with CW disposal installations.

In this context, ensuring the security and safety of such objects is a task of paramount importance. Proper decision making in this field must be interactive with the following functions:

– forecast of dangers
– ensuring systems for the protection of personnel and the environment
– monitoring of objects and ecology
– extreme emergency response.

The CWC (Paragraph 10 of Article IV) requires each state engaged in CW destruction activities "... assign the highest priority to ensuring the safety of people and to protecting the environment" (OCPW, 1994). This is fundamental obligation and, indeed, is the ultimate objective of the CW destruction process and the prohibitions contained in the CWC.

References

A.M., P. (1937) *Chemicals in War: A Treatise on Chemical Warfare*, USA, McGraw Hill.

Argetsinger, A. and Vogel, S. (2001) Excavation by Military Forces Some AU Closings, *Washington Post*.

Hart, J. (2000) Verifying destruction of old and abandoned CW: a longer, slower haul, *Trust & Verify* pp. 6–7.

Katzung, W. (1998) Disposal of M6 handgrenades, *The ASA Newsletter* pp. 19–22.

Kolodkin, V. (1988) Risk posed by the chemical weapons stockpile in the Udmurt Republic, *SIPRI Chemical & Biological Warfare Studies* pp. 94–102.

Manley, R. (2001) Overview of the status of chemical demilitarisation worldwide, and the way ahead, *OPCW Synthesis*.

Neffe, S. and Wiki, J. (2001) Development of alternative chemical technology for disposal of adamsite, DERA publication.

OCPW (1994) *Convention on the Prohibition of the Development, Production, Stockpiling and the Use of Chemical Weapons and on their Destruction*, Organization for the Prohibition of Chemical Weapons, Organisation for the Prohibition of Chemical Weapons.

Staginnus, B. (1994) pp. 1–2, Federal Armed Forces Scientific Institute for Protection Technologies and NBC protection.

Unknown (1999) Army to clean up deadly nerve agent in Indiana, *Associated Press*.

APPLICATION OF COST-EFFECTIVE TECHNOLOGIES IN THE PROCESS OF CLEAN-UP AND CONVERSION OF FORMER MILITARY BASE IN BORNE SULINOWO

Slawomir Neffe, Andrzej Spychala and Jerzy Bil
Military University of Technology, 00-908 Warsaw 49, Poland
www.wat.edu.pl

Abstract. Since 1990, Poland has launched massive efforts to manage and solve the large-scale environmental pollution on more than twenty abandoned military bases. The government project started with the development of an environmental risk assessment methodology and the estimation the environmental loses and costs which were needed to perform immediate, medium-term and long-term remediation activities.

The aim of this article is to discuss the methodological, technical and economic tools aimed at securing the optimal performance of the environmental risk assessment and remediation activities at these abandoned military complexes of land forces and fuel depots.

The typical feature of the abandoned large military base is that the relatively localised areas of high pollution are neighboured by vast areas which are free from pollution and thus could be reused for commercial or social purposes. The land and infrastructure-use management strategies aimed at the conversion of former military sites had to be focused on the real need for action in the most polluted "hot spots" and the identification of unpolluted areas.

This paper describes the experience gathered during the investigation of the abandoned Borne Sulinowo military complex, which was composed of several types of sub-areas: troop housing and barracks, armoured forces training areas, firing ranges, NBC troop training area, diesel and rocket fuel depots, munitions depots, workshops and repair stations, and hospital and wild waste dumps.

Several sub-projects aimed at the rehabilitation of the polluted and damaged sites with the purpose of meeting national environmental standards are described. The main problem was the stopping of the spread of pollution into the soil and ground water and to secure the areas contaminated during exercises against chemical warfare agents. Large quantities of hazardous wastes were found to have been dumped underground. These wastes have been recovered and neutralised on-site by using a specially developed technology.

This project has resulted in the rehabilitation of existing infrastructure, buildings and installations in Borne Sulinowo for social housing and recreational purposes. Most of the former military area has been completely remediated. A large portion of the land has been forested and is being reused for civilian purposes.

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 81–91.

TABLE I. Borne Sulinowo site apportionment.

Site Feature	Surface Area (hectares)
Settlement, barracks, roads, garages	550
Surface water	420
Forests, grasslands	12,260
Damaged land, troop training areas, etc.	4,740
Informal waste dumps	30

1. Introduction

Poland began the restructuring of its Armed Forces and the conversion of surplus military bases for civilian use in 1990. Simultaneously, due to the withdrawal of the Russian Federation military forces from Poland, large former military land areas have become available for conversion to civilian uses. One of the first activities undertaken on an abandoned military base undergoing conversion is an environmental reconnaissance and risk assessment, which help military and civilian authorities undertake decisions concerning the future uses of the land and infrastructure.

In 1993, the Polish Ministry of Environmental Protection started research projects devoted to the development of a environmental risk assessment methodology, necessary for the estimate of environmental loses and costs of short, medium and long term remediation activities on abandoned military bases. This complete and extensive study, followed by revitalisation and remediation activities, has been performed on the Borne Sulinowo site, which was abandoned at the end of 1992 by the armed forces of the Russian Federation.

Borne Sulinowo was one of the largest and most important military bases in Poland undergoing "fast track" conversion. The site is situated in north-western Poland. This military complex occupied 18,000 hectares and consisted of the garrison of Borne Sulinowo, two firing ranges, five troop training areas, a small airfield, twelve repair workshops, as well as other military facilities and infrastructure including two large fuel depots, twenty-four munitions and rocket stores, telecommunication facilities, a side railway track and railway station, a hospital, 300 garages, a drinking supply station, three heating stations, and three large depots of military equipment. Table I provides a more detailed breakdown of the site features.

The former military complex Borne Sulinowo has been designated as the highest priority site for remediation because of the following reasons:

TABLE II. The history of former use of the Borne Sulinowo site.

Date	Use
1930	Small village of Linden (there were six other small villages and hamlets in the area). 320 people live in the region.
1931–33	Building of the military base for artillery school and explosive firing ranges.
1934–44	Artillery school for Wehrmacht, training centre and firing range for armoured troops (Gross Born), and Nazi prisoner of war camp.
1945–92	One of the main military complexes of the Northern Group of Soviet troops in Poland, training and education centre for artillery and armoured troops, fuel and munitions stores, barracks and housing areas.
1993–2000	Basic town infrastructure revitalized and developed, 2750 people live in the town. Remediation activities are ongoing.
June 2005	Town infrastructure is well developed, 4149 people live in the town. Majority of remediation works have been completed.

– size and significance on the map of abandoned military sites in Poland
– complexity and diversity of environmental problems
– diversity of former military and municipal infrastructure
– possible advantages for inhabitants and future investors.

2. The History and Former use of the Region of Borne Sulinowo

The military complex at Borne Sulinowo was used for military purposes from 1933 until 1992, initially by the Wehrmacht (1933–1945), and then by the Northern Group of Soviet Troops (1945–1992) assigned here for housing and the training of ground forces. In September 1992 the abandoned military property was transferred by the Ministry of Defence to the civilian authorities of Slinowo commune. At present (May 2005) the basic town infrastructure is well developed and 4149 people live in the town. Table II provides a more detailed history of the area.

3. Environmental Risk Assessment

Common procedure and policies were used to make an initial assessment of selected land areas. An environmental audit identified areas of potential environmental concern and included a site investigation. The initial approach to the environmental site investigation used non-destructive surveying including aerial photography, soil vapour surveys and electromagnetic surveys. Non-destructive surveying techniques were usually followed by borehole investigation, soil and water sampling, monitoring well installation, and the chemical analysis of soil and surface water samples. This logical approach was designed to maintain the integrity of the environmental site investigation in a timely and cost-effective manner. The environmental audit was divided into following distinct tasks:

- review of existing data, relevant information and vital documents
- research of site history
- inventory of existing facilities and infrastructure
- execution of on-site audit
- compilation and analysis of accumulated data
- development of environmental site investigation plan.

The environmental audit characterised the types and concentrations of main contaminants present in various media on the site. This information indicated whether more detailed sampling was necessary in specific areas and provided initial input required to develop appropriate site criteria. The site investigation conducted after the environmental audit was intended to:

- identify locations and types of contaminants and ranges of contaminant concentrations
- identify directions and rate of ground water migration
- classify soil, geological and hydro-geological conditions at the site
- determine background concentration of contaminants in soil and water
- locate any underground infrastructure, including storage tanks and pipelines
- characterise subsoil/groundwater conditions in the vicinity of underground storage tanks and piping network
- estimate volumes of contaminated subsurface media in order to recommend remedial actions and estimate their costs.

A brief profile of the site investigations was composed of:

- non-destructive site screening
- subsurface soil characterisation
- groundwater sampling program
- organic vapour screening

- chemical analyses
- quality assurance/quality control program
- evaluation of chemical and environmental data
- reporting.

Based upon the findings of the environmental audit and environmental site investigation, appropriate remediation actions were recommended where warranted. All information and recommendations compiled during the environmental site assessment were presented in a comprehensive report. At a minimum, the report included the following issues:

- inventory of hazardous materials including quantities and locations
- recommendations regarding the inventory with respect to sound environmental practices
- assessment of current environmental managements practices and compliance with existing and proposed practices
- listing of all non-compliance areas at the site
- assessment of potential risk and problem areas
- recommendations and costs for remedial measures where warranted
- ranked listing of contaminated areas with recommendations for clean-up.

The following aspects of the environmental damages in Borne Sulinowo were considered: pollution of the ground water by petroleum derivatives and other chemical substances, pollution of surface water, damage and pollution of the land surface, contamination by chemical warfare agents, radioactive contamination, damage to forests and biological life; and the presence of unexploded munitions, explosives, other hazardous materials and chemicals of military origin. From the point of view of environmental media, the following elements were investigated:

- Soil: (i) at the surface, (ii) from the surface down to a depth of 0.5 m , (iii) from a depth of 0.5 m below the surface to the water table.
- Water: including (i) drinking water intake, (ii) groundwater, (iii) surface water (stagnant and running), (iv) artificial reservoirs of water (*e. g.* fire-fighting water) as well as (v) waste water.
- Air: including (i) air above the surface soil and (ii) air inside buildings, barracks, tanks, containers, etc.

The environmental risk assessment identified some heavily polluted areas in the midst of forests, lakes, rivers and meadows. The main causes of contamination were mineral oil products, chemicals, munitions and explosives, and technical and municipal wastes. Local authorities, who own the land and infrastructure, had developed the garrison and the surrounding area as a tourist and recreational region.

During the first phase of the environmental assessment of Borne Sulinowo the following issues were identified and developed:

- preliminary environmental site assessment (audit);
- national environmental criteria and standards and remediation target values for soil, ground water and surface water;
- the most suitable remediation technologies;
- pricing the assessment and remediation activities;
- possible financial sources for remediation and revitalisation activities;
- social, economical and political aspects of site conversion and remediation process.

These achievements were found to be very useful and we used them extensively when coping with the environmental problems on other abandoned military sites in Poland.

Like many local authorities, those in Borne Sulinowo lacked adequate funding to fully address the environmental and technical problems. Most clean-up activities were undertaken prior to 2000. The most difficult and expensive was the de-mining of the firing range. This activity continues to be executed. The Polish government assisted the local authorities in their plans and provided funding for larger remediation projects, which have been implemented primarily taking into account the health and safety of inhabitants and in agreement with regional development plans.

4. The Largest Remediation Problems

The environmental risk assessment of Borne Sulinowo showed that among the vast unpolluted areas (housing area, lakes and rivers) some heavily contaminated sites exist. The nature and extent of contamination in Borne Sulinowo was typical for extensive military complexes used by ground forces and armoured troops. The main contamination has been caused by mineral oil products, chemicals, unexploded munitions and explosives, rocket fuel, heavy metals and solid waste (scrap metal), as well as municipal wastes (illegal dumping sites).

The environmental pollution, though in many places serious, was localized on relatively small "hot" areas. Approximately 1% of total soil surface and 5% of ground water resources in Borne Sulinowo were polluted and had to be remediated, while 30% of forests were found to be partially damaged.

The most difficult remediation problems faced by the authorities in Borne Sulinowo are as follows:

- protection of drinking water intake against pollution originating from illegal dumping sites of communal and technical wastes, from former open air storage area of chemicals, and from the former fuel depot;
- building new dumping site for solid and liquid wastes and liquidating the existing illegal dumping sites;
- revitalisation of old sewage treatment plant;
- clean-up of soil and groundwater in the former fuel depots;
- clean-up of soil in the area of former rocket fuel and oxidant depots;
- checking and clean-up of firing ranges and target areas for the presence of unexploded munitions and explosives;
- restoration of forested areas;
- checking and if necessary chemical, technical and military waste clean-up of Lake Pile.

Several sub-projects are described that were aimed at the rehabilitation of the polluted and damaged sites in order to comply with national environmental standards. The first problem was to protect the lives and health of inhabitants by stopping the spread of pollution into the soil and groundwater and securing areas contaminated during exercises against chemical warfare agents. Large quantities of hazardous wastes were found to have been dumped underground. These wastes have been recovered and neutralised on site using a specially developed technology.

4.1. EXPLOSIVE FIRING RANGE

With surface area of approximately 2000 hectares, the firing range consisted of training areas for artillery, tanks, guns, and other military facilities. The environmental risk assessment of the firing range identified some contamination from unexploded munitions, parts of exploded munitions, scrap metal, oil-derived products, chemicals, heavy metals and building wastes. Because of inadequate founding, local authorities have as yet been unable to undertake a complete remediation project. However, the Polish Army has helped the local population by performing the assessment and collecting and destroying visible unexploded munitions. Generally it was decided that the optimal method for the revitalisation of the firing range is through the reforestation of suitable places and natural attenuation. Because of explosion danger, part of the former firing range is still not accessible to civilians.

4.2. DRINKING WATER SUPPLY

The drinking water supply of Borne Sulinowo was built in the vicinity of the settlement. It consists of twelve wells, each seventy meters deep. Until recently, the drinking water quality was very good; even chlorination was not required. Unfortunately, there were heavily polluted areas near this supply. In particular there were areas formerly used for the open air storage of chemical substances, napalm, decontaminates and other chemical substances for defence against chemical warfare agents. Special emergency and medium-term measures have been taken to protect the drinking water supply against pollution. For instance:

– Illegal waste dumps were removed and wastes were moved to the new specially designed waste dump site.
– Subsurface water in the polluted areas was cleaned by air sparking followed by technical adsorption.
– At present drinking water in Borne Sulinowo is of good quality and fulfils all legal requirements.

4.3. REMEDIATION OF ABANDONED LIQUID BALLISTIC MISSILE PROPELLANTS STORAGE AREA

The ballistic missile fuel and oxidizer storage area of was found in the forest, four kilometres west of the settlement and barracks of the Borne Sulinowo garrison. This former rocket fuel depot, with a surface area of circa three hectares, contained twenty-eight tanks with volumes ranging from 17 m^3 to 50 m^3. It was situated in the near vicinity of the main diesel fuel depot with surface area of approximately twenty-three hectares and with more than 1000 fuel tanks (total volume 38,000 m^3), as well as connecting pipes, buried in the sand. The ground in the site consisted in 96% sand, gravel and sand-gravel and only 4% of boulder-clays. The water table was about thirty-five meters under the surface of the soil. Part of the soil was found to be strongly polluted with nitric acid and amine-based liquid rocket fuel.

The samine consisted of mixture of aliphatic [triethylamine (TEA) and diethylamine (DEA)] and aromatic amines [a mixture of isomers of dimethylaniline (DMA)]. This fuel is extremely dangerous because of its toxic and explosive properties. Because this substance was, at that time, not considered an environmental concern, there was no ready-to-use analytical procedure for the detection of its presence in air, soil or water.

As the liquid oxidant for this fuel is highly concentrated (*ca.* 98%), fuming nitric acid is used. The nitric acid was stabilised by special additives (iodine or fluoride ions) and was stored in special quality aluminium tanks. The toxicity of the concentrated nitric acid is caused by its extremely oxidative and acidic properties as well as by the mixture of highly toxic nitric oxides (N_xO_x) which, if the acid is not stored in sealed storage, evaporate from the fuming nitric acid. When an organic substance (*e. g.* samine) is put in the close contact with the highly concentrated nitric acid (melanj), immediate ignition occurs.

Preliminary site inspection and initial site assessment showed that the area surrounding the former rocket fuel depot was highly polluted with organic amines, aliphatic and aromatic hydrocarbons, nitric acid, and sulphur containing organic substances. It was estimated that at least 1500 m^3 of ground should be decontaminated and cleaned up. The abandoned tanks remaining contained the highly concentrated nitric acid and amine based liquid rocket fuel.

The local authorities decided to carry out emergency measures involving the liquidation of fuels and oxidants which have been found in tanks, as well as the removal of all tanks buried in the area. A risk assessment was also performed before starting this activity. The priority was given to the former rocket fuel (samine) depot.

The objects of the remediation action were twenty-eight tanks. Twelve tanks contained a total of approximately 3100 dm^3 of the remaining amines-based liquid rocket fuel. Two tanks contained about 300 dm^3 of organic fuel containing trimethylphenols. Fourteen aluminium tanks were found to contain in total approximately 2600 dm^3 of the remaining of highly concentrated nitric acid.

4.4. ROCKET FUEL LIQUIDATION TECHNOLOGY

The fuel was pumped out by means of a special pump designed for aggressive organic liquids. The remaining fuel was adsorbed using sawdust. The fuel and sawdust were burned on site in a small-scale mobile incineration installation. Special attention was paid given to the aversion of soil pollution during the handling of organic liquids.

4.5. NITRIC ACID NEUTRALISATION TECHNOLOGY

Remaining highly concentrated nitric acid was diluted on-site with the excess of water (up to *ca.* 5% of HNO_3). Next, a calcium hydroxide suspension was added until the full neutralisation of the acid was achieved. The neutral solution of the calcium nitrate was pumped out of the tanks. The tanks were once more washed with a slightly alkaline solution of $Ca(OH)_2$, and next with water. The effectiveness of the neutralisation and tank cleaning was checked by means of a pH-meter and nitrate analysis.

4.6. FORMER NBC TRAINING AREA

The former training area for NBC protection for soldiers and troops had a area of twenty hectares and consisted of several sub-sites and installations: a decontamination preparation site, an area for training with napalm, an area for the training of soil and troop decontamination, a fire fighters training area, and a storage area for chemicals. The soil and ground water was found to be polluted with alkaline decontaminates (calcium hypochlorite), organic solvents, activated carbon (wethlerite: Cr, Cu. Ag) impregnated charcoal, and solid wastes. Also, light underground shelters were found. In close vicinity to the NBC training area, 296 barrels were discovered buried one meter underground, some of them filled with an organic liquid. During an emergency action all barrels were removed and secured in a locked storage area. The liquid in the barrels was analysed and identified as a benzole with *ca.* 5% chloroacetophenone. These barrels and their contents were disposed of by specialised company within a separate sub-project. Careful site sampling and analysis showed that sandy soil in this area is alkaline and needs to be neutralised. For this purpose fitoremediation technology (based on planting special grasses and supplying the soil with acidic fertilisers) was applied. After two years the soil became slightly acidic and suitable for reforestation. At present the site is forested with young trees.

5. Current State of Borne Sulinowo

At present the town and communal development is supported by good municipal infrastructure, relatively small distance between large agglomerations in Poland and Germany, and tourism value. The Borne Sulinowo economic development strategy is based on tourism, recreation and “environmentally friendly” commercial and light industrial ventures as the principal industries.

As a result of the conversion, remediation and revitalization processes the existing infrastructure, buildings and installations in Borne Sulinowo have been rehabilitated for social housing and recreational purposes. Most of the former military area has been fully cleaned up. A large part of the land has been reforested and reused for civilian purposes.

One of the most important source of incomes to the town Borne Sulinowo and surrounding villages is tourism. This is due to its convenient location on Lake Pile, that a high proportion of the town is forested (57%) and the resulting microclimate. An important factor was the possibility of adapting existing buildings for functions related to tourism, as well the generation of a sophisticated trade and gastronomic infrastructure and a broad range of cultural activities in former barracks and in the officers' club.

6. Lessons Learned

The successful conversion of former military sites requires short, medium and long term management plans. The process is continuous and needs a well developed plan, sufficient funding, technology and time. The remediation and conversion of former military lands is a long and complex process. These activities are often expensive to implement, and a variety of funding sources are necessary.

There is a fundamental need for an overall assessment and prioritisation of all polluted areas and hot spots within a country or region, and this assessment should be conducted at the federal or regional level. Environmental risk assessment plays a crucial role in deciding the intensity of clean-up, and should be applied before selecting the remediation technology. Health and safety issues must be considered as the most important in restoration and conversion projects. Internal resources, such as personnel, available technology and raw materials should be used for initial site assessments.

Site assessments should be balanced. They should recognise drawbacks and problems (such as contamination that must be cleaned up), but also advantages (such as the economic or natural value of the site once it has been converted). The value of new or expensive tools, such as remediation techniques or risk assessment methodologies, must be balanced against the benefits they provide. Allocations within the project budget must consider the pay-offs of each element. New, efficient, and low-cost remediation technologies dedicated to the revitalisation of polluted military sites can and still need to be developed.

THE FORMER MILITARY TRAINING AREA KÖNIGSBRÜCK AND NATURE RESERVE KÖNIGSBRÜCKER HEIDE IN THE CONTEXT OF REGIONAL POLITICS WITH PARTICULAR CONSIDERATION OF HAZARDS AND PUBLIC SAFETY FROM THE VIEWPOINT OF THE SITE OWNER

Ingo Werners
Stiftung Wald für Sachsen

Abstract. The Former Military Training Area Königsbrück and Nature Reserve Königsbrücker Heide is owned by the private foundation Wald für Sachsen ("Forests for Saxony"). The military training area is—according to natural conservation activists and authorities—the largest and most important nature preserve in Saxony. At the same time, it is subject to the interests of many different groups. Many legends prevail regarding its military uses that are often incorrect. Perhaps this report will help to shed light on the reality. This article will serve as an overview of the situation at the former military training area and of activities taking place there.

1. Recent Situation

1.1. SITE OWNERSHIP STATUS

Originally, the foundation Wald für Sachsen was founded in 1996 to facilitate reforestation in Saxony. The foundation is guided by a board of trustees with six members. The members of the board of trustees are appointed by the German Forest Protection Association (Schutzgemeinschaft Deutscher Wald), the Ministry of the Environment of the Federal State of Saxony, the Treasury Ministry of the Federal State of Saxony, the Federal Bank of Saxony (Landesbank Sachsen Girozentrale), the association of forest owners (Waldbesitzerverband), and the society "Prima Klima".

The intention was to found an institution that contributes to the political objective of increasing forestation in Saxony to 27–30%. Initially, the development and implementation of reforestation projects was the only task of the foundation. This included the development of funding strategies and the acquisition of funding for reforestation projects. Saxony financially equipped

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 93–107.

the foundation such that administration and personnel costs were fully covered, allowing donations to be used directly for projects. Two employees in Leipzig (head office) were the nucleus of the foundation.

Soon afterwards, discussions on the incorporation of the former military training areas Königsbrück and Zeithain and other former Soviet military sites into the foundation began. In 1997, the Stiftung Wald für Sachsen foundation bought the military training areas Königsbrück and Zeithain for 1 DM. At the same time, Saxony promised the foundation 25,000,000 DM in five instalments of 5,000,000 DM.

With the acquisition of the former military training areas, the foundation increased its staff: a site manager, two professional hunters and two administration staff were hired. In 2001 and 2002, a general manager and three woodsmen were hired. The latter take over most of the work in the field of public safety, including the maintenance of barriers, signposts, etc. Since 2002, special employment programme staff are no longer employed for these tasks.

The foundation became a site management institution in this manner. Reforestation projects were and still are carried out from the Leipzig head office.

1.2. MILITARY SITUATION

In 1904, a fifty-four square kilometre military training area was established by the army of the kingdom of Saxony west of the village of Schwepnitz. In this first stage, the villages Otterschütz, Quosdorf and Zietsch were resettled. The military training area was used for military training and shooting exercises by both the army of the Kingdom and, later, the Reichswehr. The military training area is the birthplace of military aerial photography in Germany.

In 1936, the military training area was taken over by the Wehrmacht. The military training area was extended in 1938. The villages of Bohra, Krakau, Rohna, Sella, Steinborn and Zochau were resettled. Some of the abandoned villages on the site were used for training in urban warfare.

It is reported that the site was used by the Wehrmacht for infantry, artillery, engineer, and tank training. It is also reported that Waffen-SS units trained on the military training area Königsbrück.

Soviet troops used the military training area as a base and training site for armoured troops, armoured infantry, ballistic missile troops and communication units. A famous rumour is that SS-20 ballistic missiles were stationed here. However, only SS-12 ballistic missiles were stationed in Königsbrück.

Parts of the military training area were used for the training of airborne troops and exercises with helicopter gunships. The military use of the military training area ended with the withdrawal of Soviet troops in 1992.

The investigation of former military uses of the site is difficult, because the military land use has varied through time. Obtaining detailed information of military uses is therefore extremely challenging and is further hampered by military secrecy. On the one hand, this results in legends about military use, and, on the other hand, in surprises in site management, investigation and the clearance of unexploded ordinance (UXO). We are, however, learning step by step about the history of our site, and every piece of information gathered over time helps to complete the image of its military past.

1.3. HAZARD SITUATION

Hazards result from unexploded ordnance and hazardous wastes resultant from the military use of the site. The hazard situation as described in continued investigation reports and risk assessments is the basis for public safety measures. Unexploded ordnance found at different locations on the site are an important source of information with respect to the reconstruction of military land use on the former military training area. The UXO Clearance Service of the Federal State of Saxony has concluded, with respect to UXO contaminations:

> "A serious and difficult contamination with unexploded ordnance resulted from the historical military use of the site. It is not limited to firing ranges for infantry, artillery and tanks but also
>
> – hand grenade training areas
> – bomb drop zones and air-surface firing ranges
> – blasting areas for training and dud disposal
> – assembly areas, bivouac sites and camps
> – defensive systems
> – ammunitions depots
> – scrap yards
> – barracks and equipment parks
>
> that were set up and used by German and Russian (Soviet) forces at different locations. Uncontrolled burials and disposal by Russian troops during the use and withdrawal periods increased the hazards considerably."

Immediately after the withdrawal of Soviet troops, the UXO clearance service started with the investigation and elimination of hazards on the former military training area. The main foci were:

- disposal of ordnance that was disposed of in buildings, and at equipment parks and scrap yards

- clearance of a road network for site management and (forest) fire protection
- clearance of water reservoirs reserved for fire fighting
- investigation of burials that were evident at the surface
- clearance of accessible fringe areas of the site.

Until today, we continue to learn new things about the site and its use on a daily basis.

1.4. NATURAL CONSERVATION SITUATION

The military use inevitably resulted in the exclusion of the civilian population from the site. At the same time, the military exercises and intensive use of firing ranges was of different intensity in different areas of the site. This in turn resulted in almost untouched areas which had been of no military interest (*e. g.* floodplains, back swamps, etc.) on the one hand and devastated areas in other parts (*e. g.* tank firing ranges, target areas, tank exercise areas) on the other hand.

In addition, the whole site was and remains deserted (*i. e.* free of humans) and not divided by roads or other infrastructure.

This land use resulted in ideal environments for certain species, vegetation forms and processes. For some this was already the case during the phase of military use, for others it became true with the termination of military use.

Today, we are proud of the "uniqueness" of the natural inventory. Examples are the beaver, sea eagle, gentian and orchid species and unique plant communities. They are all a result of human, that is to say military, action. This is often forgotten when the natural reserve is discussed.

Because of this, and because of other reasons, nature conservation is undecided between species conservation and the protection of natural processes. This becomes obvious through the functionalised sanctuary zones (development zone, zone of guided natural succession, natural development zone) and the natural conservation plan for development (Naturschutzfachlicher Pflege- und Entwicklungsplan). This plan leaves questions of public safety unconsidered and open. Also—as far as we know—it has not been agreed upon with public authorities responsible for public safety. Such a situation can lead to conflicts.

From our point of view, one important finding with respect to the conservation of certain natural development stages within the nature reserve is that natural succession and reforestation proceeds much faster than predicted by experts. Because the site is registered as both a FFH (Flora-Fauna-Habitat) area and a SPA (Special Protection Area/European Bird Sanctuary) area, discussions might arise in the future because of changes in the area.

1.5. LEGAL SITUATION

The contract for sale of the site between the federal state of Saxony and the Foundation obliges the owner to undertake "UXO/hazardous waste clearance, with the bearing of all costs." At the same time, the decree on the establishment of the nature reserve (Schutzgebietsverordnung) of October 1, 1996, restricts the owner and other users of the site with respect to access of the site. One can say that the foundation is thus limited in its autonomy and authority over its own property. This is also true when considering the contract of sale in which the foundation agreed to accept the status of nature reserve and the necessary work and research on the site with respect to nature conservation.

At the same time, the civil code (*Bürgerliches Gesetzbuch*) and the penal code (*Strafgesetzbuch*) oblige the owner to adhere to provision of traffic safety (clearance, closing) to prevent prosecution or damage claims.

Thus, the SWS is caught in a complicated legal network that sets up stringent requirements but at the same time limits the room to manoeuvre. This often results in conflicts between parties with different interests in the site.

A certain degree of protection from damage claims is obtained from a decree that prohibits unauthorised access to the site for all areas that are contaminated with unexploded ordnance and ammunition (police order from December 12, 1997). At the same time, access to the site is prohibited because of its status as a nature reserve. Thus, access to the site is limited by two decrees. This fact is unclear to the local population.

1.6. DESCRIPTION OF THE SOCIAL ENVIRONMENT

The former military training area of Königsbrück is surrounded by several villages. From an economic point of view, the area can be considered underdeveloped. Unemployment is high despite the vicinity to the state capital, Dresden.

With the withdrawal of Soviet troops in 1994, hopes arose that the newly established nature reserve would bring an economic stimulus for the region, *e. g.* through tourism. Because the population was promised advantages from the conversion of the former military training area Königsbrück, it strongly opposed any continued military use. At that time, the establishment of a combat training centre was being considered for the site. In contrast to promises made to the population, any use of the site which could draw revenue (*e. g.*

tourism) has not yet been allowed—despite the decision for a nature reserve and against continued military use.

As a consequence, the population feels excluded from the site and perceives the site as a burden to the region and regional development. Pressure on politicians to improve the situation is mounting continuously. For us this is also problematic because we are observing an increase in illegal access to the site. Such access posses a clear, self-imposed danger to the trespassers.

In the meantime, politicians are beginning to address the problem because of the mounting public pressure. Among other options, the establishment of a national park is discussed as a development objective for our site. Positive examples for similar sites are the Hainich and Eifelnational Parks. Both have also been used by military forces in the past. Similar discussions are going on for other active and former military training areas (military training area Senne and former military training area Lieberoser Heide. A decision has not yet been made on our Königsbrück site.

1.7. SITUATION FROM THE PERSPECTIVE OF THE SWS

Based on the legal and actual situation, the SWS takes the view that public safety and the protection of life and health have the first priority. This priority has been realised in actions taken by the SWS within the framework it faces.

One of the first priorities was the creation of a road network on the former military training area free of unexploded ordnance and ammunition in 1997. Also, we are trying to improve safety by beginning clearance activities at the fringes of the site and proceeding inwards.

Immediate hazards, in particular hazardous wastes disposed of in an uncontrolled manner and contaminated soil and groundwater, were addressed from the beginning and were largely eliminated by the former owner, the Saxony State Bank. Thus, no acute hazards were to be addressed when the site was taken over by the SWS.

In 2001, the strategy (improving safety from the fringes to the centre) was detailed with a priority plan. Steps were taken to define further measures, to evaluate measures taken against an evaluation matrix and to contribute to a systematic reduction of hazards on the site.

The following aspects were considered for the derivation of the priority plan:

- likelihood of accession of the site by third party persons (legal and illegal)
- hazard situation based on knowledge about UXO contamination
- likelihood of liability claims

- insurance coverage in the case of damages to third parties
- contribution to the management and site development
- evaluation of forest fire hazards
- significance of site use for recreation and nature conservation
- time needed to yield results from measures taken.

The demolition of barracks and other built structures became more and more important. However, hazardous wastes, contaminated sites and unexploded ordnance and ammunition still remained the focus.

During the implementation of the priority plan, different interest groups appeared. The situation became more complicated when the different protagonists accepted a common strategy for improving public safety but have their own ideas about single measures and objectives that often change over time (the SWS, too, changes objectives and measures if new, relevant information is obtained). These factors make the situation more difficult with respect to the elimination of hazards, site management and site development.

Additionally, the general public in the region does not regard the foundation as a site owner but rather as an institution of the public authorities. Because of this, pubic expectations are unrealistic.

For each measure to be taken on the site, the foundation, as a private site owner and because of the site's status as nature reserve and the decree that prohibits access to the site, must apply for permission from the public authorities. The terms and conditions of the granted permits are often in excess of what is generally accepted. In these cases we feel that we are not regarded as a private site owner. As a private site owner, the SWS often lacks the power to implement its environmental and public safety objectives within the projected time frame.

Another objective of the SWS is to avert liability and damage claims. As a consequence, measures planned for the improvement of public safety must be enforced by legal means. Of course we know and accept that interests brought forward by other interest groups have their justification. However, considering the overall success we are proud of the degree of demilitarisation that we have reached during the last years.

1.8. PLANNING SCENARIOS AND INSTRUMENTS APPLIED BY THE SWS AND THEIR EVALUATION

1.8.1. *Instruments*

One instrument that is important for successful conversion is the development of a network of interested parties with a good mutual understanding. Because this is a workshop with a major focus on public safety, I will focus on public safety institutions, namely the UXO clearance service of the federal state of Saxony, the police, the Bundeswehr and the local fire brigades. The municipal public affairs offices also play an important role.

When considering forest fire prevention, cooperation with the state forestry commission is of particular importance. Cooperation with the authorities mentioned has been excellent during the last couple of years. Only with them are we able to provide and improve public safety on and around the former military training area Königsbrück.

Every measure taken on the site is first agreed upon by the state UXO clearance service. Before any measure is realised in the field, a joint consultation with other interest groups (*e. g.* groups concerned with nature conservation, protection of historic buildings and monuments, and building authorities, etc.) takes place.

Apart from the priorities presented above, an attempt was launched to summarise the existing knowledge and experts' opinions in order to prioritise necessary measures to improve and provide public safety. This involved the development of a geographic information system (GIS) that is now used for site management and development planning and continues to become more and more important. The development of the GIS site management system was achieved in cooperation with the Chair of Chemical Engineering and Hazardous Wastes of the Brandenburg University of Technology.

The GIS site management system that was first introduced in 2001 did not initially meet our expectations as the practitioners in the field. We were quite impatient. The system was newly redeveloped with all newly acquired data. This seemed to have advantages over purchasing basic data from public authorities.

With the continuing development of the system, further consultation and increasing knowledge about the possible uses of the system, it has become more and more accepted. Today we are convinced that the introduction of the GIS system was an important step.

Third parties often envy us our GIS system, in particular because more and more data are accumulated in it. Data on hazardous wastes and contaminated sites, unexploded ordnance contamination and—to some extent—data on nature conservation are part of the data included incrementally in the system.

Another instrument used for site management is forest inventory (Forsteinrichtung). This is an up-to-date instrument that presents the recent forest development situation on the site and can be used to make predictions with respect to forest development over the next decade. Combined with detailed planning, it is a good basis for our forest management.

We use high precision TOPCON-GPS and hand-held computers with GPS to apply our GIS in the field. This also improves emergency response in cooperation with rescue and fire fighting forces.

In the meantime, the SWS has tried to introduce the TharGet planning program of the state forestry commission. The initial introduction failed because the need for site-specific adaptations was too high (land parcels, UXO contamination, etc.). However, our plans continue to become more detailed and precise from year to year.

Over time we continues to accumulate not only new knowledge, but also questions posed by our board of trustees. Recent events on the site, in particular findings of ammunition where no ammunition had been expected and forest fires on the site, contributed to the raising of new questions. Additionally, we exchanged information and paid visits to colleagues in Brandenburg and thus gained new experiences and information. For these reasons, the board of trustees decided that the legal situation had to be reviewed, and, correspondingly, the priority list and measures to improve public safety required updating.

2. Review of the Public Safety Strategy

2.1. EXPERTS' OPINIONS AND COSTS

In May 2004, the board of trustees reached the conclusion that the situation of the SWS, with respect to its Königsbrück property, required a new direction. The basis for this conclusion was a risk assessment study of the site that had identified measures necessary for the protection of public safety and associated legal questions.

Until then, the consideration of legal questions was limited to single areas of law (*e. g.* civil code, penal code, etc.). The new study included the following relevant areas of law:

– law on foundations
– public law
– civil law
– criminal law
– environmental law
– law on explosives
– law on the prohibition of warfare arms
– law on war burdens.

In summary, the study concluded that the SWS is obliged to do take every possible measure to prevent damages and accidents. This results from police law and environmental laws, in particular laws for the protection of water resources and soils. This was not necessarily new, however the balancing act between being obliged to take every possible step to prevent damages and accidents on the one hand, contrasted with a lack of authority to implement one's objectives, a limited public acceptance of the situation, unreasonable public expectations, and a large number of additional interest groups on the other hand, have made management exceedingly difficult.

With respect to the priority list derived from the risk analysis and the legal analysis, an expert, Prof. Peine of Berlin, referred to hazardous wastes and unexploded ordnance experts for further guidance.

The results of the risk analysis developed by Prof. Spyra were also highly interesting. With respect to the situation concerning hazardous wastes and contaminations the study comes to the following conclusion:

> "Because of the inhomogeneities of the unknown burials and contaminations that have not been registered or investigated, no statement is possible with respect to possible contaminations of soil and groundwater (in particular groundwater) with contaminants like fuel hydrocarbons, chlorinated hydrocarbons, explosives and other substances. Potential contamination can therefore not be assessed."

Concerning contamination with unexploded ordnance, the study concludes:

> "Because of the evidently highly abundant unexploded ordnance and known history of use as a military training area, a contamination with unexploded ordnance must be assumed for every piece of the site until there is proof to the contrary or until existing hazards have been eliminated."

Additionally the UXO clearance service stated that the use of irritants and chemical warfare agents by Soviet forces on the former military training area that was proven by findings of fog mines and containers containing chloropicrin was certain.

Prof. Spyra proposed that the SWS take the following measures:

- Systematic reduction of hazards to public safety by systematic UXO clearance from the fringes to the centre with particular consideration of Bundeswehr directive (Heeresdienstvorschrift) 183/100. A reduction of safety distances in coordination with the state UXO clearance service seems to be possible.
- Development of a remediation plan with prioritisation and cost estimates.

TABLE I. Cost assessment estimates for UXO clearance.

Safety buffer	Length	Cost € 0.40/m^2 (min.)	Cost € 0.50/m^2 (max.)
Outer border	44,000 m	€ 17,000,000	€ 22,000,000
Road network	100,000 m	€ 40,000,000	€ 50,000,000

- Development of strategic objectives from the point of view of the SWS for the further development of the Königsbrück site.
- Continuation of investigations with respect to detailed risk assessment, in particular a detailed historic investigation on the military use of the site.
- Measures to protect own employees and third party persons.
- Re-consideration and assessment of the insurance policies for the site.
- Implementation of the decree on the prohibition of access to the site and reduction of access to the site to an absolute minimum.
- Continued and step-by-step UXO clearance of the whole site based on the developed remediation plan and the priority list.
- Evaluation of reports on the first assessment and registration of contaminated sites, remediation and demolition work and emergency response from 1992 to 1997 and implementation of the information from these reports into the GIS site management system.
- The board of trustees was advised to consider the clearance of a road network with a buffer of 500 m left and right of each road for emergency response.
- Within the frame of the historic investigation and the extension of the GIS site management system, a reconstruction and re-assessment of known contaminations and disposals should be considered.

2.2. RESULTING COSTS

If the proposals of Prof. Spyra are calculated from a cost point of view and based on the statistics of earlier UXO clearance projects, a cost assessment for the former military training area Königsbrück would be similiar to what is shown in tab. I on page 103.

2.3. UPDATE OF THE PRIORITY PLAN

Not only based on the above mentioned methodology, but also in cooperation with the state UXO clearance agency and the environmental authorities on a regional level, the SWS decided to update its priority plan. Among others, the objective was to get a more detailed overview of costs arising in the future if the plan is implemented.

At first, the hazards arising were defined:

- unexploded ordnance, ammunition and explosives;
- hazardous wastes and contaminated sites;
- built structures: barracks, bunkers, equipment parks (built structures attract people who are then endangered by their presence on the site);
- potential for forest fires (in particular in combination with UXO contaminations).

Apart from the Zeisholzer Lager, all major barracks have been demolished. Thus, the attraction for the general public has been considerably reduced. With respect to the studies of Prof. Spyra and Prof. Peine, UXO contamination, hazardous wastes and contaminated sites are now the major focus of our work, though they were never neglected in earlier activities.

The responsible regional authority is now assessing whether the SWS needs to address contaminated sites and hazardous wastes based on recent data. A final decision has not yet been made.

With respect to the update of the priority plan on unexploded ordnance, the SWS has contacted the state UXO clearance service which has promised support. The following procedure has been agreed upon to assess the risks and develop major foci and priorities:

- Production of a map that depicts military land-use of the site to the best of our knowledge.
- Definition of eighty test sites (10 × 10 m) based on military land use, the vicinity of the borders of the site and the proximity of living quarters. Geophysical investigation and, where necessary, UXO clearance according to the state of the art.
- Visual UXO clearance on an area of 100 × 100 m surrounding every test site with the objective of obtaining an improved knowledge of UXO contamination over larger areas while at the same time limiting the technological and fiscal effort.
- Depiction of the results in a map on UXO contamination.
- Derivation of priorities (priority plan), including where possible a cost estimate.

– Implementation of the priority plan in cooperation with the state UXO clearance service and specialised private sector companies.

Altogether, the priority plan is expected to provide a maximum of information and contribute to the improved development of the site.

2.4. FOREST FIRE PROBLEMS

The hazard of forest fires on the former military training area is high. The Königsbrücker Heide is classed as forest fire hazard class A1, the highest class in Saxony. During the last ten years, no development with respect to forest fire prevention has taken place at the site. The road network that was cleared of UXO for emergency response purposes is being degraded by natural succession. Problems with respect to the maintenance of the road network arise because of interests in nature conservation. Also, the road network is not marked and operative-tactical exercises have rarely been exercised during the last years. Because of this and because of continuing natural succession, orientation on the site is becoming more and more difficult for emergency response personnel.

However, based on the latest studies and improved communications, in particular between UXO clearance service, fire services and the foundation, the awareness for the hazards has improved. Improvements of forest fire protection are a future topic for the SWS.

2.5. FIRE FIGHTING OBJECTIVES

The main objective of fire fighting is to prevent an uncontrollable fire that could spread into the neighbouring cultivated land. Included in this general objective is the protection of life, health and property.

At the same time it is necessary to prevent secondary events such as the spreading of fire to disposed hazardous wastes or ammunition, or the explosion of ammunition at the surface exploding because of exposure to fire. We do not know what will happen in a major fire beyond the forest fire itself and therefore need to prevent forest fires. This is also true when considering that unexploded ordnance becomes more unpredictable after it has been exposed to fire but not has detonated.

2.6. MODERN APPROACHES TO FIRE FIGHTING

Fire fighting is only permitted from the road network cleared of ammunition using high-range of fire fighting equipment (“water monitors” – 60 m). The maintenance of the cleared road network is therefore a priority in forest fire prevention on the site.

Fire fighting from the air can only supplement efforts on the ground because of the limited availability of suitable helicopters from state police, federal police or even the armed forces. Until helicopters become available during a fire, much time could be lost and the fire might have developed into a major fire.

Also, the basic task of these institutions is different from fire fighting support. Other demands and claims that forest fire fighting on the site could take place completely from the air are wishful thinking. Further, fires ultimately need to be extinguished by trained fire fighters. It includes the extinguishing of pockets of embers, the prevention of subsurface spreading of fires and repeated flaring up of fires. At the same time, the risks posed by ammunition and unexploded ordnance are recognized by fire fighting authorities.

2.7. PROBLEMS

The risk for forest fires is particularly high in the pine forests in the northern part of the site. In any event, the risk for forest fires is assessed as very high for the whole site. Ammunition poses a particular risk.

2.8. FUTURE APPROACH

The nature reserve Königsbrücker Heide will soon be subject to a fire prevention inspection according to the state law on fire protection. Following the fire prevention inspection, the SWS will receive notification from the local authorities with directives for further fire prevention measures. The fire prevention concept will be updated in the autumn of 2005 in combination with the UXO hazard map for the site. The state UXO clearance agency will be consulted for this.

After the concept has been updated, nature conservation will be consulted because necessary measures will require approval. This concept is supposed to be designed such that future re-negotiations are mitigated and to allow for an implementation of prevention measures.

Part of the prevention measures are:

- maintenance and marking of the road network
- maintenance and development of forest fire lanes
- creation and maintenance of water supplies for fire fighting
- maintenance of access points to the site.

At the same time, the concept is supposed to describe weaknesses and open questions in order to bring the discussion to a higher level of administration. The SWS will then—for the first time—have an overall concept that unites the problems of hazardous wastes, contaminated sites, unexploded ordnance and fire prevention that has been developed in coordination with the responsible authorities and can be implemented in the future.

3. Discussion

Considering the developments described, the following questions remain for discussion:

How high are the real hazards that are posed by the site? This question can not be sufficiently well answered by anybody. However, our present state of knowledge has improved considerably.

Could a systematic approach have been taken earlier? Basically, the approach was practised earlier when we engaged public authorities in a dialogue. The decision of the board of trustees is the logical consequence of the experience gained in earlier years. However, not all differing interests in the site are united in this decision. As far as public safety is concerned, progress has been made. In all, we must notice that the existence of a high number of interest groups representing their legitimate interests does not facilitate the development of the site. However, those parties with responsibility for public safety are now working in the same direction.

What are the future prospects for the former military training area? Our objective is that the site contributes to regional development and that it is no longer regarded as an obstacle hampering this development. Therefore we aim at a combination of all forces, as this will help in the development of the site. One instrument could be the establishment of a national park. The nature inventory allows for this option and related examples exist. Our tasks in the field of public safety require a supreme effort from our staff on a daily basis. Without them and the cooperation of the public authorities, this task could not be accomplished.

HAZARDS TYPICALLY ASSOCIATED WITH DIFFERENT CONVERSION SITES AND INVESTIGATION STRATEGIES FOR HISTORIC MILITARY LAND-USE ANALYSIS AND RISK ASSESSMENT

Kay Winkelmann, Ph.D.
Research Assistant
Brandenburg University of Technology Cottbus

Abstract. Based on the experiences of projects in the field of conversion, the hazards typically associated with different conversion sites such as former military training areas, air fields, barracks, bunkers and fortifications, depots, battlefields, armament factories, explosives production facilities and chemical warfare agent production facilities are presented. Then, strategies for the historic investigation of former military sites and sources of information including historic maps, aerial photographs, archival records, eye witness interviews, analysis of contemporary literature, military specifications and service regulations are discussed with respect to their utilisation and acquisition from different archives and libraries and their value as sources of historic information. Finally, the combination of single pieces of historic information into a mosaic depicting a near-complete image of activities at former military sites and its application for risk assessment are considered.

1. Introduction

Undoubtedly, former military sites and battlefields pose threats to public safety and environmental security. Former armament production facilities and former military sites that are subject to military-civilian conversion usually reveal numerous hazards, including burials and disposals of hazardous wastes, wide-spread contamination with unexploded ordnances (UXO), contaminations of soil and groundwater with explosives, fuel hydrocarbons and other organic and inorganic contaminants. Depending on the history of a certain site, hazards and contaminations occur either concentrated in hot spots or as more or less uniform contaminations over larger areas, or both. Also depending on the history of a site, certain contaminations may occur in homogeneous patters while others are distributed in a highly inhomogeneous way. The specific hazards at conversion sites largely depend on the site type and military

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 109–125.

land-use forms. Typically, hazards and contaminations found on former military training areas are different from those found at the sites of barracks, airfields, depots, former battlefields, etc.

Despite being obstacles to successful military-civilian conversion, these hazards need to be addressed to prevent damages to the civilian population or continued environmental pollution from source areas after the termination of military use.

Police law and other laws on public safety generally require the protection of the public from hazards or risks that exceed the average risk level of normal life. The protection of the public from the threats posed by former military sites might be achieved by closure of the sites to the public and/or unexploded ordnance (UXO) clearance, clean up and remediation.

The first option, the prohibition of access to sites that have already been closed for decades because they were used by the military, is often unpopular with the general public in general and the local population in particular. The second option, the elimination of hazards posed by hazardous wastes, unexploded ordnance and contaminants, is often unaffordable, even in for "wealthy" industrialised countries, because much painstaking manual labour is required for the clean up of these sites due to the hazards involved.

However, both options require comprehensive site investigation to identify the hazards (*e. g.* hazardous waste deposits and burials, UXO contamination, etc.) on a particular site and conduct a thorough risk assessment. In the first case, the knowledge of the hazards is necessary to define the areas to be closed to the public and the surrounding safety buffers. In the latter case, knowledge of the hazards that have to be expected is necessary to develop a remediation plan with a priority list and to provide the necessary occupational safety measures for employees working in the clean-up projects. For example, it is absolutely necessary to know or assess whether chemical warfare agents, depleted uranium ammunition or other particularly hazardous materials have been or could have been used on a particular site.

To achieve this objective, either a technical site investigation or an in-depth historical investigation of historic military land use can be carried out. Technical site investigation applying geophysics, UXO clearance of representative areas of a particular site and sampling and analysis is extremely expensive (in particular for large sites and facilities) and does not provide complete coverage. Due to inhomogeneities and hot spots, important information might be missed in a technical site investigation limited to representative sampling, *e. g.* the use of chemical warfare agents or ammunitions could be highly localised and could escape detection by representative sampling.

A detailed historical investigation including multiple sources of information (or virtually all available sources of information) does not require the resources of a technical site investigation but can provide a comprehensive patchwork of historic and spatial information that cannot be obtained from technical site investigation measures.

The subsequent sections will summarise experiences obtained during projects of the Chair of Chemical Engineering and Hazardous Wastes of the Brandenburg University of Technology, Cottbus, with respect to historical investigations of former military sites now subject to conversion efforts.

First, the typical hazards and contaminations encountered on different types of conversion sites will be considered. Then, the strategies and tools for the reconstruction of military land use at different times using a comprehensive approach for historical investigation that often results in a patchwork of relevant information that can be put together like a puzzle to provide a nearly complete image of military activities on a site during the different periods of their use will be outlined.

2. Typical Hazards on Conversion Sites

Generally, UXO contamination cannot be ruled out on former military sites and former battlefields except when they have been cleared of unexploded ordnance. The use of explosive ordnance in training, exercises and war lies in the basic nature of military services in all nations worldwide since early times. Therefore, UXO contamination has to be expected on every type of conversion site until the contrary is proven.

Also, the military perception of "clean" in the past seems to have been considerably different from the civilian perception. When summarising experiences at numerous military sites both in Germany and abroad with countless burials and uncontrolled deposits of ammunitions, unexploded ordnance, explosives and hazardous and domestic wastes on former military sites, the motto among military institutions in the past often seems to have been "it's clean when it's not visible or otherwise evident at the surface."

Here, only military-specific contaminations that either resulted from the use of military-specific materials or equipment (in particular weapons, munitions, explosives and warfare agents), contaminations that resulted from the production of the former, are considered. Non-military specific contaminations are only considered insofar as they are a direct result of military action and not related to activities occurring similarly in the civilian sector (*e. g.* maintenance of vehicles, fuel storage, etc.).

Basically, contamination patterns on conversion sites have to be placed in two categories: systematic and non-systematic contamination patterns. Systematic contaminations result from the long-term use of certain areas for a certain purpose according to specific military regulations, for example tank or artillery shooting practice on special firing ranges on a former military training area. Non-systematic contaminations, *i. e.* singular hot spots like random contaminations, uncontrolled burials or UXO or waste deposits, usually result from singular events like battles or air raids during a war.

MILITARY TRAINING AREAS

Former military training areas as subjects of conversion are probably the most complex site types. Military training areas have typically been used for several decades up to almost 200 years. During this time, they have typically been extended and have undergone changes and modifications to adapt them for their purpose, namely the training of specific military branches with specialised equipment, weapons systems, and tactics.

On military training areas, systematic military land-use dominates the contamination patterns. Infantry, tank, artillery and air-to-surface firing ranges, blasting sites, tank and vehicle training courses, infantry training areas, are different types of training areas.

Due to their long-term and highly intensive use, contamination patterns on former military training areas are complex. While contaminations that were caused by systematic military land use can usually be described and limited to certain areas, different contaminations patterns of different periods are often found to be superimposed in varying numbers of “historic layers”.

In addition, not only systematic contaminations are found to occur on these sites, but also non-systematic, hot-spot type contaminations that can usually not be connected to certain systematic activities on the site. This is based on the fact that most military training areas not only served for standard military training and exercises, but also for research and development of new equipment, explosives, ammunitions, warfare agents and tactics.

While large areas of former military training facilities are found to be highly contaminated with unexploded ordnance (both live and practice ammunitions, explosives and mines) and military waste burials (for example decontamination agents, respirator filters, etc.), other areas that were useless for the required training, inaccessible for certain equipment or served as safety corridors to adjacent civilian-used areas, are found to be almost un-contaminated. Additional hazards are caused by dilapidated structures, including provisional buildings, abandoned villages and barracks, and old bunkers and fortifications.

The overall contamination pattern of a former military training area that is subject to conversion therefore tends to be a patchwork of highly contaminated areas, slightly to moderately contaminated areas and uncontaminated areas.

DEPOTS

Different kinds of military depots were used to store military supplies. Usually, depots store specific supplies for one or a few branches (*e. g.* artillery ammunition depots, medical depots, etc.) or general supplies (*e. g.* fuels, rations, vehicle spare parts, etc.).

While UXO contaminations are unlikely at military depots, except when they were the subject of battles in wartimes, uncontrolled burials and disposals of discarded (expired) goods, in particular of hazardous materials, are abundant at these sites. Unstable explosives were, in particular, often buried on the sites of depots and on neighbouring sites, especially during and after World War I and World War II. These include munitions not considered safe for handling and chemical warfare agents and munitions.

At the sites of fuel depots, soil and groundwater contaminations with fuel hydrocarbons, specialised fuels (*e. g.* liquid rocket fuels) and lubricants are often evident.

AIRFIELDS

The typical contaminations found at the sites of military airfields include unexploded ordnance, fuel hydrocarbon contaminations of soil and groundwater, and waste burials in so-called “million-dollar-graves”.

Unexploded ordnance at the sites of former military airfields in Germany typically include bomb duds (high explosives bombs, incendiaries) from allied air strikes in World War II, but often also infantry and artillery ammunitions that were disassembled and/or destroyed at the sites of former airfields after World War I.

While fuel hydrocarbon spills often occurred over long periods at these sites, some go back to World War II when refuelling facilities were destroyed during air raids.

A speciality of airfields is the so-called “million-dollar-grave”: burials of partial and whole aircraft wrecks, and ammunitions and unexploded ordnance that were buried for secrecy reasons when it was not possible to destroy them.

BATTLEFIELDS

Battlefields are different from former military facilities in many respects. The dominant hazards on former battlefield are posed by unexploded ordnance including artillery ammunitions, aerial ammunitions including bombs and bomblets, explosive devices, and minefields featuring anti-personnel mines, anti-tank mines and booby traps. Unexploded ordnance found on former battlefields is exclusively live ammunition.

Because wartime events on battlefields were usually short-term and locally restricted events extending over several days to weeks and sometimes months, only standard weapons systems and ammunitions of the respective period are to be expected. In some cases however, in particular on battlefields of the last days of the Second World War, also improvised and non-standard weapons and ammunitions are to be expected.

BARRACKS

Barracks, as the living quarters of troops with their associated technical facilities and garages for equipment, typically feature soil and groundwater contaminations in and around technical facilities (fuel hydrocarbons, solvents, paints, etc.), burials and disposal sites of military-specific and non-specific (domestic-type) wastes that are often mixed in landfills or improvised deposits. In some cases, ammunitions, unexploded ordnance and warfare agents have been found on the sites of barracks and even in buildings that served as living quarters.

BUNKERS, FORTS AND FORTIFICATIONS

The main hazard of abandoned, unsecured bunkers, forts and fortifications is typically related to the fact that they are unsafely built structures featuring vaults and unstable building infrastructure. Along borders, on military training areas and former battlefields, bunkers and fortifications have often been used for the storage and disposal of ammunitions and unexploded ordnance. After World War II, many bunkers were destroyed to make them useless for military purposes–often not completely successful.

EXPLOSIVES AND WARFARE AGENT PRODUCTION FACILITIES AND AMMUNITION PLANTS

Armament factories such as explosives production facilities, chemical warfare agent production facilities and ammunition plants that have been operated for long periods typically feature multiple and complex hazards and contaminations.

Raw materials (basic chemicals), process materials (solvents, cleaning agents, etc.), intermediate products and products like explosives, chemical warfare agents and live ammunition can pose severe hazards at these sites.

Pipeline systems and underground storage facilities are often found to still contain raw materials, intermediate products or products such as explosives. Intermediate products, residuals and wastes are typically found on on-site or proximate landfills. Liquid wastes at the sites of explosives and warfare agent production facilities were often injected into the subsurface through injection wells. Extended soil and groundwater contaminations with chemicals, products and degradation products are typical.

Discarded ammunition (rejects) and unexploded ordnance can be found at associated testing facilities like blasting sites and firing ranges.

3. Historic Investigation Strategies

For most of the above-mentioned cases, historic investigations can be a great help in describing the potential hazards on a former military site or battlefield. Historic military land use analysis can be conducted for most of the above-mentioned cases by puzzling together small pieces of information that are found in different archives, libraries and other sources. However, although much information can be retrieved from archives, it will never be sufficient to provide a full and complete image of military activities on a certain site.

A systematic approach for time-consuming and painstaking research is necessary in order to retrieve relevant information that is not always found via direct hit searches but in indirectly related fields or the files of institutions that, for one or the other reason, received copies of relevant papers concerning a site or have a relevant product or military unit connected to a site.

Of general interest in a historical investigation of a former military facility are the beginning of military use, important historic periods of military use (*e. g.* in Germany pre-WWI, WWI, post-WWI, interwar years, WWII, post-WWII), troops stationed and/or exercising on the site during each historic period, and military and military-industrial institutions conducting research and development on a site. Additionally, the weapons systems, tactics and strategies of each period and the associated installations and training facilities used, erected or modified during each period, are of interest.

Sources of information that can be used for military land-use analyses include:

- aerial photographs and other remote sensing imagery;
- historic maps;
- military specifications and military service regulations;
- archival records of military units, branches, administrations and armament factories;
- eyewitness interviews;
- site visits;
- secondary sources (*e. g.* historic photo-postcards, contemporary literature, memoirs, etc.);

– UXO clearance data.

As a general observation, archival information of all above-mentioned kinds is highly diversified and delocalised in many private, company and different state archives. This is in part due to the heterogeneous organisational structures of the military and civilian institutions involved, but also to war losses and the seizure of important materials by allied forces, in particular after World War II.

AERIAL PHOTOGRAPHS

Historic aerial photographs that are (in Germany) usually available from the mid-1930s onwards in five to ten-year intervals can provide accurate, unbiased information on the situation on a site at the time of image acquisition.

Countless aerial photographs were taken of important German cities and military facilities during World War II. However, only a minor fraction of allied reconnaissance photographs is available in Germany. Most of these aerial photographs are found exclusively in archives in the United States and the United Kingdom. In the United States, most wartime aerial photographs are archived by the Smithsonian Institute. Due to the vast number of photographs, only parts have been recorded and can be considered as fully accessible. In the United Kingdom, wartime aerial photographs are archived in the Aerial Reconnaissance Archives at Keele University. Large stocks of World War II aerial photographs of Eastern Germany that were still held at a UK military facility for mapping purposes were only recently disclosed.

During the Cold War era, access to imagery of military installations was restricted and—in East Germany—usually erased from the images by military or counter-espionage services. Thus, almost no aerial imagery of military facilities—whether Soviet or German—is available for Eastern Germany for the period of *ca.* 1960 to 1990.

It is generally assumed that both reconnaissance photographs of the German air force from the World War II period and Soviet reconnaissance photographs of the Soviet air force of Eastern Germany are still held in now-Russian archives. However, these stocks are not documented and have to be considered as inaccessible at this time.

Where aerial photography is unavailable, imagery of the US Corona and Keyhole programs, and Cold War era satellite reconnaissance programs, may provide information on military land use structure despite their relatively low resolution of two to ten meters per pixel.

HISTORIC MAPS

Historic maps of former military sites are typically available onwards of the mid-nineteenth century. Especially for military training areas and armament factories, detailed maps and plans can usually be found in map libraries and military archives. These maps not only provide topographical information on the sites, but also thematic information on training facilities and installations. Among the information found in these maps are the size and location of firing ranges, observation posts, communication lines, assembly points, areas for dug-outs, bunkers, barracks, stationary radio towers, and sites for specialised training (*e. g.* hand grenade exercise ground, driving school areas, etc.).

However, misinformation in maps was common in publicly available maps of important military installations, especially during wartimes. Therefore it is always necessary to verify information from historic maps independently, *e. g.* by comparison of maps of different years or comparison of maps with aerial photographs or written reports.

MILITARY SPECIFICATIONS AND SERVICE REGULATIONS

While military service regulations and specifications for equipment, ammunitions, weapons systems and other explosive ordnance cannot provide direct information on a military site under investigation, it can greatly help to enhance the understanding of what was done how and where on a former military site.

Another advantage of military specifications and service regulations is that they are—in contrast to other materials like archival records—widely available from libraries and archives as they were usually mass-produced. However, for advanced military equipment, weapons and ammunitions that were used in the past, regulations might not be available due to reasons of secrecy.

Information obtained from specifications and regulations might include detailed descriptions of training facilities for certain equipment and systems, the range of weapons systems, training plans, etc.

However, specifications and regulations only describe state-of-the-art systems and military conduct valid for the time period between the first publication and the publication of a revised or new version. They do not account for non-conformal or improvised training and conduct.

ARCHIVAL RECORDS

Often, no direct records of recent military use of a site that is now subject to conversion are available because they remain in the property of military institutions after a site is given up. Also, the course of history with two major wars in Europe and different players (in Germany for example imperial forces, the Wehrmacht, Soviet, US, British, French and other troops) has resulted in the loss and scattering of relevant records.

If records can be retrieved from archives, they are always found to be incomplete, non-representative of the information that probably was accumulated in records, and only allow for an insight into small portions of the investigated object (*i. e.* , time periods, areas or fields). Often, the information that can be retrieved is limited to information that was exchanged with fiscal and environmental authorities that were involved in the administration of these sites or that were informed about certain events.

Where available, archival records are highly diversified and delocalised in a large number of different archives. For example, relevant records on the former military training area Döberitz were found in the US National Archives in Washington D.C., in the UK Public Records Office in London, the Archives of the Max-Planck-Foundation in Berlin, the German National Archives in Berlin and Koblenz, the German National Military Archives in Freiburg, and a number of municipal, personal and company archives.

EYEWITNESS INTERVIEWS

Eyewitness interviews have long been regarded as a valuable source of information in the historical investigation of former military in civilian brownfields. However, the value of eyewitness interviews for the historical investigation of military land-use at former military installations is generally questionable, regardless of whether civilians or former military staff are interviewed.

Personal records are often imprecise and unreliable as they only represent one person's subjective perspective on events and sites.

Military myth and misinformation have generally been found to be widely believed by civilians living in the vicinity of former military installations. To some extent, this is also true for military staff, as their view of the activities on a site was in most cases limited. This is because military personnel often serve clearly defined functions and for a limited periods at a garrison. This observation particularly true for military training areas to which troops were usually deployed for unit exercises and training for periods ranging from days to weeks. Military training areas usually had only very few permanent staff for the administration and maintenance of the site. If such staff are still available for interviewing, they may be able to provide valuable insights into the activities at a site. However, this is generally only for a limited period of time, usually a few years.

In general it is found that the “results” from eye witness interviews often require intensive additional research to verify the information obtained and often lead to dead ends.

OTHER SOURCES

Other historic sources that might provide small but valuable pieces of information and give insight into the visual appearance of a site include photo-postcards, photos found in personal photo collections and historic literature and memoirs. Especially during the early 1900s, photo-postcards of points of interest at former military training areas included firing ranges, bunkers, hills, etc., and were frequently produced and sent home by military staff. Today, these photo postcards are sold as collectibles. Similarly, personal photo collections of former military staff might provide valuable visual insight into the appearance of former military sites.

Historic literature and memoirs sometimes also provide insight into the activities on certain sites, in particular as far as the development of new weapons and weapons systems (*e. g.* chemical warfare agents, nuclear weapons, etc.) are concerned. Many scientists involved in these research and development activities wrote diaries and memoirs. As well, contemporary scientific literature could offer relevant information.

RECENT MILITARY LAND USE ANALYSIS

As usually no written records on historic and recent land use are available, in particular as far as former military training areas are concerned, the analysis of built structures and anthropogenic earthworks on former military training areas can provide insight into activities at these sites.

Expert knowledge or at least expert systems (*e. g.* software that provides a guide to the interpretation of land use structures) is necessary for the interpretation of landforms and built structures of military origin and their connection to military land use and activities.

UXO CLEARANCE DATA

Data accumulated during UXO clearance operations on former military sites—whether on a systematic basis, on an occasional basis in preparation for construction work or when UXO are incidentally found—can be used for the interpretation of land use intensity and land use types.

Information on the density of UXO contamination, types and ages of UXO found, the mode of disposal (duds on firing ranges, burials, disposals), the condition of the UXO (safe for handling or not, fired or unfired, marks of blasting, etc.) and the spatial distribution pattern on a site can greatly help to understand land use structures and is required for a careful risk assessment.

Surveying during UXO clearance using differential global positioning system or other high-resolution surveying instruments and the use of a geographic information system for administration and visualisation of UXO clearance data are the basic elements that allow for an utilisation of UXO clearance data for historic investigation and risk assessment.

Unusual objects that are not classed as unexploded ordnance, such as gas cylinders or special military equipment that hint at certain activities of interest and that are usually removed during UXO clearance operations, should also be considered.

In summary, UXO clearance data, where properly acquired and visualised, can greatly help during a historic investigation with new findings and verification of results from other sources.

COMBINATION AND VERIFICATION OF HISTORICAL DATA

With continuing historic research using the above-mentioned information sources, more and more site-related specific and general information is accumulated. By weighing and combining these "puzzle pieces" of historic information on former military land-use, a comprehensive image of military land-use can usually be derived.

In the case of most former military sites that have been used over long periods of time, it is useful and in many cases also essential for a successful analysis that data and analysis results be arranged according to historic periods that correspond to certain relevant developments in general or military history, or to changes of users.

For most former military sites in Germany, whether in former East or West Germany, the following periods have been found to best match historic developments:

The historic development of most former military sites in both the former East and West Germanys are found to match the periods show in tab. I.

The verification of historic information is of particular importance as most sources only provide tiny pieces of information that are often not in a context that allows for their verification or assessment. Therefore it is necessary to verify all pieces of historic information by comparison with information from other sources. For example, information from maps should always be verified by comparison with aerial photographs of the nearest year and with

TABLE I. Significant periods for German military sites.

Time-frame	Description
1850–1913	Pre-World-War I
1914–1918	World War I (wartime economy, intensive build-up and training of military staff, development of chemical warfare agents and weapons)
1919–1938	Interwar Years (disarmament after Worl War I, 1919–1922; re-armament, 1933–mid–1939)
1939–1945	World War II (wartime economy, intensive build-up and training of military staff, development of many new weapons systems and military tactics, air attacks and battles fought on German soil)
1945–1990	Cold War era (disarmament after WW II, 1945–1950; Cold War, 1950–1990)
1990–today	Post Cold War era (disarmament, withdrawal of allied troops, in particular Soviet troops, conversion of former military sites)

photographs and photo-postcards, and vice versa. Written reports and eye-witness accounts should always be verified by comparing information on, for example, installations and topography to maps. Information on firing ranges used during certain periods should always be compared to the military specifications and regulations valid at that time. Also, a site inspection at points of interest usually helps to get a better understanding of activities on a former military site and to verify information from historic sources.

Thus, the value of information can be increased by confirming facts and excluding others that can not be verified or are found likely to be incorrect.

THE CASE STUDY: DÖBERITZER HEIDE

During 2003 and 2004, the Chair of Chemical Engineering and Hazardous Wastes was carrying out a historic investigation project for the former military training area Döberitz, now known as Döberitzer Heide. The main focus of the historic investigation was the development of chemical warfare agents by the Kaiser-Wilhelm-Institute for Physical Chemistry and Electrochemistry (KWI), because chemical ammunitions that were considered to belong to experiments carried out by the KWI were found. However, the general land use and its developments on the site were also investigated in order to derive an UXO hazard map and identify suspected burial sites. The following information was retrieved from more than twenty different archives and libraries in Germany, the United Kingdom and the United States:

Aerial photographs. While only single flight lines of aerial photographs taken before, during or after air attacks on targets in the vicinity of the Döberitz site were found in German archives for the time of the Second World War, two full sets of aerial photographs from 1941 and 1943 were retrieved from archives in the UK and the US, respectively. Altogether, more than 350 aerial photographs for the time period from 1939 to 1996 were acquired from archives.

Maps. About seventy historic maps with a scale of 1:10,000 to 1:50,000 for the time frame 1876–2003 were collected from a number of national and international archives and libraries, most of them also containing specific information on military land-use and training facilities.

Military specifications and regulations. Military regulations with a major focus on firing exercises and the disposal of chemical warfare ammunition provided important information on the structure and size of firing ranges for artillery during and prior to World Wars I and II and the methods of disposal of chemical warfare ammunition in the field.

Archival records. In the UK Public Records Office at London, the US National Archives at Washington D.C., the German National Archives, the Archives of the Max Planck Foundation, and the German National Military Archives, more than 800 files were searched for relevant information. Among others, administration records of the former military training area, files on building projects, records on the destruction of excess ammunition after World War I, laboratory and field test records on chemical warfare agent experiments and police records on incidents with civilians on the site were retrieved.

Historic literature. About two hundred books and journal articles on chemical warfare agents, their development, use and protection against them were searched for relevant information. Some contemporary books on chemical warfare and personal memoirs written by scientists involved in the development of chemical warfare agents during World War I were found to contain detailed information on experiments carried out at Döberitz. Examples in the field of chemical warfare agent development are the memoirs *My Life* by Otto Hahn and the book *Chemical Warfare* by Curt Wachtel. Both were involved as scientists and military staff in the research carried out at the

Kaiser-Wilhelm-Institute of Physical Chemistry and Electrochemistry during World War I.

Eyewitness interviews. Interviews with eyewitnesses were found to provide little valuable information but rather produce incorrect information. For example, two witnesses reported burials of chemical warfare agents during World War II. Despite considerable efforts, no hint of the storage at or transport of chemical warfare agents to the Döberitz site was found. Rather, detailed information suggested that no chemical warfare agents were transported to, stored on or handled at the site during World War II.

UXO clearance data. The reconstruction of the location of chemical warfare agent findings clearly showed that chemical warfare agents were usually found at two topographically interesting structures on the former military training area obviously used as test sites. One, a local circular depression, obviously corresponded to a site referred to as "Döberitz Circus" in test protocols retrieved from archives.

4. Risk Assessment

Following the acquisition of virtually all historic information and data available from archives, a risk assessment based on the greatest hazards posed by unexploded ordnance, chemical warfare agents or other hazards like contaminations and waste deposits on a specific site and the distance between these hazards and goods that require protection can be conducted. The prerequisite for a risk assessment therefore is—apart from the historic investigation and the fusion of the information into a detailed history of military land use—the identification and mapping of goods that need to be protected (abiotic goods such as soil and groundwater, biotic goods such as vegetation and wildlife, and humans). However, not only the distance between hazards and goods that require protection must be considered, but also the accessibility of sites where perpetrators might induce additional hazards or increase existing hazards due to illegal activities including the theft of explosive ordnance.

The main problem of risk assessment for hazards of military origin is that usually no binding regulations on minimum safety distances for unexploded ordnance are available for the civilian sector. Safety distances defined for blasting of stone, concrete and steel structures in the civilian sector (*e. g.* German Occupational Safety Standard BGV C24) or safety distances defined for the destruction of ammunitions by detonation in the military sector (*e. g.* German Army Service Regulations HDv 183/100) might be assumed as standards that can be used as a guideline for defining necessary safety distances for former military facilities and sites that are contaminated with unexploded ordnance and disposed munitions. However, the introduction of an additional safety factor for the application of military standards for the civilian sector might be necessary and should be considered.

Although one might argue that the above-mentioned standards were developed for the actual detonation or blasting of ammunitions or structures, it is generally necessary to consider unexploded ordnance and other explosive devices on former military sites as unsafe for handling and to assume the risk of self-detonation or detonation in the event of forest fires or other impacts. Therefore it is always necessary to define safety distances and buffers to sites under civilian use considering the detonation of explosive ordnance on the site for which the risk is being assessed. The risk is defined in terms of the actual likelihood of damages to goods that require protection caused by the hazards identified, and is generally difficult, if not impossible to calculate in the case of unexploded ordnance. Also, although a historic investigation might reveal a large part of the historic military activities on a former military training area, it has to be kept in mind that unidentified hazards must always be expected, as some activities were never recorded and might only be known to a very small group of people.

5. Conclusions

Historic land use analysis can provide deep insights into historic military land use on former military sites. However, this requires painstaking, time-consuming and expensive research in numerous archives and libraries.

Historic military land use analysis can provide relevant information on most hazards that have to be expected on former military sites but will never be able to guarantee that all possible hazards are identified. This is particularly true for former military training areas that have been used for military training, exercises and research and development by numerous forces over decades or centuries, and are therefore highly complex with respect to their military land use history.

Despite many obstacles to historic investigation, in particular considerable wartime losses of relevant files, maps and aerial photographs, non-disclosure of relevant files due to military secrecy and diversified and delocalised sources in numerous archives in different countries, it is worth the effort. The results obtained from a thorough historical investigation can be used to assess the risks posed by former military sites to their surroundings.

References

Berufsgenossenschaftliche Vorschriften BGV C 24 (VBG 46) Sprengarbeiten.

(2002) Heeresdienstvorschrift der Deutschen Bundeswehr HDv183/100, Durchführungsbestimmungen für das Vernichten von Munition.

Borries, H. (1991) *Altlastenerfassung und Erstbewertung durch multitemporale Karten- und Luftbildauswertung*.

Spyra, W. (1991) *Untersuchung von Rüstungsaltlasten*, Berlin, WF-Verlag für Energie- und Umwelttechni.

Spyra, W. (1997) *Rüstungsaltlasten. Erfassung, Erstbewertung, Erkundung und Gefährdungsabschätzung*, Renningen-Malmsheim, Expert-Verlag.

Winkelmann, K. and Spyra, W. (2005) Responsibilities for chemical warfare agent and ammunition production during World War I, Project report, BTU Cottbus.

Winkelmann, K., Spyra, W., and colleagues (2004) Assessment of chemical warfare agent findings, hazard mapping and detection of suspected burial sites on the former military training area Döberitz, Project report, BTU Cottbus.

Winkelmann, K., Spyra, W., and Katzch, M. (2005) Risk assessment for the former military training area Königsbrück based on historic information on military land use and UXO clearance data, Project report, BTU Cottbus.

THE FORTRESS OF KAUNAS: HISTORY PRESENT SITUATION AND CONVERSION CHALLENGES

Neringa Jarmalaviciute, M.B.A., and Rimvydas Strazdas
Kaunas City Municipal Administration, Kaunas, Lithuania

Abstract. This article presents an overview of the history of the Kaunas Fortress, the construction of particular fortress objects, its intended use from the end of the ninth century up to the present, as well as information about the current condition of the Kaunas Fortress complex. Focus is placed on the reasons and consequences of the uniqueness of the Kaunas Fortress, and the problems and challenges related to the preservation of the unique object of fortification and its adaptation to the needs of the public. The article also contains information on the research related to the Kaunas Fortress and the conversion projects currently pending.

Key words: Fort, fortress, history, construction, present situation, former military objects, former military buildings, heritage protection, conversion.

1. Introduction

Kaunas Fortress is a unique object of fortification heritage. Development of the Kaunas Fortress complex, covering over 200 different constructions, equipment and other objects, commenced at the end of the ninth century following the order of Tsar Alexander II of Russia, and lasted until World War I. Of the twenty-five military fortresses of the tsarist Russian empire, the Kaunas Fortress was considered to be the most modern. The most aged constructions of the fortification are already over 100 years old. After losing their strategic role following World War I, forts of the Kaunas Fortress complex and other objects were utilised for different purposes, but the attention to the cultural and historical value of these fortifications and the preservation of this value was focused only after the Soviet Army abandoned the Kaunas Fortress following fifty years of inappropriate exploitation.

Two stages might be benchmarked in the history of Kaunas Fortress:

– construction and modernisation prior World War I
– usage for various purposes after World War I.

One should regard the period beginning from the withdrawal of the Soviet Army from the forts and barracks of Kaunas in 1993 to the present day as a

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 127–145.

stage in the fortress' history. This period is analysed by the authors as the present situation of the Kaunas Fortress complex. Construction and modernisation stages of the Kaunas Fortress and usage peculiarities of forts and other objects after World War I are approached in Section 2.

Obviously, this chequered history significantly influenced the present situation of the Kaunas Fortress complex and also determined the majority of problems we are now facing. The conversion of the former tsarist fortress faces numerous challenges. In other words, the discussion on conversion of the Kaunas Fortress should be focused on the most pressing problems, such as:

- economic and social development of former military objects
- infrastructural development of the abandoned military territories and their integration into the urban municipal structure by inventing a new public function for them (residential, economical, cultural etc.)
- building of a marketable image and developing favourable attitudes towards the former military objects and territories
- elimination of hazards related to public safety and environment by disposing of explosives and chemicals remaining in the former military territories, and especially in forts
- preservation of historical and cultural heritage
- analysis of the investment needs for fortress conversion, search for possible investors, etc.

Specialists from different fields and funding from various sources must be incorporated into the solutions of these problems. This refers to both public and private sources of funding, and not only local but also national or EU-scale financing. The starting point for the solution of these problems should be the detailed research and development of conversion strategies. Up until the restoration of Lithuanian independence, this fortress remained almost uninvestigated. The main reason for that is the reticence of its territories as well as the fact that many people associated these buildings with the occupying army, and therefore not worthy of researchers' attention and protection.

It was often the improper and irresponsible exploitation of forts and other objects of the Kaunas Fortress after World War I, including the changing of ownership of particular fortress objects or even the absence of ownership, which determined the current condition of the fortress objects and caused many of the problems related to the fortress conversion. The current situation of the objects of former Kaunas Fortress, problems related to its conversion and usage, and conversion projects are all discussed in Section 3. This article describes the present condition of the fortress in a situation emerging after the restoration of Lithuanian independence in 1990 and withdrawal of Soviet troops from the country's territory in 1993.

2. History of Kaunas Fortress

The ranges of mounds with wooden and later stone castles, defence walls and other fortifications surrounded Kaunas City and its vicinities. During various periods of history, the city was occupied by various states and Lithuanians, Germans, Swedes, French, and Russians built the fortifications in the city. In the ninth century, Kaunas had a decisive significance for the protection of the western border of the Russian Empire. Kaunas City was situated in the zone of possible assaults in the direction of Vilnius and Riga. The railway between St. Petersburg and Warsaw crossed the city and was of strategic meaning. The Nemunas River formed a convenient natural defence line, and the city vicinities were a good place for the construction of the fortress.

2.1. CONSTRUCTION AND MODERNISATION

The political situation in Europe shifted in 1917 after the Franco-Prussian War. The unified Germany was intensely arming itself, strengthening defence fortifications on its eastern borders. It was becoming increasingly clear that Germany and the Austrian-Hungarian Empire would be the potential enemies of Russia in a forthcoming war. Russia recognised the necessity of fortifying its western borders. For this reason, the development of borderline fortress systems was mapped. Kaunas Fortress was supposed to be one of the most potent fortresses in this system.

The construction of the first class Kaunas Fortress was started in 1882 by order of Tsar Alexander II of Russia. The construction of the fortress and its enlargement and modernisation, lasted until the assault in 1915. The fortress was to be surrounded by two rings of twenty-one forts and nine stationary artillery batteries. Eight forts of the first ring and one fort of the second ring, as well as nine stationary artillery batteries were built and modernised. The construction of three forts of the second ring remained incomplete. Kaunas Fortress was a totally independent military system of an impressive size. The environment (the esplanade) of the forts was cleaned and levelled; and the roads connecting forts were lined with trees. Artillery batteries with ammunition depots were distributed between the forts. A large military/administrative facility for the fortress, a complex of engineering, administrative, residential, economic, and communication objects were built. Three military camps were erected within the fortress, offering sufficient housing for the 18,000 soldiers listed in the population census of 1897.

Kaunas Fortress had its own railway station, power plant, water supply system, mill, bakery, beer brewery, a developed road network and telegraph. The fortress was the only fortress in Tsarist Russia which had an internal railway system, the total length of which was nearly thirty kilometres. Within the city and deep underground, a large food repository was installed, assuring the provisioning of the soldiers during a long siege. Kaunas Fortress was the strongest and most modern at the time; it had the biggest garrison and occupied the most important place in the fortress system of Tsarist Russia. The strict rules of the fortress regulated the city life as well as its development; "There is no city of Kaunas, there is only the Fortress of Kaunas", wrote the commandant of the fortress. However, the Fortress of Kaunas, under construction for almost one third of a century, despite all the expectations and huge expenses, did not perform its function in the defence of the Russian Empire, and in 1915 was occupied by the German army within eleven days. After the bombardment of the large calibre artillery, some artillery shells struck deep into the ground and have remained there unexploded, even to this day.

2.2. KAUNAS FORTRESS AFTER WORLD WAR I

After World War I, the independent Republic of Lithuania was established and forts lost their military and strategic meaning. They remained empty for a long time. Later forts were utilised by the army of the Republic of Lithuania during the inter-war period; they were also used for civilian purposes. The Kaunas Fortress was never again used for military purposes. During World War II, some of the forts were used as camps for military captives, as concentration camps, and as camps for the massive holocaust of people. After World War II, the military bases of the Soviet army were established in five forts, but these forts were used as military depots. The Soviet army soldiers were settled in the former military campuses of Kaunas Fortress. The old military buildings of the fortress were not protected; they were reconstructed, and demolished, often with huge buildings of little value built in their place. After the movement of the Soviet army, all the military bases in the forts, with the exception of the seventh fort used by the soldiers of the Lithuanian army, were destroyed. Most of the buildings of the fortress were released to the Municipality of Kaunas City. After the enlargement of Kaunas City, some of the forts were already situated in the territory of the city; residential buildings surround them and the streets have been constructed along the defence trenches.

Despite the fact that since World War I the complex of Kaunas Fortress was improperly used and ruined, it still retains huge historic, urban, architectural, and recreational potential. The following section approaches the present situation of forts and objects that belonged to the Kaunas Fortress, problems of their preservation and conversion.

3. Present Situation of Kaunas Fortress

Discussing the current situation of Kaunas Fortress' objects, the most unique and important of which are the forts, it is necessary to analyse various descriptive indicators and their influence on the conversion of former military buildings and territories. The present situation of the former Kaunas Fortress can be defined, taking into consideration the following key aspects:

1. physical condition of forts and other objects, methods and problems of their preservation;
2. rendering the status of cultural heritage to the particular objects of the fortress and to the fortress complex as a whole, and effect of requirements related to the cultural heritage protection on the conversion processes of the fortress forts and other objects;
3. ownership issues of forts and other former military objects, and financial issues of their management;
4. ecological, environmental and public safety problems;
5. research performed on the Kaunas Fortress complex and the need for further research.

3.1. PHYSICAL CONDITION

The Soviet Army paid minimum attention to the fort arrangement and their function was limited to warehousing. On many sites, ammunition storage or garages were installed. There were frequent cases when, in the attempt of making the fort utilisation more convenient, window arches of fort barracks were demolished, gates installed, unique vents concreted, drainage systems damaged, among other damaging measures. Investments in the forts' welfare after the World War II were minimal and the forts were slowly perishing. Even more rapid devastation of forts started after they were abandoned by the Soviet Army and thus remained unprotected. Notably, many forts have been significantly damaged by explosions, suffering blocked tunnels, damaged posterns and casemate premises, etc. This obstructed ventilation and drainage, and resulted in water accumulation and the decay of walls. Some forts (fourth, eighth) are now partially flooded with water.

The territories of Kaunas Fortress defence objects are more or less smothered by wild-growing bushes that destroy the relief. Because grass growing in the shade of the bushes is very scarce, the slopes of the fillings are unstable and moving downwards. The plants are very disastrous for the buildings beneath the earth mounds as their roots penetrate into the stone and concrete constructions. The plants are also very harmful for the drainage system of the forts and other buildings, as the roots block water drainage routes in many places. Due to these factors, a large part of the defence trenches and buildings have become swampy. The plants not only destroy the construction of the buildings, but also degrade the urban-architectural and landscape value of the defence objects.

Due to various reasons, especially because of the maintenance costs of the forts' infrastructure are significant, they have been barely maintained. The forts of Kaunas Fortress were constructed in such a way as to make them as inconspicuous as possible in the general landscape, less noticeable by an enemy, and more suitable for defence. To this end, the open fortifications were made lower than the mean ground level. Maintenance and use of the open fortification terrains, such as defence slopes, taluses, trenches, ramparts, and other land constructions, is extremely complicated. The results of such management should not only be the preservation and recovery of their profile and layout, but also the creation of as favourable conditions as possible for their exposition.

3.2. HERITAGE PROTECTION

It is notable that the historical context of the Kaunas Fortress nascence is presented in this article. It enables us to perceive the historical and architectural value of the remaining buildings of former Kaunas Fortress and other related objects. For the preservation of these values, it is important to provide the appropriate legal status for the fortress' objects and ensure their management according to the requirements of preservation of this unique historical and cultural heritage. Yet the status of historical and cultural heritage not only ensures a better protection of the fortress' buildings and territories and the gain in its cultural and tourist attractiveness, but also poses a certain challenge for the conversion of the fortress complex and its distinct parts. These include:

- necessity to carry out the detailed historical and architectural research of forts, living quarters and other fortress objects;
- increased price for former military constructions and territories, because heritage protection requirements must be observed, and the necessity to look for the additional funding and new forms of partnership between public institutions and private capital;
- need to develop new tourist products, to implement the active marketing of former military objects and to model their attractive image, in the

attempt to engage the local population and foreign guests, thus rendering active economically beneficial businesses and processes;

– necessity to ensure the safety of fort visitors (public safety).

A large part of the defence objects, territories and buildings of the former Kaunas Fortress are protected by law. The process of protection was undertaken between 1992 and 1993 in accordance with the Protection of Cultural Monuments Act. Between 2000 and 2002, in compliance with the Law on the Protection of the Immovable Cultural Values, the territories of the defence structures of the fortress as well as the protection zones were specified and confirmed. The specification of the limits of territories and the protection zones is still in progress.

The complex of Kaunas Fortress objects is a unique object of fortification heritage that is not yet included into the Registry of the Lithuanian Cultural Values due to the size of the territory occupied by the fortress, the large number of element combining it, their dispersal, and also because it has not yet been thoroughly examined and inventoried. By finding private and public uses for the fortress, the difficulty of protecting such a scattered group of monuments could be overcome. Although the law does not protect the whole complex of Kaunas Fortress at the moment, it does preserve a large proportion of the properties containing the objects and buildings. The Registry of Lithuanian Immovable Cultural Values includes twelve forts (nine completely built forts and three unfinished forts), five artillery batteries, three artillery depot complexes, fifteen bunkers, and complexes of military buildings and extant defence fortification. The forts have been registered as buildings, other objects as complexes of buildings, and military towns as urban values.

In 2003, when designing the Master Plan of Kaunas City, it was foreseen to preserve the complex of Kaunas Fortress with all the extant communication systems as a value of urban and historical heritage, heritage of military engineering and architecture, as well as a potential centre of recreation and tourism. It has been proposed to grant the Kaunas Fortress the status of a historical-urban conservation area.

3.3. OWNERSHIP AND FINANCIAL QUESTIONS

The ownership form of the Kaunas Fortress forts has varied through time. The ninth fort, which was used as a concentration camp and a place of massive holocaust during World War II, now belongs to the Ministry of Culture. It is well maintained and preserved. The Museum of Kaunas Fortress and Genocide Victims is established in it. Two forts (the fourth and the seventh) belong to Ministry of Defence (the seventh fort is used by National Defence Volunteer Forces). Three forts (the first, the second and the third) belong to the State Property Fund of the Republic of Lithuania and only two forts (the third and the fifth) belong to the Kaunas City Municipality. The ownership of the eighth fort, which is an underground building, and three unfinished forts of the second ring has not been legally established.

Of the remaining artillery batteries, only one is directly owned (the Military Sergeant School) in the territory in which it is located. The territory of the battery is in order and well maintained. However, due to its specific purpose it is not accessible for visitors. The ownership of other artillery batteries has not yet been determined.

It is inevitable that the forts, now owned by the State Property Fund, will be privatised. That different forts belong to different owners, each of whom has individual viewpoints about the purpose and future of their fort, aggravates the implementation of conversion projects in the forts Kaunas. Further, the financial capacities of fort owners for the implementation of conversion projects vary. To prevent the different forms of ownership from becoming a cause for improper fort management, it is important to implement in practice the principle of bilateral responsibility so that the destiny of each and every fort would become important not only to its owner, but also to the state. Without support from the national institutions and EU structural funds and the partnership with the private sector, the Municipality of Kaunas is not in the position to preserve this unique cultural resource.

3.4. ECOLOGICAL, ENVIRONMENTAL AND PUBLIC SAFETY PROBLEMS

An important question relevant to the conversion of forts is the protection of biodiversity. During the winter, bats occupy the abandoned and unused catacombs of some forts. Teriological conservation areas have been created in the territories of five forts and several bunkers. It is forbidden to visit these places during the bat occupation period between October and April. It is also forbidden to make changes to the natural environment and internal conditions of the buildings, making the possibilities of maintenance and use of such objects even more complicated.

The territory of the forts is dangerous. The trenches are full of water and high counterscarp walls are unfenced; deep wells and ventilation holes are also very dangerous. Explosives that have remained since Word War I and some chemical and military pollutants may also be found. Most of the dangerous explosives and chemicals (there is information regarding mustard gas) may have been concreted and remain in the forts from the time they were used as warehouses by the Soviet Army. In 1995, approximately € 867,000 were allocated by the decision of the Parliament of the Republic of Lithuania (Seimas) for detection and elimination of the explosives still remaining in the forts, but only € 348,000 were actually delivered. These funds were used for partial elimination of explosives in the fourth fort.

Wild growing bushes, swampy territories, dumps, possibly existing explosives and chemical pollutants, poorly planned and dangerous approaches and other factors make the territories of the former fortress difficult to approach, not only for tourists or local inhabitants, but also for the researchers of these objects. Further, the status of the objects as potential tourist and recreational zones is degraded.

3.5. RESEARCH OF KAUNAS FORTRESS

A certain basis for implementation of the revitalisation of the fortress has been created by means of historical materials collected at the Central National Military History Archive of Russia and Kaunas County Archive, as well as research performed on the exterior of the previous defence system of Kaunas Fortress which describes the present condition and degree of deterioration of its infrastructure. A basis upon which for the starting of renovations and adaptation works of the extant fortification territories and buildings using modern methods has been established.

4. Conversion Alternatives and Projects

Discussions about the future of Kaunas Fortress have continued for over ten years. The pursuit of the restoration of the fortress complex, whether in its entirety or some portion thereof, and its adaptation for public needs began after the troops of the Soviet Army vacated the forts and barracks of the fortress.

In order to preserve the best remaining first-class fortress on the western border of the Russian Empire, which embodies the most advanced achievements of the Russian and European military engineering schools of that time in the field of fortress construction, it is necessary to define new functions for the existing buildings and territories. Such functions should be relevant from the public and cultural viewpoint. Nevertheless, favourable conditions for preservation and use of unemployed buildings and fortifications should be created.

Depending on the geographical location of former military constructions, territories and other objects, there are two alternatives of their possible usage:

1. If the forts or other constructions are in the vicinity of residential territories and/or important roads, they can assume the commercial, cultural, educational, leisure and recreational functions through the addi-

tion of catering facilities, accommodation establishments, and leisure and entertainment complexes. In such cases the former military objects are exhibited as the heritage of martial history and culture in combination with public catering, leisure and educational functions. Such objects are usually attractive and intensely attended, and therefore profitable.

2. If the former military constructions and territories are remote from residential areas and roads, conversion into attractive entertainment objects is more difficult, in which case they are usually used for the industrial activities such as warehousing.

The majority of forts, other constructions and objects of the former Kaunas Fortress can be utilised according to the first scheme by providing a new and attractive function to the military objects that were secret and inaccessible to the public for many years. However, for any restoration plans to be implemented, many preparatory tasks must be performed. Initially, various research projects must be undertaken on the forts: archaeological explorations, investigation of explosive and chemical contamination, etc. Further, the detailed plans of fort territories must be prepared and the surrounding vegetation trimmed and groomed. Significant financial assets are required for the necessary research and documentation preparation of documents alone. Meanwhile, for the financing of the management measure of the properties, disposal of explosives and chemicals contained therein and for fort renovation, support both from the Government, EU and the private investors may be required.

The complex of Kaunas Fortress is a unique and well preserved monument of military engineering. In order to adapt it for the modern public needs without damaging the identity and infrastructure of the extant buildings, it is necessary to create a qualified concept for the use of the whole complex of Kaunas Fortress, with due assessment of the experience of European countries in the field of renovation and operation of analogous fortification complexes.

Even though the revitalisation concept of Kaunas Fortress is not yet prepared, the detached incentives for the forts' resurrection, their arrangement and adaptation for public needs do exist. There are plans to establish a branch of the Vytautas Great War Museum and an exhibition of combat technique in the sixth fort, which is now rented for private businessmen and used as warehouse. Such intentions are coming from the Ministry of Defence.

The territory of the fifth fort is used for recreation, namely paintball exercises and competitions. With the construction of Kaunas Hydroelectric Power Station and embankment of the Nemunas River, the fifth fort became located on a picturesque landscape, on the slope of artificial Kaunas Sea. With the proper maintenance of this fort and elimination of the low-value greenery, this would become a perfect location for recreation and leisure activities.

The most suitable use of Kaunas Fortress forts is to include them into tourism infrastructure through development of local and international tourism routes, accommodation, recreation and entertainment activities, for which renovations are required. The underground casemates of the forts are a perfect place for establishing cafés and restaurants. There would be enough openings in the tourism infrastructure to start different small and medium sized businesses.

There is little chance that funds for the removal of explosives, maintenance of Kaunas Fortress facilities and their use for tourism and business infrastructure will be allotted from the municipal budget or national treasury. Only partial funding or co-financing of different projects is possible.

Several conversion projects initiated by the Kaunas City Municipality in cooperation with foreign partners and currently being implemented and for which the support of the EU structural funds was granted, became the baseline for solving the issue of preservation and financing of the Kaunas Fortress complex.

One of the projects that enabled the EU-level approach to the conversion problems of the Kaunas Fortress was the CONVERNET project "Development of a Conversion Network in the Baltic Sea Region". The aim of the project is to create a trans-national network for organising thematic workshops and seminars, collecting, sharing and disseminating information, acting as "conversion lobby" vis-à-vis third parties, and helping the participating partners develop innovative solutions by means of demonstration projects. The work of the network focuses on conversion in the fields of spatial planning, sustainable regional development and cross-border co-operation.

During the implementation of the CONVERNET project an idea of the new project was formulated and application to the BSR INTERREG III B programme was prepared. This project was successful and now the municipality of Kaunas is a partner of the Baltic Fort Route project (Baltic Fortresses Culture and Tourism Route). The aim of the project is to construct a network for the development and economic utilisation of cultural heritage, to create trans-national culture and tourism products and to promote trans-national scientific cooperation. The municipality of Kaunas plans to partially renovate the fifth fort of Kaunas Fortress and its surroundings so that it would be suitable for the activities of culture, recreation and youth sports such as paintball, mountain biking sports, as well as attract local and foreign tourist groups.

An important problem is represented by the former military residential areas in the territory of the city. There are three former military camps in Kaunas and it is necessary to preserve old buildings and territories, which have a heritage status, and to find new functions for these territories and buildings. Because it is difficult to attract private capital to these territories, Kaunas has participated in an additional BSR INTERREG III B project: ReMiDo (Sustainable Reintegration of Post-soviet Military Residential Areas as a Challenge and Opportunity for Regional Development). The objective of the project is to facilitate the promotion of polycentric settlement structures by more effective governance of post-military territories in favour of balanced and sustainable spatial development (economic, social, cultural and environmental factors). It is planned: 1) to select indicators and methodologies for the evaluation of reintegration potential and its implementation in post-military residential areas; 2) to assess different national experiences and the positive and negative practices in post-military residential areas; 3) to analyse challenges and opportunities for post-military settlement development with spatial planning tools; 4) to prepare selected post-military residential areas for investments.

Successful implementation of these projects would be an important step towards the revitalisation of the Kaunas Fortress and its adaptation to current public needs. Yet implementation of these projects will not help us to adapt to all the challenges, nor solve the array of problems related to the conversion of the former Kaunas Fortress complex. Both local and national authorities must seek proper approaches to attract the financing sources and private capital needed to carry out the necessary research; to resolve issues of public safety, preservation and restoration of historical and cultural heritage, environment protection; and to deal with other social, economical, legal and financial aspects of the Kaunas Fortress conversion.

5. Conclusions and Future Tasks

The complex of Kaunas Fortress that remains is part of the historical and cultural heritage of not only Lithuania, but of Europe as well. Kaunas Fortress is a remarkable historic, urban and architectural cultural resource.

The only way to preserve this complex of unique military-historic heritage is to find new functions for the former military buildings and territories, to include them into the urban-functional structure of the city, region and country. In order to achieve these goals, the following actions should be taken:

1. Precise inventory and register of all buildings, territories, and engineering equipment of the former fortress; their assessment in terms of cultural heritage values; and granting of special status, which would ensure specification and protection of the objects;

2. Assessment of the territories and buildings of the fortress and preparation of a concept for possible uses of such objects;
3. Analysis and elimination of remaining explosives and chemical pollutants in the territories of the fortress;
4. Evaluation of required investment, search for potential investors and attractive financial partnership (public-private partnership, etc.) for implementing of conversion projects.

Such actions should be accompanied by archaeological, historical, and architectural research, as well as research related to the physical conditions and pollution of the buildings and territories. It is necessary to prepare documents for the utilisation, restoration and conversion of Kaunas Fortress.

A huge investment and the participation of qualified specialists are necessary for the research on pollution of forts as well as for the elimination of remaining explosives and chemical pollutants. The partial elimination of explosives was carried out in the fourth fort in 1995. During that work, 1320 items (weighing a total of 1.9 tonnes) of various explosives were removed and destroyed.

Kaunas City is not able to carry out these tasks alone. Support through EU Structural Funds, private initiatives, and public-private partnerships could help to solve this problem. Successfully implemented conversion projects offer a hope that the Kaunas Fortress will be revitalised and preserved for future generations.

References

Barkauskas, V., Miskinis, A., and Steponaityte, N. (1992) Research of Kaunas Fortress, Evaluation of its Value and Protection Status, and Suggestions for Renovation and Use, vol. 1, Technical Report SA.07.11.89.02, Ministry of Construction and Urbanism, Institute of Architecture and Construction, Kaunas, Lithuania.

Česonis, G. (2004) Kaunas Fortress, Internet site, `http://tvirtove.kaunas.lt/en`, accessed 14/02/2006.

CONVERNET (2005) Conversion Handbook for the Baltic Sea Region, Prepared and published while implementing of BSR INTERREG III B project "Development of a Central and Eastern European Conversion Network".

Matulis, A. (1992) Suggested Principles for Using of Buildings and Structures of Kaunas Fortress, Taura Cultural Association.

Steponaitytė, N. (2001) The Kaunas Fortress: Design and Construction, *Town Planning and Architecture* **XXV**, 150–163.

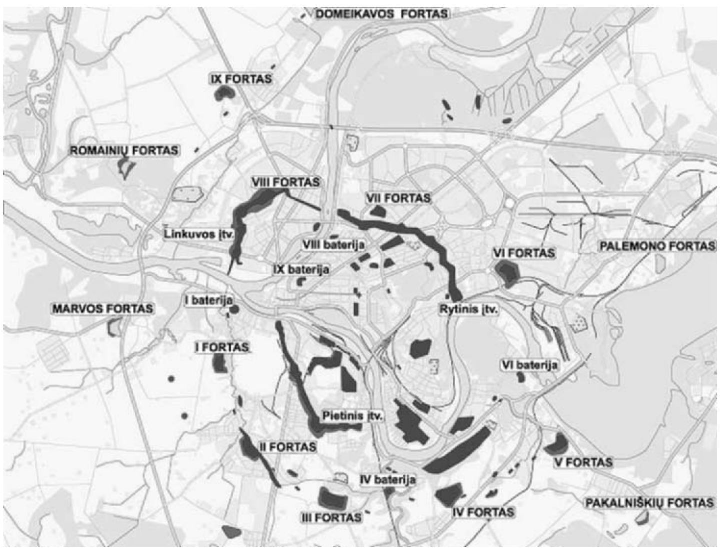
Steponaitytė, N. (2003) Influence of Kaunas Fortress on the Expansion of the City, *Town Planning and Architecture* **XXVII**, 64–75.

Steponaitytė, N. and Česonis, G. (2004) Kaunas Fortress, Internet site, `http://tvirtove.kaunas.lt/en`, accessed 14/02/2006.

Steponaitytė, N., Mirinas, S., and Navasaitis, M. (1996) *Evaluation of Vegetation in first, second, third, fourth, fifth, sixth, seventh, eigth, ninth Forts and Fortification of Linkuva, and Suggestions for Preservation and Management*, Vol. 1, Kaunas, Lithuania, .

Strazdas, R. (2004) Conversion of Military Forts of Kaunas Historic Fortress, Material for the second CONVERNET Partner meeting in Stockholm.

6. Maps and Photographic Documentation of the Forts



Source: (Steponaitytė and Česonis, 2004).

Figure 1. The complex of Kaunas Fortress before World War I: not every object is currently extant. Legend: *fortas* is fort, *baterija* is battery, and *įtv.* is fortification.

Source: (Česonis, 2004).

Figure 2. The first fort was built between 1888 and 1889, and reconstructed in 1893 and 1908. It is situated near the highway Via Baltica. This is one of the least urbanised forts. It was heavily damaged during World War I, but the original relief remained.

Source: (Česonis, 2004).

Figure 3. The second fort was built in 1887–1888, and reconstructed between 1893 and 1898 and again in 1908). The fort is very urbanised and surrounded by residential buildings.

Source: (Steponaitytė and Česonis, 2004).

Figure 4. The third fort was built in 1887–1888, and reconstructed between 1893 and 1898, and again in 1908. Only the northern part of territory is intensely urbanised. The fort is overgrown with impassable brush. The landscape is contorted by the industrial constructions erected within the fort territory.

Source: (Česonis, 2004).

Figure 5. The fourth fort (built in 1889) is partially submerged. The territory is densely overgrown with low greenery. In 1995 mine removal activities were conducted there, but interrupted following the suspension of financing.

Source: (Steponaitytė and Česonis, 2004).

Figure 6. The fifth fort (built in 1889) is built in an especially attractive location, yet the territory is densely overgrown with trees and bushes. Concrete blocks discarded by the Soviet Army, concrete-paved roads and buildings of the air defence missile base contort the landscape.

The fort was built in 1889. Source: (Steponaitytė and Česonis, 2004).

Figure 7. The sixth fort approaches are urbanised from all sides. Important arterial roads follow nearly all the fort's walls.

Source: (Steponaitytė and Česonis, 2004).

Figure 8. The Lithuanian Army uses the seventh fort, which was built in 1889. During the Soviet times, the territory was covered with low-value buildings. Surrounding territory is intensively urbanised and a busy highway was laid along the western edge of the fort.

Source: (Steponaitytė and Česonis, 2004).

Figure 9. The appearance of the eighth fort is distorted by the gardens and hovels of residents, occupying the major part of the territory. The land surrounding the fort is intensively urbanised. The fort built was between 1889 and 1890.

Source: (Steponaitytė and Česonis, 2004).

Figure 10. The territory of the ninth fort, which was built between 1901 and 1913, is situated on a high hill close to highway crossroads. The fort hosts a museum. Its territory and constructions are maintained and visited by local and foreign tourists. A massive monument for the victims of Jewish Holocaust is erected nearby.

MILITARY AREA REVIVAL IN THE CZECH REPUBLIC: A CASE STUDY FROM THE CITY OF HRADEC KRÁLOVÉ—DIFFERENT ERAS, DIFFERENT APPROACHES

Vladimíra Šilhánková
University of Pardubice, Faculty of Administration

Abstract. Significant political and social changes in the Czech Republic have caused not only economic transformation in the country but also big changes in city and landscape structure. New social and spatial tendencies have emerged in Czech towns and cities, such as suburbanisation, urban sprawl and urban revival.

Due to great changes in the economic situation in the country, many brownfields have appeared, whether industrial, agricultural or commercial. Former military areas are a special type of brownfield. There are several types of former military areas found in the Czech Republic: historical, post-war and Soviet army areas. Each of these types requires a special approach to conversion and revival. This paper focuses on the revival of former military areas from different eras. This paper describes the city of Hradec Králové and its conversion from a former baroque fortress at the turn of 19th and 20th centuries and the contemporary process of reviving a former military airport. Different planning phase approaches (different planning tools) and different economic aspects to conversion are observed.

1. Introduction

Brownfields are territories in the urban environment that have lost their former function or fallen into disuse. There are often ecological problems and devastated industrial buildings or other structures associated with such sites (Bergatt, 2004).

"Military area brownfields" are a specific variety of abandoned sites associated with the ceasing of active use of land by military forces. The brownfields theme is contemporarily highly important and there are many theoretical works found in international and Czech scientific literature. Despite this boom of interest, the problem of brownfield redevelopment (as well as former military area brownfields) is not new.

It is not common to speak of brownfield regeneration, revival or conversion in historical periods, but there are many examples of such processes. We can observe many historic examples of largely or even completely reconstructed cities or city districts with former military utilisation. These

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 147–159.

Figure 1. Troy: Historical example of military area re-use.

examples include in Mesopotamia (Babylon Ur, Uruk, etc.) as well as later in the transformation of Roman military camps to medieval cities (London, Regensburg, Vienna, etc.) or much later during Hausmann's reconstruction of Paris or wall-demolitions during the 19th century.

In this paper I will not discuss examples from antiquity (although it would be very interesting), but will rather compare the re-conversion and revival approaches in two historical periods at the turn of 19th and 20th centuries and the present. I have chosen the city of Hradec Králové as a case study and I would like to compare its transformation from a baroque fortress to the modern city with the contemporary transformation of a military airport into a new city district.

2. The First Example: Baroque Fortress

The Austrian army's repeated failures during the Seven Years War were the impetus for Joseph II to transform the city of Hradec Králové, due to its strategic location, into a baroque fortress in 1765. The construction began in 1766 when the large and historic suburbs of Pražské and Mýtské were demolished. The inhabitants were moved into newly established villages exterior to the fortress' protective zones of Nový Hradec Králové, Kukleny, Farářství and Pouchov. The wall-system was supported by foot soldiers and cavalry garrisons, arsenals, loophole casemates, and so on. Both the Rivers Labe and Orlice were regulated with a system of canals and it was possible to swamp artificially lowered territories. The fortress was finished in

1789 with a pentagonal ground plan and an area of 330 hectares. According to a number of authors, the completion of the baroque fortress absolutely changed the image of the city (Toman and colleagues, 1993, Friedrich, 1948, Richter and Semotanová, 1998).

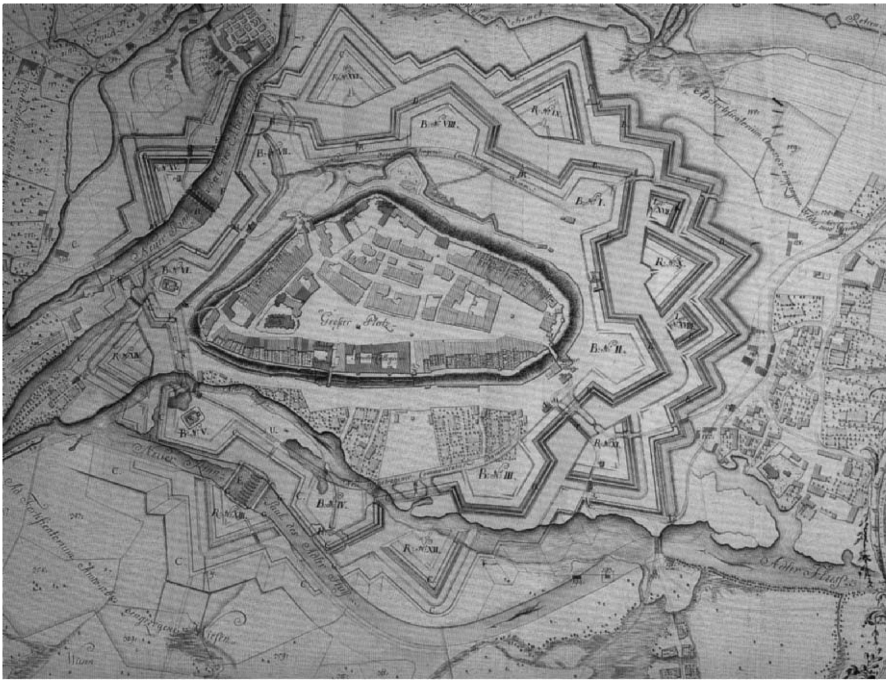
BAROQUE FORTRESS CONVERSION AND REVIVAL INTO THE MODERN CITY

The Austro–Prussian War was decided before the fortress walls in 1866. The war showed that the fortress was absolutely useless, and marked a break in the future development of the city. The municipality asked Emperor Franz Joseph I not only to cancel the fortress but also to sell fortress territory to the municipality. The fortress was cancelled in 1884 after long and difficult negotiations. The central role in these negotiations was played by the deputy mayor, Ladislav Jan Pospíšil. The city bought the entire fortress property as well as all walls and military buildings under a "transactional contract" in 1893 for the price of one million Austrian quid. After a discount was agreed upon for the demolition and layout works, the city paid only 580,000 Austrian quid (Toman and colleagues, 1992).

At that time, it was the city's intention to begin a new development stage based on a new urban conception. The municipality organised an urban planning competition for the former military area in 1884. The regulatory plan sought to respect existing roads and bridges, modern rules of hygiene, flood control systems, and so on. The city also passed urban renewal laws in 1897 and 1908 and regulated the Rivers Labe and Orlice, including new hydro power stations constructed between 1907 and 1914.

The architects Václav Reichl and Oldřich Liska elaborated the new urban master plan in 1911. This master plan included the road system, residential and greenery system, and the location of the public buildings. The main concept of the master plan was based on a radial layout and created linkages to the suburbs (Pražské Předměstí and Věkoše) (Friedrich, 1948, Richter and Semotanová, 1998, Toman and colleagues, 1993). Prof. Josef Gočár brought a new quality of regulation to the new part of Hradec Králové with his regulatory 1926–1928 regulatory plan. Gočár and his predecessors developed the city in the radial-circular system (Tušl and colleagues, 1997). Gočár's significance for urban development is found not only in his regulatory plan, but also in his care for parterre existing and new streets and squares. The best of his works in that field are Ulrich Square construction and the re-construction of Masaryk Square.

The city development was based strictly on urban planning regulations and the construction was divided into periods. The municipality laid out the plots for public works (streets, squares, parks) which were funded from the



(Richter and Semotanová, 1998)

Figure 2. Fortress ground plan, 1767–1768.

city budget, and plots for private investments, mainly for residential and residential/ commercial zoning. The plots for private investments were sold and profits reinvested into future development. The construction was coordinated by Hradecká technická kancelář (the Technical Bureau of Hradec Králové). The economic aspects of these projects are exemplified by the 1924–1926 construction of Masaryk Square. This construction presented the new parterre of Josef Gočár and the T.G. Masaryk statue by Otto Guttfreud. In 1926, the total cost of this project included the statue (376,000 Czech Crowns), the square pattern including the Leger Street (today's Baťkovo Square) and Čelakovského Street (today's Čelakovského and Švehlova Street) and amounted to 1,052,000 Czech Crowns (Toman and colleagues, 1992, Tušl and colleagues,1990).

The city grew rapidly in the first half of the 20th century due to its massive and coordinated development. There were 8523 inhabitants shortly after the fortress cancellation in the year 1890, but at the end of this development period (in 1930) there were just 18,243 inhabitants. There were even 44,818 inhabitants in the agglomeration of so-called Big Hradec (Tušl and colleagues, 1978). The city's development, organised by municipal agencies

(Richter and Semotanová, 1998)

Figure 3. Regulatory Plan of Hradec Králové from the year 1890.

according to urban planning tools, led not only to the enlargement of the city but also to an increase in the prestige of the city. The city was given the nickname "The Salon of the Republic", which underlines its importance as a centre of East Bohemia. There were more than just political benefits from this development. The revival and conversion processes offered significant economic benefits to the municipality.

(Tušl and colleagues, 1981)

Figure 4. Ulrich Square in 1909.

3. The Second Example: Military Airport

City development and economic success based on the conversion of the baroque fortress into a modern city has given rise to the second and much more recent revival and conversion case study. The wealthy and rapidly grow city established the municipally funded airport in the northern part of the city. Upon the completion of the airport during the 1920s and 1930s. The airport was given as a gift to the Czechoslovakian army by the city of Hradec Králové.

The airport began to function as a combined military/civilian facility in 1931. A number of new buildings were constructed for the “aerial station”. The local aircraft club and the branch of “Masaryk Aerial League” also used the hangar, built in 1934. The airport has held its current configuration since it was enlarged and reorganised in the 1950s with the construction of a 2400 m take-off and landing runway. The airport was further upgraded in the 1980s with the construction of storage and repair hangers and the resurfacing of the runway. The airport area today covers an area of 340 hectares (Kotas and Samohrd, 2004b).

The military utilisation of the airport was stopped in 1993 year by the intervention of the city of Hradec Králové. The reorganisation of the military forces also contributed to this end of military usage. From this time on, the army began leaving the airport buildings. The decision to transfer ownership back into the city of Hradec Králové was completed in 2004. Because

(Tušl and colleagues, 1981)

Figure 5. Ulrich Square in 1935.

(Tušl and colleagues, 1981)

Figure 6. The city airport in 1931.

TABLE I. Project timetable.

	Activity	Responsible Party	Output	Duration	Budget (CZK)
1	Project confirmation	Deputy mayor of strategic development	City Council decision	1 month	0
2	Real estate mapping	Municipal Department of Real Estate	Real estate map	1 month	0
3	Preparation of noise study	Municipal Department of Architecture	Noise study specification	1 month	0
4	Noise study	Municipal Department of Architecture	Noise study	3 months	200,000
5	Preparation of urban study	Municipal Department of Architecture	Urban study specifications	1 month	0
6	Urban study	Municipal Department of Architecture	Urban study	5 months	700,000
7	Preparation of feasibility study	Department of Strategic Development	Feasibility study	3 months	500,000

the transfer of real estate is often a long-term procedure, the city started to prepare for the transfer as develop a usage concept. The first step was the inclusion of airport area problems into the strategic documents of the city (Kotas and Samohrd, 2004c, Kotas and Samohrd, 2004a). An integral part of these strategic documents is a set of so-called "Projects of investment priorities". These projects define goals, relationships towards the higher strategic documents, preconditions for project realisation, sources (existing sources as well as sources that must be created), project coordinators, financial sources, project risks and also project indicators (Kotas and Samohrd, 2003).

Project 13, entitled "Military Airport Revival and Conversion", has the principle goals of finding "new functions for existing buildings at the former airport area and eliminating the largest brownfield in the city". Specific aims include the development of civil air transport and improving commercial and investment opportunities in the region. It was also hoped that technical industries would locate in the region. It was hoped that the airport and its facilities would draw tourists and tourist events, further contributing to the local economy. All of these developments would positively affect employment in the region, possibly with a relatively high ratio of professional jobs being created. The timetable of the project is shown in tab. I on page 154.

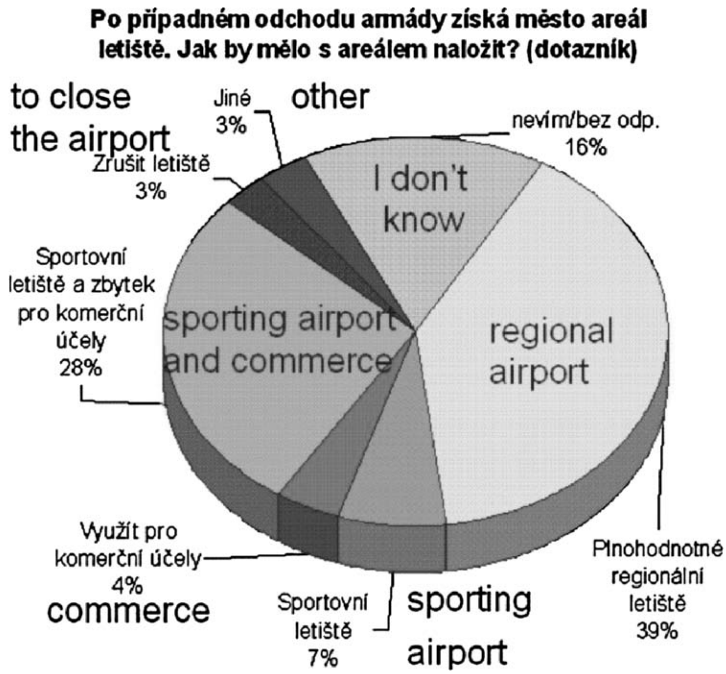


Figure 7. The results of the public opinion inquiry, 2003.

The first phase of the project realisation was the mapping of the study area. This phase included the mapping of potential ecological impacts and a public opinion inquiry. The mapping includes approximately 231 separate properties situated nearby to the airport. Within the project area are numerous water works facilities and wells, supply and storage buildings, electrical stations, underground bunkers, and other constructions. Further, there exist 29 other buildings suitable for new utilisation. All of these buildings have been identified as being in good condition without static defects and a number of businesses are situated in the area of the airport (Kotas and Samohrd, 2003).

The public opinion inquiry took place as part of large opinion poll during the preparation of the strategic plan in October 2003. There were 1954 respondents to the poll. From the opinion inquiry, the city received the following results: only 3% of respondents were in favour of the closing of the airport; 16% of respondents had no suggestion or preference; 28% preferred a split recreational/commercial facility; 39% selected a conventional regional civil airport as most suitable (Kotas and Samohrd, 2003).

The project is divided into several phases. The first project phase cost the municipality 1.5 million Czech crowns (*i. e.* approximately € 50,000) and consisted of the following steps: real estate mapping, urban study, change in the city master plan, and a noise study feasibility study. The phase currently being undertaken is the preparation of the urban transport study. The study focuses on the possible spatial organisation of urban functions. There were three possible spatial and functional alternatives and the city council chose alternative A. The study respects the municipality's intention to conserve the area as a civil airport for smaller planes and create a new relationship between the airport and the city. A new main road is proposed as an urban axis between the city centre and the new airport terminal. The proposed air traffic control tower would act as a new visual axis and as a central urban feature dominating the airport area. The newly planned airport terminal will be situated nearby existing runway and plane stands. The capacity of the airport terminal is designed to accommodate anticipated long-term requirements. A roundabout traffic system is proposed for the front of the terminal. The areas adjacent to the airport terminal are reserved for typical airport companion functions (commercial and office centres, cargo terminal, possibly a transit hotel). Rail transport and public transit connections are accommodated by long-term plans. Further functions have also been proposed in the urban study, including an air-museum and aviation industries.

An integral part of the project is the timetable, which is reviewed four times annually by the city council. According to this timetable, the following phases have been planned: feasibility study preparation, changes to include the newly proposed functions to the municipal master plan, and the subdivision of the area to accommodate the changes. The second implementation phase of the project will begin after the realisation of the steps listed above. Phase 2 is expected to run between 2006 and 2020.

4. Conclusions

The comparison of the conversion of military facilities in urban areas undertaken at the turn of the 19th and 20th centuries affords insights into the conversion process. We are also able to describe different approaches to this process and to identify the core requirements of the transformation process.

One of the most common and clear aspects is that an area transformation is always a long-term process. The duration of the transformation is several decades (for example the fortress transformation lasted 50 years, from 1884 to 1935), exceeding the duration of the electoral terms of numerous political leaders. The continuity of the process is an absolute prerequisite for its success. One of the crucial elements of the transformation of the baroque

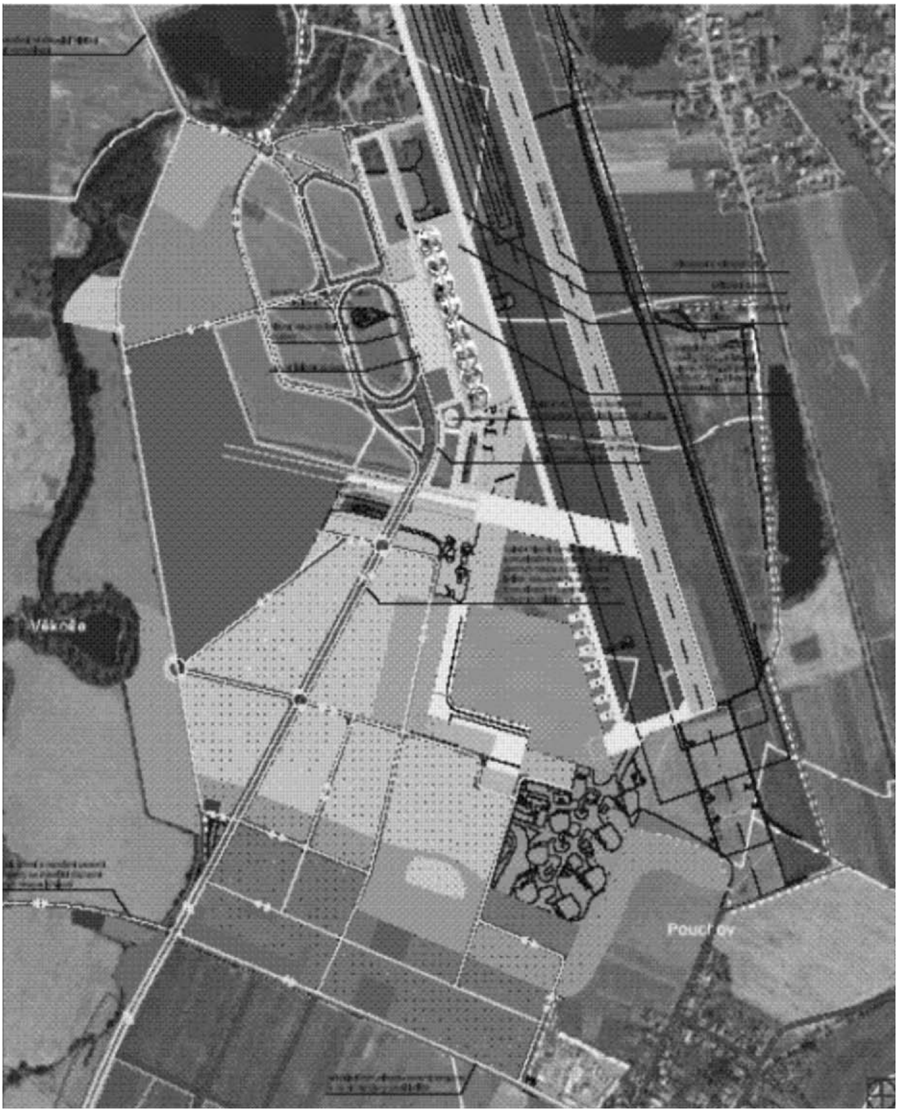


Figure 8. Urban transport study of functional and spatial organisation of Hradec Králové Military Airport: Alternative A.

fortress into the modern city of Hradec Králové was that Dr. František Ulrich remained the mayor for almost thirtyfive years. This extended political continuity has become very uncommon (and it may not be healthy for a contemporary city). Other mechanisms must be utilised to preserve continuity in the transformation process, such as strategic planning tools, such as a twenty-year strategic plan.

This comparison also reveals interesting aspects of changes in planning techniques through this time period. Urban planning was a novelty at the turn of 19th and 20th centuries and its implementation should satisfy transformation process necessities and requirements. Contemporary urban planning is a “planning standard”, but there is an observable movement from pro-active planning only towards “paper plan” preparation”. Contemporary urban planning does not play as crucial a role in the transformation process as it did 100 years ago. Contemporary urban planning plays only a minor role in the process realisation phase. From this point of view, we must use the strategic planning and strategic management tools (action plans, projects, projects management etc.).

Another aspect of the transformation process is the financial aspect. The historical experiences (not only from Hradec Králové[1]) show considerable economic benefit from the reconstruction and revival process for a municipality. These experiences contradict the contemporary expectation and prediction that brownfield conversion must bring financial loses to the public sector. The example from Hradec Králové even shows us that good transformation management should bring economic benefits for the municipality (public finance) in the situation when the municipality must buy the brownfield area for conversion.

References

Benešová, M. and Pošva, R. (1993) *Pražské ghetto - asanace*, Prague, ABF-ARCH.

Bergatt, J. (2004) Brownfields snadno a lehce, Technical report, Institut pro udržitelný rozvoj sídel o.s., Prague, http://www.brownfields.cz/publikace/Brownfields.pdf, accessed 14/02/2006.

Friedrich, K. (1948) *Stavební vývoj Hradce Králové do května 1945 in Stanislav Kadečka*, Czechoslovakia, MNV Hradec Králové.

Kotas, P. and Samohrd, M. (2003) *Projekt “Regionální letiště s mezinárodním civilním provozem,revitalizace a rekonverze souvisejícího areálu bývalého vojenského letiště”*, Czeck Republic, Magistrát města Hradec Králové.

Kotas, P. and Samohrd, M. (2004)a *Akční plán města Hradec Králové*, Czeck Republic, Magistrát města Hradec Králové.

Kotas, P. and Samohrd, M. (2004)b *Dopravně urbanistická studie. Využití a rozvoj areálu bývalého vojenského letiště v Hradci Králové*, Czeck Republic, Magistrát města Hradec Králové.

Kotas, P. and Samohrd, M. (2004)c *Strategický plán města Hradec Králové*, Czeck Republic, Magistrát města Hradec Králové.

Richter, M. and Semotanová, E. (1998) *Historický atlas měst České republiky*, Vol. č. 5, Prague, Historický ústav Akademie věd ČR.

[1] For example see Hausmann’s reconstruction of Paris or the reconstruction of the Josefov Jewish ghetto in Prague (Benešová and Pošva, 1993).

Toman, P. and colleagues (1992) *Přehled desetileté práce 1924–1934*, Czeck Republic, Úřad města Hradec Králové.

Toman, P. and colleagues (1993) *Hradec Králové, mapa města 1:15,000*, Czech Republic, Úřad města Hradec Králové.

Tušl, P. and colleagues (1978) *Retrospektivní lexikon obcí ČSSR 1859–1970*, Czeck Republic, .

Tušl, P. and colleagues (1981) *1881–1981, Proměny architektury a rozvoj města*, Czeck Republic, Městský národní výbor v Hradci Králové.

Tušl, P. and colleagues (1990) *Návrat k odkazu svobody, demokracie a mravnosti—znovuobnovení sochy T.G. Masaryka v Hradci Králové*, Czeck Republic, Městský národní výbor v Hradci Králové.

Tušl, P. and colleagues (1997) *City Master Plan of Hradec Králov*, Czeck Republic, Magistrát města Hradec Králové.

CONCEPTS IN ENVIRONMENTAL SECURITY IN CENTRAL AND EASTERN EUROPE—THE LEGACY OF WAR

Wendell Chris King, Ph.D., P.E.
United States Military Academy, West Point, New York

Abstract. The legacy of war—cold and hot—has left scars on the landscapes of many countries in Eastern Europe in the form of damaged ecosystems and hazardous residues. Clean-up of these areas is necessary, but is an expensive and time consuming process. This paper examines approaches developed in similar efforts in the United States that may help to reduce costs and expedite safe solutions to these issues.

1. Introduction

It has been stated that environmental security is a process (King, 2000) of understanding how environmental issues can affect the security and stability of a region and then designing ways to effectively respond to these issues to provide for a lasting security. One such issue is the environmental pollution and ecological damage that now exists at former military sites in Central and Eastern Europe and their impact on regional and or national stability. This is a region where the scars of war are still clearly evident, with damage dating back to World War II. The legacy of the Cold War in this region includes abandoned toxic waste, unexploded ordnance in training areas, and damaged ecosystems from over-training on certain lands. These lands, including many large tracts, represent valuable resources on a regional or national level for these countries. It is important from a safety and security standpoint to restore these resources and remove the imminent hazards they contain. One effective way to analyse and assess these sites is to consider or evaluate the impact of former military sites within the broader context of overall environmental security of the region.

This paper will begin by presenting a framework for environmental security analysis in a general sense. It will examine the environmental factors that are known to influence security. These areas of study include water as a scarce resource, arable lands, deforestation, air pollution, and hazardous/toxic waste contamination, just to highlight primary concerns. Former military sites

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 161–169.

are dominated by hazardous waste contamination, but these sites require a broader level of consideration and that will be an approach of this work.

With a framework or analytical model developed, it is then possible consider the specific issues of conversion of former military sites back to public use. This paper is not a discussion of the technologies that are available to clean-up different kinds of wastes, but focuses on presenting an approach that should be followed in evaluating the environmental security risks posed by former military sites. Tough questions must be addressed to assure that limited resources are focused on the most critical problems and this requires a risk based approach to decision-making on what to do and where.

The overall objective of this paper can be seen as developing a framework that can be used to evaluate clean-up and management alternatives in achieving the best possible solutions within a resource-constrained environment.

2. Concepts in Environmental Security

> "...national security is not just about fighting forces and weaponry. It relates to watersheds, croplands, forests, genetic resources, climate and other factors that rarely figure in the minds of military experts and political leaders."
>
> —Norman Myers, (1986)

Before any discussion of the science of environmental security issues can be presented, it must be established that population is the independent variable that controls all other factors in these strategic calculations. One way to describe this concept is to apply a principle used by ecologists: carrying capacity. Defined in general terms, carrying capacity is the total population the resources of an area can support over an indefinite period of time. The hypothesis contends that only a finite number of people can indefinitely live in any particular area. That number varies based on climate, soils and geology, and, to a certain extent, on human activity. Further, the principle applies only as long as forces external to the system, such as climate, remain constant. Changes in inputs such as rainfall or insolation can raise or lower the carrying capacity of a region. From a human perspective, this principle is equally valid—even with the marvellous products of human ingenuity. Technology can change the relative value of human carrying capacity by enabling us to conserve resources from one region at the expense of those from another by changing efficiency of use, and by providing solutions to many other specific problems. However, there are finite limits to the number of people any region can support and, by extension, the total population the entire world can support (Brown and Kane, 1994). For example, consider the water scarcity issues in several regions of the world. Water scarcity is caused by pollution of existing sources, reduction of available supplies, or increases in demand from either per capita demand increase or more people consuming at the same rate. In reality, most cases of regional water scarcity result from all of these factors occurring simultaneously. Clearly then, population trends must be examined in predicting water demand and anticipating scarcity issues.

It is important to recognise that the damage that has been done in war and military training generally adversely impacts the usefulness or carrying capacity of an area. The restriction of access caused by imminent hazards is the most direct issue, but there are many more impacts. The carrying capacity analysis of an area is a means of calculating the value to be received in the restoration of any area.

When one considers the concept of carrying capacity in the context of human population increases, one question immediately arises: what is the total carrying capacity of the Earth? Will the Earth be able to sustain a steady-state world population of over eleven billion people after 2100 (Getis, 1998), nearly double the current world population? It is not possible to even attempt to answer the questions without first considering the spatial distribution of both people and resources. Where will these eleven or so billion people be located and how well aligned will the people be with essential resources? Another issue that complicates any analysis of regional or world carrying capacity is the ability to share or transfer resources effectively. All great modern cities now operate through a worldwide supply network.

Countries such as Japan and the United Kingdom thrive at a very high standard of living, while providing only a small portion of consumed natural resources from within their geographic boundaries. Further, there is no assurance that this transfer process can be sustained over time.

Applying this analysis to our regional focus in Eastern Europe, it is seen that Albania, Azerbaijan, Turkmenistan, and Uzbekistan have moderate to high population growth rates that will strain resources while many countries in the region are slowly losing population with time (United Nations, 2004). This shows that a focus on restoring resources such as arable lands, removing contamination and protecting water resources will be important factors in helping produce regional stability.

3. The Science of Environmental Security

To this point, this discussion has been directed toward justifying environmental security as a component of environmental clean-up planning. Several specific environmental issues have been alluded to in order to illustrate key points. It is now appropriate to identify the most significant environmental issues and their impacts, primarily to demonstrate how they could impact world stability and security. There is no space here to discuss the science of these environmental concerns in detail; however, tab. I on page 167 summarises the key issues with their associated security impacts. This list is based on works published by the United States Environmental Protection Agency (USEPA, 1999), Lee (1999), King and Dale (2003), and others. This author has presented a detailed explanation of the scientific bases of the most significant environmental security issues (King, 2000).

Examining tab. I in the context of restoration of former military sites reveals a need to focus on hazardous waste clean-up, restoration of arable lands or deforested areas, and the dangers to critical groundwater resources. The most common types of contamination and environmental damage seen at military training sites include unexploded ordnance fired onto training sites, lead contamination at firing ranges, fuel and lubricant spills from maintenance activities, and improper disposal of toxic military materials. The later are often materials that have been dumped or buried and which have migrated into the groundwater. Over time, spills and leaks into the groundwater allow contamination to migrate off-site polluting public water supplies long distances from the site of the contamination and spreading the health risk to large populations. Another overall impact on military training sites is the alteration of the natural ecosystem that can result from military training use. Heavy use, particularly with military vehicles, damages the soil structure, destroys vegetation which can also result in soil erosion, and makes areas susceptible to attack from invasive species of plants. All of these impacts can reduce the carrying capacity and the ability of an area to support the natural plant and animal communities of the region. Ecological damage or carrying capacity loss may be the hardest of the environmental damages to reverse or fully recover from. In this part of Europe, the biggest challenge is the size of the areas that must be addressed. In the United States only smaller areas of a few thousand hectares have required intensive remediation. The scale of the problem at many existing training areas in Eastern Europe is immense. The following factors will describe the process that must be developed:

- remediation criteria
- must define future land use
- to what level of cleanliness must the land be restored to
- costs can be very high
- decision making must include national, regional, and local authorities
- no migration of contaminants must be allowed.

Let us examine each of these in order. A key question to answer will be "What use will be made of this land once it has been restored?" This decision leads to the second factor: "How clean must the site be before it is declared safe for future use?" The environmental truth is that these lands cannot be restored to natural environmental conditions. The harsh reality is that many former military sites cannot be restored to the point that they may be used without significant land-use restrictions. You will not be able to build houses and have children playing on most sites that have been used for military training. For example, assuring that 100% of explosive hazards have been removed from a former artillery range may be technically and/or cost prohibitive. But that same land could be cleaned to the point that some agricultural use could be restored. It may also be possible to use this land as a nature preserve or wildlife sanctuary within affordable clean-up criteria. As another example, it may be too expensive to remove lead from a long-used firing range to the point that the soil would be safe for children to play on. It is technically and economically feasible to use this land for some commercial and industrial uses without risk to its users. The use selected for a property will determine what standards will have to be met in the remediation process and this cost must be justified by the value of the follow-on use. That brings us to the next bullet: costs can be high. Let's restate this: the cost will be high. There are no easy and cheap solutions to military contamination problems. Even fencing off a property and isolating the hazards represents a cost. At a minimum, the value of the land for another use is lost. At worst the contamination may migrate and increase the cost of clean-up over time.

It must be recognised that successful planning for a project is a negotiation and discussion with all governmental organizations and often the surrounding population. This is often very difficult for military managers to recognise because it represents a different way of doing business for the military. Many are used to being exempt from these types of cooperation, but that does not apply in this case. The key for any project is gaining agreement on what the land will be used for in the future and that requires all stakeholders to participate. Finally, experience has shown that no proposed plan that allows contamination to migrate from the site will work. Many have tried this, sometimes even as an interim proposal, but it does not work. Cost is always the driver in this. Experience has shown again and again that the long-term costs are always higher when a toxin is allowed to migrate, thereby contaminating larger areas and exposing more people to these health risks.

4. A Model for Site Remediation

The overarching consideration for military site clean-up work is to recognise that every project will be unique in how it must be solved. There is, however, a process that has been developed by the United States Environmental Protection Agency and successfully employed at many military clean-ups in the United States. That process is outlined in tab. II on page 168–The Superfund Process (LaGrega et al., 1994). The first step in this process is called remedial investigation and it is intended to screen all available data to determine the nature and extent of the problem. Historical records can reveal the types of materials that were used at a site. Former workers may have knowledge of the fate of any substances that were made or used in a place. Winkelmann will discuss this approach in his chapter of this text. Limited sampling may be necessary to search out or confirm information collected in the historical review. A first decision point comes at the end of this investigation if it is determined that potentially hazardous conditions exist on the site. If in the initial phase an imminent hazard is identified, an immediate clean-up can be initiated to remove or isolate the hazard until the long-term solution can be further developed.

A very important step that must be initiated as soon as any health risks are detected is the public information plan. For any clean-up plan to work: the public needs to be kept informed throughout the process. There should not be any surprises in the study process or in the alternatives that are being considered. This aspect of the process greatly assists the achieving of public support throughout the process.

The next phase of the process follows a decision that, based on remedial investigation, the site poses a health and safety risk to the extent that a clean-up is justified. The feasibility study is a detailed engineering study of the site which measures the contamination, develops courses of action for clean-up, and determines costs and risks for each alternative. This can be an expensive process, often driven by soil, air and groundwater monitoring costs. This cost is justified based on the overall cost of most of these clean-up projects, but it further emphasises the importance of making the proper decisions on future site uses early in the process. Normally, a set of alternatives will be developed based on low, medium, and high clean-up standards. The process to be used in making the decision should be agreed to by all of the partners in the process before the final results and costs are submitted by the study team. This analysis includes the factors of public health risk, cost, public acceptance, and technical risk of success.

From this point forward the project is similar to most engineering design and construction work, except if explosives are involved. In this case it may be that the work requires a combination of civilian construction and military explosives removal experts. A final point in this summary of the site clean-up process is the need for post-project environmental monitoring. Depending on the nature of the project, it is typically necessary to monitor soil, groundwater, or air for the presence of residual contaminants. This phase often is

TABLE I. Major Environmental Concerns

Environmental Security Threat	Major Adverse Impacts
Global Climate Change	
Carbon dioxide and greenhouse gases	Global warming, sea coast flooding, desertification
Lower atmospheric pollution	Health costs, acute respiratory injury, increased asthma, physical damage
El Niño/La Niña	Changes in rainfall patterns, flooding, increased storms
Ozone depletion in the stratosphere	Increased cancer risk, ecological resource damage
Land Use	
Deforestation, esp. rainforests	Loss of biodiversity, loss of climate controls provided by biomass
Desertification	Loss of farm and grazing lands, displaced populations
Hazardous wastes	Acute health risks, long health care costs
Loss of arable land	Loss of food production capacity
Water as a Scarce Resource	
Fresh Water	Limits populations, health threats, ability to farm arid lands, toxic of water, damage to fish resources
Oceans	Loss of critical food source

critical in gaining public acceptance for a project. Only through post clean-up monitoring can the public be assured that established health and safety standards are being achieved.

5. Summary

Peace is not the absence of war, but the existence of stable communities of people who have the basic human needs satisfied. Environmental security is a method of analysing regions for the conditions that support peace and security. The science of environmental security broadly examines issues such as deforestation, loss of arable lands, toxic contamination, and water as a scarce resource, to determine their impacts on security.

TABLE II. The Superfund Process

Process	Sub-process
Remedial Investigation	Site history
	Inspection
	Limited sampling
	Emergency clean-up if justified
Public Information Plan	
Feasibility Study	Health and safety plan
	Sampling plan
	Quality control quality assessment
Alternatives Analysis: Use Proposals	Evaluate by public health and safety, risk, public opinion, economics
Clean-up Design and Construction	
Long-term Monitoring	

The damage done by war, Cold War training and actual combat, is a security and stability issue for Eastern Europe. This damage includes the contamination of large land tracts by explosives and toxic chemical and the ecological damage from long-term training impacts. These lands represent important resources in Eastern Europe and restoring them will lead to better stability in this region.

A classic model for evaluating and cleaning up toxic waste sites has been adopted for use on military lands. This model is not completely prescriptive because each site is unique in natural setting and site conditions. The model is generally applicable to most sites because the process it outlines is adaptable to many sets of site and contaminant conditions. Even with proven models and the best experience, cleaning up these sites is slow and expensive. The only path to success is through a cooperative relationship with all concerned political organisations and the public. The value of these projects can be huge, from the return to use of valuable lands to, maybe even more importantly, the return of public trust of the government that defends its security.

References

Brown, L. and Kane, H. (1994) *Full House: Reassessing the Earth's Carrying Capacity*, New Yrok, Norton.

Getis, A. (1998) *Introduction to Geography*, Boston, McGraw-Hill.

King, W. (2000) *Understanding Environmental Security: A Strategic Military Perspective*, Atlanta, Army Environmental Policy Institute.

King, W. and Dale, V. (2003) What in the World is Worth Fighting for? Using Models for Environmental Security, In V. Dale (ed.), *Ecological Modeling for Resource Management*, New York, , Springer.

LaGrega, M., Buckingham, P., and Evans, J. (1994) *Hazardous Waste Management*, New York, McGraw-Hill.

Lee, J. (1999) Inventory of Conflict and Environment, *AEPI*.

Myers, N. (1986) The Environmental Dimension to Security Issues, *The Environmentalist* pp. 251–257.

United Nations (2004) World Population Prospects: The 2002 Revision, Internet site, `http://esa.un.org/unpp`, accessed 02/02/2004.

USEPA (1999) *Environmental Security*, Washington, DC, US Environmental Protection Agency, (USEPA 160-F99-001).

UXO FIELD IDENTIFICATION DATABASE: A TOOL FOR UXO CLEARANCE

Günter Fricke
Managing Director, Dresdner Sprengschule

Abstract. In close co-operation with the company SENSYS, a database with approximately 1000 entries with MuniMan software was created. These include German, American, British or Russian ammunition often found on the former theatres of war. Mainly, this ammunition is from World War II. Furthermore, the database has approximately 250 datasets describing modern ammunition (Warsaw Pact and NATO). The spatial coverage of the database extends over Europe, North Africa and South-east Asia to include all crisis regions after the World War II.

Every entry represents one ammunition body or fuse and contains a data set with the information required for identification and handling.

Every data set was assigned to a main ammunition group, type and kind, as well as to a period of use and a manufacturing nation. One can identify the required objects (data sets) on the basis of dimensions, type of materials, form, description and additional information. Moreover, the fuses as well as the used source were assigned. Mostly, the representations consist of a preview (photo or general view), a database picture (sectional view and general view) and a database photo.

1. Preliminary Notes

The ammunition database of the Dresdner Sprengschule contains technical and other information about selected and commonly occurring German and Allied ammunition of the World War II, as well as ammunition of the former Warsaw Pact and NATO. The database should assist technical ammunition experts in identifying unexploded ordnance and therefore support decision-making preparations for the further handling of this ammunition.

The database is based on the software MUNIMAN of the company SENSYS Sensorik & Systemtechnologie GmbH and a special user interface developed by the Dresdner Sprengschule. It enables a quick access to all information related to unexploded ordnance and can be used for the training and instruction of employees. All details, representations and notes are tuned to the context of explosive ordnance disposal. For secondary information, references to original literature are available.

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 171–177.

2. Structure of the Database

The **name** of British/US-American ammunition is the original name. Otherwise it is a literal translation of the original name. For example,

shell, Q.F., 25-pr, HE, streamline *or*
7.5 cm infantry projectile 18 *or*
57 mm podkalibernßü snarjd, is indicated by
57 mm sub-calibre projectile.

The original, untranslated name is found under *notes*.

Every piece of ammunition forms a data set, which is assigned to a main group, a type and a kind of ammunition. *Main Groups* are listed here, while *types* and *kinds* are found in tab. 2 on page 173.

- small arms ammunition
- mortar ammunition
- demolition material
- grenades and anti-tank hand weapons
- artillery ammunition
- bombs
- mines
- pyrotechnics
- rockets
- fuses.

The decisive factor for the **assignment** is not the initial or original name but the classification of the ammunition according to principles valid today. The data set of every ammunition usually consists of:

- a preview picture (photo or overall view, cross section and total view with measurements)
- a photo (technical details and other information).

3. Technical Details and Other Information

The producing countries are described as follows:

- Germany is accepted for the German Empire, the Weimar Republic, the Third Reich, German Democratic republic and the Federal Republic of Germany.
- Yugoslavia is accepted for the state of Yugoslavia (after World War I), for today's rest Yugoslavia and the former Yugoslavian federal states of Croatia, Slovenia, Bosnia and Herzegovina.
- Russia is accepted for Russia prior to 1917, the former Soviet Union as well as for all countries of the former Soviet Union.

TABLE I. Ammunition *Types* and *Kinds*.

	Types	Kinds
Small arms ammunition	pistol cartridge	steel core projectile
	short cartridge	lead core projectile
	carbine cartridge	incendiary projectile
	and others	A.P.I. projectile
		and others
Artillery ammunition	artillery projectile	H.E. projectile
	anti-aircraft projectile	H.E.A.T. projectile
	ship artillery projectile	ICM projectile
	others	smoke projectile
		H.E.I. projectile
		illuminating projectile
		others
Mines	anti-personnel mine	H.E. mine
	anti-tank mine	fragmentation mine
	landing defence mine	bounding fragmentation mine
	sea mine	H.E.A.T. mine
	special mine	smoke mine
		ground mine
		floating mine
		signal mine
		anchor mine
		practice mine
		drill mine
		chemical agent mine
		directed fragmentation mine

- The Czech Republic is accepted for the former Czechoslovakian Republic, the former Czechoslovakian Socialist Republic and for the Czech Republic and Slovakia.
- The ammunition is assigned to a period of use as follows:
  - Pre WW I
  - WW I
  - WW II
  - post-WW II.

- Measurements are provided for dimensions such as diameter, width, height. Further, length is provided if only one length is measured, whereas body length and total length are indicated when it is appropriate.
- The weight is indicated in grams or kilograms, subdivided by total weight, filling weight, or some other parameter.
- The material designation (main material) mainly refers to the material used for the ammunition body. If other materials were used for further parts, *e. g.* the rotating band or tail unit, it is indicated under additional material. The material is described in simplified terms (see A on page 175), *e.g.*:

  material is "ingot steel, pressed"
  "steel" will be indicated.
- The information about the filling is given in a simplified form for all contained substances. That means, the usually code names will be replaced by common names, *e.g.*:

  indicated is "Füllpulver 02"
  "TNT" will be indicated.
- The fuses are indicated for every munition.
- If a booster is used for non-detonating fuses, it is indicated with a name.
- Further details:
  - Rotating band
  - Propellant/cartridge
  - Visible and special characteristics
  - Forms (see. 5.4).
- Finally, the used bibliographical references are mentioned (5.5).

4. How to Work With the Database

- Use the buttons "Edit Filter" and "Filter on/off" as well as "Reset".
- View picture, zoom function.
- Select on ammunition according to main group, types and kinds.
- Search function
- Link to fuses.

Appendix

A. List of Materials

- steel
- iron
- lead
- copper
- aluminium
- zinc
- magnesium
- brass
- titanium
- electron
- plastic
- glass
- rubber
- ceramics
- leather
- cardboard
- textiles
- concrete
- wood
- paper

A.1. STEELS

- steel sheet
- steel sheet surface-refined
- steel wire
- forged steel/pressed steel
- cast steel
- hardened steel
- ingot steel
- rolled steel
- alloyed steel
- spring steel
- special steel (*e. g.* KPS)

A.2. IRONS

- cast iron
- soft iron
- iron sinter (FeS)

B. Laws and Regulations

- Law on Transport of Dangerous Goods (Gefahrgutbeförderungsgesetz: GGBefG) of 29/08/1998, last changed by Article 11 § 5 of the Law for the Reogranisation of Consumer Protection and Food Safety of 06/08/2002 (BGBl. I p. 3082).

- Law Concerning Explosives (Sprengstoffgesetz: SprengG) in an official statement of 17/4/1986 (BGBl. I (p. 577)), Last changed by Article 1 of the second Law for the Changing of the Law on Transport of Dangerous Goods (2. SprengÄndG) of 1/9/2002 (BGBl. I p. 3434).
- Federal Immission Control Act [Gesetz zum Schutz vor schädlichen Umwelteinwirkungen durch Luftverunreinigung, Geräusche, Erschütterungen und ähnliche Vorgänge – Bundes-Immissionsschutzgesetz (BImSchG)].
- Closed Substance Cycle Waste Management Act (Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Beseitigung von Abfällen – Kreislaufwirtschafts- und Abfallgesetz (KrW/AbfG)).
- Law for the Application of the EU Framework Directive for Employment Protection and Employment Protection Directives [Gesetz zur Umsetzung der EG-Rahmenrichtlinie Arbeitsschutz und weiterer Arbeitsschutz Richtlinien Arbeitsschutzgesetz (ArbSchG – CHV 2)] of 07.08.1996, changed in 1999.
- Act for Interior and Transnational Transportation of Dangerous Substances on Roadways and by Rail [Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße und mit der Eisenbahn (Gefahrgutverordnung Straße und Eisenbahn – GGVSE)] of 2001, last changed by Article 1 of a directive from 28.04.2003 (BGBl. I p. 595).

C. Regulations of Professional Associations

- BGR 114, Regulations for Safety and Helath Protection for the Disassemply of Objects Containing Explosive Substances or During the Destruction of Explosives or objects Containing Explosives (Regeln für Sicherheit und Gesundheitsschutz beim Zerlegen von Gegenständen mit Explosivstoff oder beim Vernichten von Explosivstoff oder Gegenständen mit Explosivstoff), HVBG, 1996.
- BGR 128, Working in Contaminated Areas (Arbeiten in kontaminierten Bereichen).
- BGR 176, Safety Regulations for Trench Excavation Equipment (Sicherheitsregeln für Grabenverbaugeräte), 1992.

– BGV A1, General Directive, 1991.
– BGV A5, First Aid, 1997.
– BGV C22, Construction, 1997.
– BGV C24, Accident Prevention Directives for Work with Explosives (Unfallverhütungsvorschrift Sprengarbeiten), 1994.
– CHV 4, Regulation for Worksites [Verordnung über Arbeitsstätten (ArbStättV)], 1997.

CONSEQUENCES OF CONTAMINANT LIQUIDATION AT FORMER MILITARY INSTALLATIONS

Borys Zlobenko
Ministry of Emergencies and Affairs of Population Protection from the Consequences of Chernobyl Catastrophe, Ukraine

Vadim Kadoshnikov
Institute of Environmental Geochemistry (IEG), Kiev

Abstract. Traditional methods of decontamination have not ensured the required completeness of treatment. The new composition of coatings for decontamination on buildings and structures was developed at the Institute of Environmental Geochemistry (IEG). The objective of this investigation was to examine the effect of decontamination of the building materials by simultaneous application of various species of micromycets and decontamination coverings. The destructive effect of micromycetes, especially of their dark coloured varieties containing melanin, is conditioned by:

– Mechanical destruction of the surface layer by the interaction of building materials with growing of micro mycelium
– Chemical destruction of surfaces caused by actions of metabolism products.

Investigations conducted by IEG showed the possibility of the decontamination of concrete walls and removing 0.2–0.4 mm of contaminated concrete surface by means of a microbiological destruction of concrete.

1. Introduction

With independence, Ukraine took possession of huge volumes of military hardware and stockpiles. Owing to its geographical position, dozens of military airbases, sites for nuclear strategic missiles, and affiliated service installations were located in the Ukraine. This legacy included the world's third largest nuclear arsenal. The strategic weapon carriers included 176 land based intercontinental ballistic missiles (ICBM) (SS-19 and SS-24 missiles) with 1240 warheads, and 121 strategic bombers (Tu-160s, Tu-95s). In addition, Ukraine inherited approximately 2500 tactical nuclear weapons, designed for delivery by tactical aircraft, artillery and surface-to-surface missiles.

Military sites of the so called "Military Defence Complex" are distributed throughout the country are in part situated in areas highly vulnerable

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 179–189.

to ecological impact. At the time of independence, in 1991, these included 4500 garrisons, testing areas and military individual sites occupying 600,000 hectares. In the period between 1991 and 2003, approximately 140,000 hectares of territory, 147 military bases and 507 separate defence objects were withdrawn from Ministry of Defence (MoD) jurisdiction.

In 2003, the Cabinet of Ministers of Ukraine approved the "Programme of Conversion of Former Military Objects for the Period of Reforming the Armed Forces and Other Military Formations". This programme aims to provide efficient utilisation of former military objects and ensure the resolution of social and economic problems for retired military personnel and their family members. A state program on the environmentally friendly utilisation of highly toxic components of rocket fuel has been elaborated. In addition, the subsequent programmes of the MoD of Ukraine directed that ecological problems be addressed:

– Environmental provisions of the "Programme on the ensuring of safety of arsenals, bases and storehouses for weapons, rockets and ammunitions of the Ukraine Military Forces" for the period 1995–2015 (approved by the Cabinet of Ministers, Decree 472 of 28/06/1995) are recognised as highly important;
– "Programme of the rehabilitation of territories contaminated by military activity", 2002–2015.

Currently, the MoD has officially declared 220 military sites as "ecologically dangerous". The environmental situation at former military bases in Ukraine has never been studied in detail. In general, information concerning operations and the management of military sites was kept secret. The sites were usually operated without any environmental control measures. Furthermore, the legacy of the Chernobyl disaster has caused an extensive contamination of land by radionuclides. Until now, there have remained unsolved problems inhibiting the rehabilitation of contaminated military sites and objects.

2. Abandoned Military Sites in the Ukraine

The Steel Yard OTH "Chernobyl-2" of the military site is located in the region of Kiev, on the right bank of the Pripyat River. The Chernobyl-2 facility was brought into operation in 1976 and had the status of a top-secret facility in Soviet times, located a distance of less than 10 km from the working Chernobyl NPP.

Chernobyl-2 consists of a residential complex, a helicopter field, and four technological sites. These sites include two over-the-horizon antennas of the

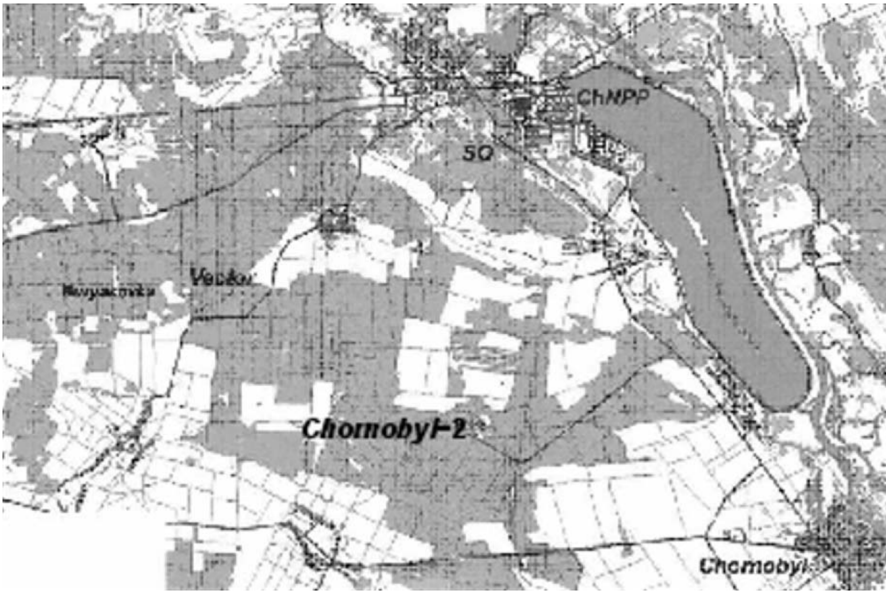


Figure 1. Location of the site Chernobyl-2 within the Exclusion Zone.

radar complex, a space communications centre with the antenna complex of the "Kruh" facility, a bio-energy antenna, and a laser interferometer graviton.

Located two kilometres from the Chernobyl-2 surface town, there is a carefully camouflaged underground reserve command station. Chernobyl-2 was not only built as an anti-missile defence system complex but also as a facility for space surveillance and communications and as an important research centre. Several military units were also deployed here.

The largest accident at Unit 4 of the Chernobyl nuclear power plant on the 26th of April, 1986, opened the reactor's active zone and a large quantity of radioactive substances were dispersed into the atmosphere, contaminating a vast area. Initially the major decontamination of Chernobyl-2 was carried out by special divisions of engineering troops from the Ministry of Defence and subdivisions of civil defence forces. The main countermeasure adopted in these areas was the spraying of buildings with decontamination solutions. The water-jet method, using the standard military vehicle ARS-14 or a fire-hose with or without the surface-active additive "SF-2U" for the decontamination of concrete surfaces was adopted. The concrete surfaces remained almost as dirty after the treatment as they had been before and needed to be intensively cleaned with brushes.

Some years later, a decision to conduct the test decontamination of some buildings was made. Between 1992 and 1996, various buildings at Chernobyl-

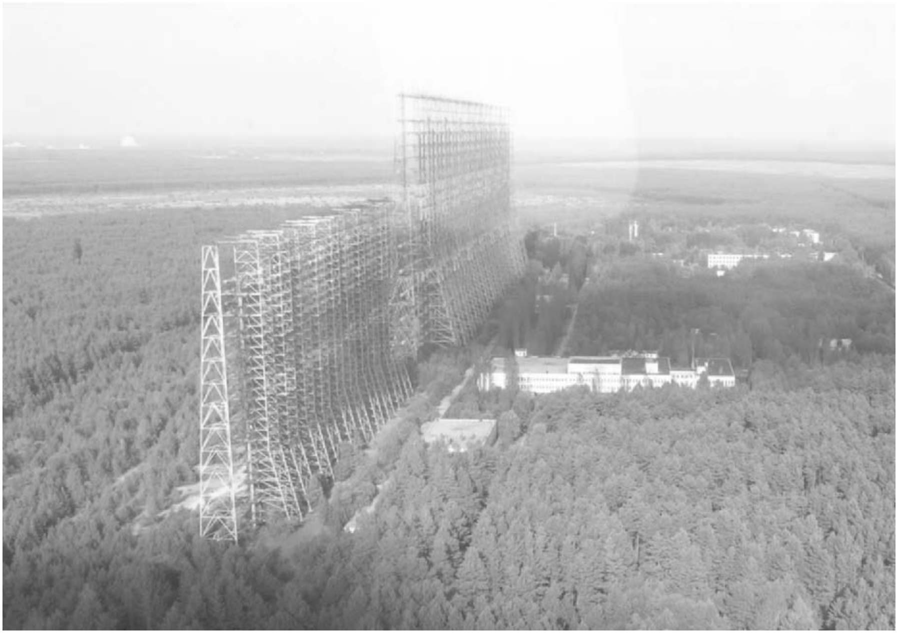
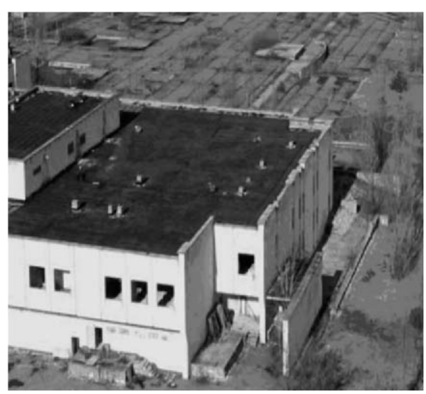


Figure 2. The over-the-horizon antennas of the radar complex at Chernobyl-2.

a. Chernobyl-2 surface town, and carefully camouflaged underground reserve command station.



b. A typical concrete building.

Figure 3. Aeriel views of Chernobyl-2.

2 were experimentally decontaminated in order to select the most successful method of decontamination. Field studies included the determination of the contamination character of each object, *in-situ* experiments on decontamination, and the sampling of concrete, white brick and substances used in the experiments for laboratory research.

3. Biodecontamination of Concrete Surfaces

Concrete and reinforced concrete were widely used as building materials in former military facilities owing to their mechanical stability and low cost. After the Chernobyl accident, a number of the reviews and reports of the research on decontamination techniques available for clean-up have been published.

Because there are literally square kilometres of radioactively contaminated concrete surfaces within the US Department of Energy (DoE) complex, the task of decontamination (both scope and cost) is staggering. Complex-wide clean-up using conventional methodology does not appear to be feasible for every facility because of prioritisation and the cost and labour required. A novel technology for biologically decontaminating concrete is being jointly developed by scientists at the Idaho National Engineering Laboratory (INEL) and British Nuclear Fuels plc (BNFL). The technology exploits a naturally occurring phenomenon referred to as microbially influenced degradation (MID), in which bacteria produce acids that dissolve the cement matrix of concrete.

Most radionuclide contamination of concrete is fixed in the outer few millimetres of the concrete's surface. By capturing and controlling this natural process, a biological method of removing the surface of concrete to depths of up to several millimetres is being developed. The analyses of relevant publications shows that the application of fungal organisms or their subcellular components along with associated process technology applied to manufacturing service industries and environmental management has received much attention in recent years. Several treatment approaches have been proposed for the clean-up of contaminated materials.

The new composition of decontamination coatings (DC) for the decontamination of radioactive deposits on buildings and structures was developed at the Ukrainian Academy of Science. Decontamination using a DC coating is suitable for large-scale decontamination operations in urban environment, since it is safe, practical and cost effective. However, in many cases the residual contamination remains rather high. This is due to the initial contaminant level, the depth of contaminant penetration in porous substrates and the physical-chemical conditions of the surface of the building materials.

One of the most promising new methods of bio-decontamination uses micro-organisms. These fungi have been extensively studied in laboratory testing systems which permit the observation and characterisation of the interaction between the fungi and a radioactive source. These fungi are of interest to environmental clean-up research because a number of their properties, including the ability to adsorb radionuclides, make them ideally suitable for application with a decontamination coating.

The objective of this investigation was to examine the effectiveness of decontamination of building materials by simultaneous application of various species of micro-organisms and decontamination coatings. The investigation studied the resistance of the material to microbiological corrosion and to micro-organism metabolism product-simulators. In addition, the study examined the ability of micro-organisms to grow in different media under the condition of radioactive contamination of the tested surface of materials. During the work, three groups of methods of building decontamination were approved:

1. Mechanical removal using vacuum, sandblasting, and the removal of layers of the contaminated material;
2. Physical-chemical methods of decontamination using partial dissolving and washing away of radioactive contamination with different water and organic solutions;
3. Combination of biologically decontamination with physical-chemical and mechanical methods.

3.1. MATERIALS AND METHODS

The main micro-organisms destructing reinforced concrete are bacteria and fungi. They are widely spread heterotropheous microorganisms able to produce organic acids by assimilating organic carbon compounds. Organic acids such as lactic, citric, acetic, gluconic, malic and other acids, which are by-products of metabolism of micro-organisms, produce acidic conditions with a pH less than three, resulting in the dissolution and disintegration of the concrete matrix.

In our investigation we used specimens of genus *Aspergillus* (family *Moniliaceae*) – *Aspergillus niger*, and of genus *Cladosporium* (family *Dematiaceae*) – *Cladosporium cladosporioides*. Cultures of these fungi were given to us by the Institute of Microbiology and Virology of NAS, Ukraine. Fungi of genuses *Aspergillus* and *Cladosporium* are able to grow under a wide range of pH conditions. It contributes to their oecising at inorganic substrata with alkaline properties, such as concrete.

TABLE I. Fungi growth activity in the model system.

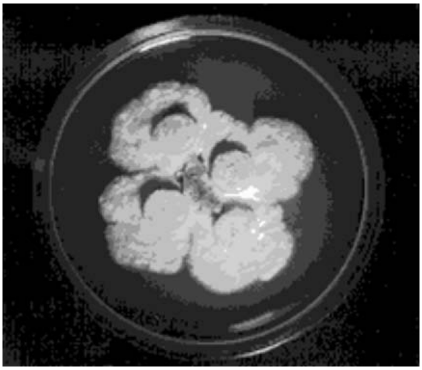
Micromycetes cultures	Oecising		Morphologic characteristics of concrete
	Agarised medium	Concrete	
Aspergillus flavipes 38	⋆ ⋆ ⋆	⋆ ⋆ ⋆ ⋆ ⋆	Heavy sporification, drops of yellow exudation
Aspergillus niger 42	⋆ ⋆ ⋆⋆	⋆ ⋆ ⋆ ⋆ ⋆	Mycelium with heavy sporification, small drops of yellow exudation
Aspergillus versicolor 26	⋆⋆	⋆ ⋆ ⋆ ⋆ ⋆	Thick mycelium, change of mycelium colour from rosy-cream to yellow-green, creation of exudation
Cladosporium cladosporioides 4	⋆⋆	⋆ ⋆ ⋆	Heavy sporification
Cladosporium cladosporioides 340	⋆⋆	⋆ ⋆ ⋆	Heavy sporification

Legend: ⋆ ⋆ ⋆ ⋆ ⋆– excellent, ⋆ ⋆ ⋆⋆– very good, ⋆ ⋆ ⋆– good, ⋆⋆– fair, ⋆– marginal.

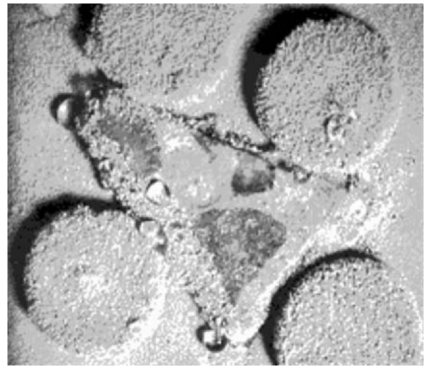
Processes of biological corrosion are conditioned to a great extent by the chemical influence of acids (organic and inorganic) and carbon dioxide produced by micro-organisms in the process of their growth. It is evident that the intensity, direction and extent of destruction and biological corrosion processes will be determined by specific (physiologic) properties of micro-organisms, chemical and mineral composition of concrete components, and capillary porous structure of concrete. The latter plays an extremely important role in the development of corrosion processes, because starting at the interface of environment and concrete, these processes penetrate into the material through pores and capillaries.

To restore natural conditions, which are heterogeneous by sources of nutrition, the agar tablet method was used. We applied techniques of manipulation with an agaric culture medium and concrete samples. To minimise the influence of the culture medium on the course of the experiment we used the most simple agarised Czapek's medium: NaNO–3; KH_2PO_4–1; $MgSO_4$; KCl–0.5; $FeSO_4$–trace; sucrose–30; agar–20 (grams per litre of H_2O).

The observational data of culture growth, their oecising of agarised medium and reinforced sample surface, presented in tab. I and illustrated by fig. 4a and 4b, reflect the state of the model system one month after inocula-



a. Growth of *Aspergillus flavipes 38* at the surface of a sample (general view of the model system).



b. Oecising of a sample's surface by *Alternaria alternata 37*. Active secretion of exudation droplets is observed.

Figure 4. Microbial cultures oecising concrete in laboratory conditions.

TABLE II. Growth ability of micromycetes.

Micromycete	Activated	Dry
Cladosporium cladosporioides 340	⋆ ⋆ ⋆	⋆⋆
Alternaria alternata 1761	⋆ ⋆ ⋆⋆	⋆ ⋆ ⋆
Aspergillus versicolor 26	⋆	⋆
Aspergillus flavipes 38	⋆⋆	⋆
Aspergillus niger 42	⋆ ⋆ ⋆⋆	⋆⋆

Legend: ⋆ ⋆ ⋆ ⋆ ⋆– excellent, ⋆ ⋆ ⋆⋆– very good, ⋆ ⋆ ⋆– good, ⋆⋆– fair, ⋆– marginal.

tion. Oecising was estimated according to a 5-point scale. In this study expert values were used, due to difficulties obtaining cardinal numbers.

It should be noted that *Cladosporium cladosporioides* is a slow-growing species. Its growth rate in a liquid culture medium is many times slower than that of *Aspergillus niger*.

The obtained data can only partially and approximately elucidate microbiological corrosion processes. Only a comparative analysis of the results of a long-term experiment and the thorough study of concrete properties after exposition in the model system can reveal which species are the most active bio-destructors of concrete.

The most important physical factors for growth of micromycetes are: temperature, hydrogen ion concentration and various clay media characteristics (texture, structure, water and gaseous exchange). The experiments have been performed to determine the effect of different species states. The examined micromycetes were separated into two groups. The first group consisted of micromycetes, which had been prepared in advance. The second group was composed by dry spores. The latent period is also affected by different factors such as hydrogen ion concentration and temperature. The temperatures in the neighbourhood of $\approx 295°$ K and pH were common. For many fungi, swelling of the spore accompanied the enchanted respiration. The rate of respiration is dependent on water content. In tab. II, the effects of the growth ability of micromycetes using expert values are illustrated.

We also studied the influence of metabolism product simulators of micro-organisms, *e. g.* solutions of citric and oxalic acids, at the surface layer of the concrete. Concrete samples were put into respective acid solutions and held at room temperature for a certain time period (from 8 to 200 hours depending on the intensity of corrosion effects of various acids). The samples were then rinsed with distilled water for twenty-four hours.

The following changes were observed in the concrete samples: the surface relief was changed owing to solving of the crystallohydrate component of cement stone within eight hours; a decrease in alumoferrite mass and change in colour from brown-red to black was noted in clinker zones; silicate crystals remained unaffected; in the interface of concrete and coarse-grain filler, and in cracks of concrete stone, recrystallisation with enlargement of grains occurred; the width of the recrystallisation zone was 0.03–0.1 mm; within 20 hours, no significant changes were noted in crystallohydrate mass and concrete stone. The partial decolouration of the alumoferrite component of clinker grains and the growth of new formations (small colourless crystals) at the surface of calcium silicate grains were observed; white, sugar-like 0.01–0.02 mm edging was noted around grains of coarse filler; crystallohydrate mass also remained unaffected within 200 hours; complete decolouration of allumoferrous of calcium and further increase in new formations at calcium silicate grains was observed in clinker grains.

The degree of corrosion resistance is the material corrosion rate in a certain environment under certain conditions. The corrosion rate of a material is interpreted as the mass of material (g) turned into corrosion products in a unit of time (1 hour) on a unit of its surface (1 m^3) (unit of surface is expressed in m^2). The quantitative estimation of surface condition change under the influence of leaching agents is an extension of surface area given the complication of surface relief resulting from corrosion [6]. The roughness indicator describes the surfaces of samples both before and after treatment with various acids. It was found that after treatment, the surfaces were characterised by considerable differences in vertical coordinates of neighbouring measures. Based on the obtained data, it may be inferred that irregular (local)

TABLE III. Decontamination factor.

Material type	Contamination before treatment	Contamination after treatment	Decontamination factor (Ff)
concrete	240 ± 18	89 ± 6	2.7 ± 0.82
white silicate brick	148 ± 10	55 ± 4	2.5 ± 0.7

corrosion occurred as a result of treatment with citric acid. In some places differences of 70 μm and more are observed. The average value of differences was 27.4±7.1 μm with confidence probability $P = 0.95$. These parameters, including mean square deviation (in this case $\sigma = 27.4\,\mu$m), characterise surface profile roughness and can be used as additional characteristics of corrosion rates.

From the obtained data, it is evident that, based on the detailed study of peculiar surface form properties, quantitative information on corrosion processes can be obtained and corrosion rates can be assessed, especially in cases when samples are porous and its mass increases the mass of destructed layer. Quantitative measurement of corrosion products (especially X-ray amorphous phase ones) in such samples requires application of expensive investigative techniques, while the obtained information is not always unambiguous. In this situation, the study of surface profiles heads the list and can essentially add to data collected by other methods.

3.2. CLEAN-UP

In order to determine the efficiency of the decontamination procedure, the colonies of micromycetes were removed using self-stripping “DC”. This procedure involves covering the contaminated surface with grown micromycetes. After drying it cracks, flakes, peels and fall off as a solid with loose surface material entrained in the peelings, removing the fungal layers. The results of the laboratory research showed that decontamination with micromycetes decreases the contamination level from 55% to 120% compared to DC treatments (tab. III). This corresponds to a decontamination factor in the range of 1.8–2.7. In a laboratory environment, the bio-decontamination process has successfully been used to remove 350 m ^{2} of the surface of concrete.

In pilot tests of DC using a standard military vehicle with standard pumping equipment, the rate of spraying was 24 $m^2 min^{-1}$ and it took 15–20 minutes for 2 operators to cover a 100 m^2 (in base) building and then about 6 hours were necessary for the DC to dry and peel (air temperature of 22° C, air humidity of 75%). The speed of the vacuum sweeping of DC peelings was 3 $m^2\,min^{-1}$.

4. Conclusions

The optimised bio-decontaminating technique has successively been set-up and applied on contaminated materials. However, in many cases the residual contamination remains rather high because of the porous nature and physical-chemical conditions of the surface of the concrete being cleaned up several years after contamination.

The results of the studies show that this novel technology is suitable for large scale decontamination operations as it is safe, practical, efficient and cost effective.

References

Esposito, M., McArdle, J., Crone, A., Greber, J., Clark, R., Brown, S., Hallowell, J., Langham, A., and McCandalish, C. (1987) *Decontamination Techniques for Buildings, Structures and Equipment*, No. 142 in Pollution Technology Review No. 142, Park Ridge, USA, Noyes Data Corporation.

Gadd, G. and White, C. (1992) Removal of Thorium from Simulated Acid Process Streams by Fungal Biomass: Potential for Thorium Desorption and Reuse of Biomass and Desorbent, *Journal of Chemical Technology and Biotechnology* **55**, 39–54.

Kadoshnikov, V., Zlobenko, B., Zhdanova, N., and Redchitz, T., Studies of application of micromycetes and clay composition for decontamination of building materials, Proc. HLW, LLW, mixed wastes and environmental restoration. Working towards a cleaner environment, WM'95, Tucson, Arizona, CD.

Kanevskaia, I. (1979) *Methods of experimental mycology*, Kiev, Naukova Dumka.

Kanevskaia, I. (1984) *Biological damages of industrial materials [in Russian]*, Leningrade, Nauka.

Kulynyak, D. (1996) What Is 'Chernobyl-Two' Actually?, *MOLOD UKRAYIN* p. 2.

Larsen, S. (1997) An Overview of Defense Conversion in the Ukraine, *BICC* pp. Bonn, Germany.

Movchan, N., Zlobenko, B., Shpigun, A., Fdorenko, Y. G., Govorun, A., and Polskiy, E. (1990) SU Patent No. 1817 935.

Olynyk, S., Ukraine as a Post-Cold War Military Power, *JFQ Forum* **Spring**, 87–94.

Rogers, R., Hamilton, M., Nelson, L., Benson, J., and Green, M. (1997) Evaluation of microbially influenced degradation as a method for the decontamination of radioactively contaminated concrete, In *Scientific basis for nuclear waste management*, Pittsburgh, USA, , Materials Research Society, pp. 317–322.

Slobotovitch, E. and Zlobenko, B. (2003) Chernobyl Experience at Design of New Methods for Decontamination of Urbanized Territories, In *Innovation Technologies and Technical Solutions for Fighting Against Terrorism*, Charkov, pp. 63–68.

Vovk, I., Movchan, N., Federenko, Y. G., Shpigun, A., and Zlobenko, B. (1993) Research on Clean-up of Buildings and Structures in Urban Areas of Ukraine Affected by the Accident at the Chernobyl NPP, In *Proceedings of the Int. Conf. on Nuclear Waste Management and Environmental Remediation*, Vol. 2, Prague, pp. 313–321.

THE ECOLOGICAL CONDITION OF KADJI-SAI URANIUM TAILINGS

A.K. Tynybekov and M.S. Aliev
Kyrgyz Russian Slavonic University

Abstract. The radioactive conditions in the Tien-Shan Mountains are caused by natural factors and the commercial extraction and processing of raw uranium within the Kyrgyz Republic. After the closing of uranium mines and processing facilities, there remained large quantities of radioactive tailings and rock dumps within the territory of the Kyrgyz Republic. They are exposed to decay and weathering under the influence of anthropogenic and natural factors. There is a distribution of radioactive substances in the environment, representing a danger to the health of the population and to the biosphere as a whole.

1. Introduction

Explorations for uranium and the operation of uranium processing facilities began in the mid-1940s, and by the end of the 1970s, the extraction of nuclear fuel had fully ceased in the territory of Kyrgyz Republic. Since this time, a portion of the uranium deposits has degraded while the remaineder has been shut down. The mountain dumps of radioactive slag were formed during prospecting and development, and during mine construction and operations. As a result of these activities, an estimated 34 million tons of ore containing uranium and thorium have been deposited on the surface. Dump locations are shown in fig. 1 on page 192, while a detailed map of the study area is shown in fig. 1 on page 192.

The purpose of our work was to carry out a survey of background raditation in the region of the southern coastal areas of Lake Issyk Kul. The research study area was a coastal zone of Lake Issyk Kul and nearby settlements. To this end, the following tasks were identified:

- to carry out georeferenced measurements of background
- to investigate the soil structure and the presence of radioactive elements in rivers and settlements in the study area
- to present the received results as radio-ecological maps.

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 191–195.

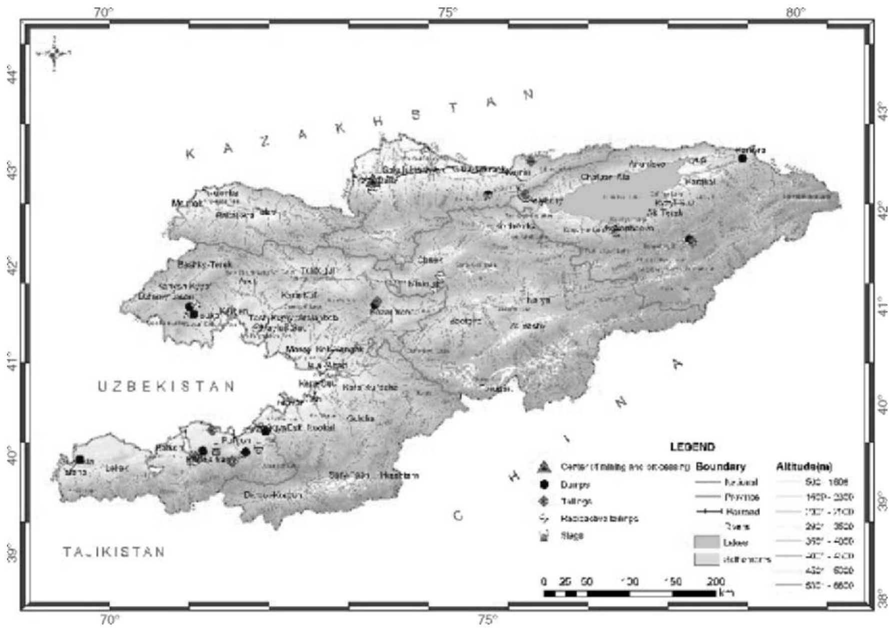


Figure 1. Uranium tailing dumps in Kyrgyzstan.

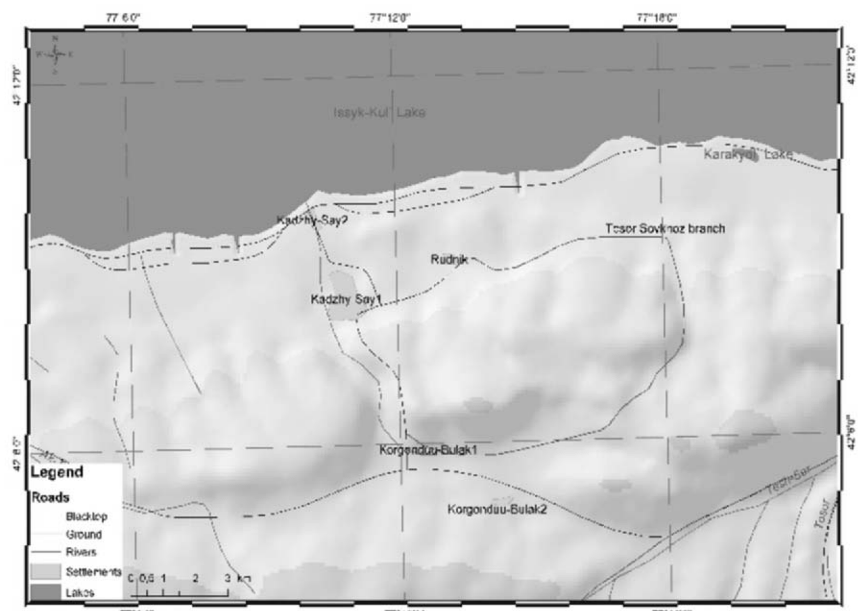


Figure 2. Detailed map of the study area.

The technique used to measure radiation involved the simultaneous recording of a site's geographical coordinates using a differential global positioning system and the measurement of background radiation by exponometer-detector (Eberline). During expeditions, the parameters of background radiation were saved in the memory of exponometer-detector. The satellite device automatically fixed the geographical coordinates of a deposit and also saved these data to memory.

Locations with indications of increased radioactivity included a costal zone near the village of Dzhenish, the area surrounding Shop No. 7 near the village of Ton, and the tailing dump near to the village of Kadji-Sai.

High levels of gamma background radiation, up to 130 $mkRh^{-1}$, were observed on the southern coast of Lake Issyk Kul and on separate sites of shoreline in the area of Zhenish village. Radiation near the village of Tosor in the Gulf of Ak-Chii reached 103 $mkRh^{-1}$. These anomalies are due to the unsafe deposition of radioactive material containing thorium and radium, both products of uranium disintegration.

An example of a dangerous tailing deposit is located on the southern shore of Lake Issyk Kul, situated downstream of the Kadji-Sai River. Lake Issyk Kul lies at 1608.8 m above sea level. The ore deposits and workers' settlememt are located at altitudes of 1700–1850 m at a distance of 1.5 km eastwards of the village of Kadji-Sai in the Suhoi-Sai canyon.

Kadji-Sai is a former uranium mine 2.5 km from Lake Issyk Kul and is also near the settlement of Kadzhi-Saj. The mine was in operation from 1949–1967. According to one source, 400,000 m^3 of tailings covering an area of 10,000 m^2 are located at Kadji-Sai (Torgoev, 1994). A second source estimates that the volume of the tailings is only 150,000m^3 (Momunaliev, 1996). Because these tailings universally contain uranium waste products, radiation levels ranging between 30 and 1500 $mkRh^{-1}$ can be observed. The tailings are the result of two industrial operations, an industrial construction site and gold excavations.

The ash deposition site contains materials of very small diameter, as these materials are limited to ashes taken from waste products. Following the disintegration of the USSR, safety measures and the remediation of tailing sites were not undertaken. This has considerably strengthened the threat of an ecological disaster. Because no resources were available to repair and maintain the facilities, constructions have become dilapidated and drainage channels have become covered with slime.

2. Influence of Natural and Anthropogenic Factors on the Condition of Tailings

Because the mine is located near to Lake Issyk Kul, there is a danger of lake contamination with radioactive waste products. The Kadji-Sai tailings and a protective dam are under natural and anthropogenic influences, and there is a process of tailing decomposition and weathering. The mine at Kadji-Sai is vulnerable to washouts, high waters and landslides that could result in the transportation of radioactive materials from the surface. This is one of the potential polluters of the southern coast of Lake Issyk Kul. In 1997, a number of sites 2–3 m in width, 200–300 m in length, and with a radioactivity of up to 300 mkRh^{-1} were found. Storm rains in 1998 also seriously damaged an isolation layer of the Kadji-Sai dam located 1.5 km from the coast of the lake. The background radiation at a number of sites has also appreciably increased, thereby causing alarm among the public of the country and the nature protection organisations.

The tailings dam is the only retention structure in place, and is currently assessed to be instable. A tailing washout would lead to the radioactive and chemical pollution of large areas of Lake Issyk Kul. The strengthening of protective dams and or the construction of new water-bearing channels would do little to solve the problem.

3. Results of Radiological Survey

In order to determine the actual level of radiation in this region, and in particular to identify areas with elevated levels of radiation, research was carried out between 1997 and 2000 in the Issyk Kul region with support of grants from INTAS (European Union) and CRDF (USA). This research has shown that levels of gamma radiation do not exceed 20–25 mkRh^{-1} and can be considered to be natural background radiation (NBR). It is only at some locations that higher levels have been observed.

4. Conclusions

The tourism zone on the shores of Lake Issyk Kul is endangered because of its location near the uranium tailings. The monitoring of radiation levels is important for the sustainable development of this region.

It is necessary to estimate possible hazards to air, water and ground resources in nearby to radioactive storage facilities, to develop appropriate technologies and to design treatment methods for ground contaminated by radioactive substances, and to carry out an ecological assessment of the polluted territories.

References

Hambly, D. and Tynybekov, A. (1999) Radiological monitoring of Southern coast of Lake IssykKul, *Physics Health* **77**, 427–430.

Tynybekov, A. (2001)a Problems of influence of radioactive storages on ecology, In *International conference ECO-INFORMA 2001 Environmental risk the Global Community*, Argonne National Laboratory, USA, , Network Poster N-P7.

Tynybekov, A. (2001)b Radiological researches in a southeast part of Lake Issyk Kul, In *International Conference Human Health and Environment. Strategies and Programs in New Millenium*, Bishkek, Kyrgyz Republic, , INTAS Advanced Monitoring Conference Grants.

Tynybekov, A. (2004) Research of ecological risk modelling: influence of uranium storage on environment, In *Radiation Safety Problems in the Caspian Region*, pp. 79–85, Kluwer Academic Publishers.

MAJOR PROBLEMS FACED AFTER THE WITHDRAWAL OF THE SOVIET ARMY FROM MOLDOVA

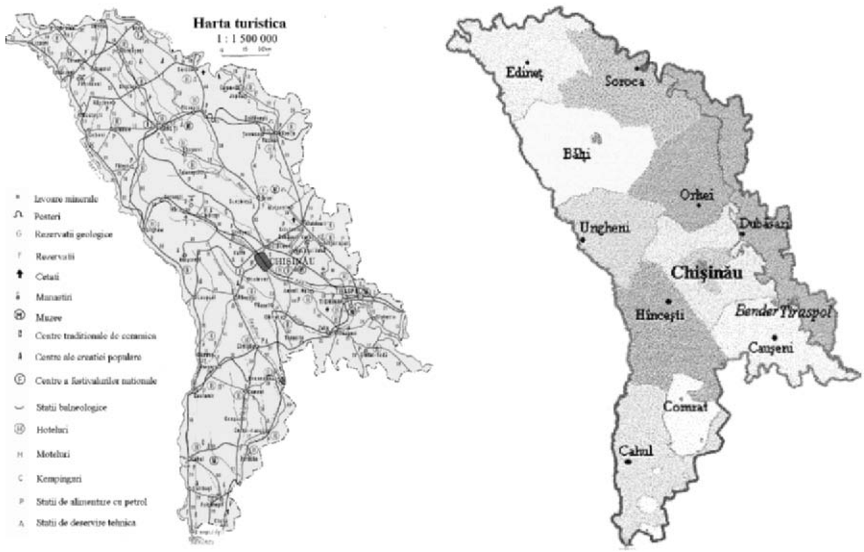
Sergiu Galitchi
Director, Investment, Innovation and Modern Technologies Center of Moldova

Abstract. Many years have passed since Moldova proclaimed independence, but because of a lack of financial resources and staff preparedness during the period of transition, some important problems regarding the conversion of military sites have arisen in Moldova. Following the withdrawal of the Soviet Army, both abandoned and operative military objects could be characterised as having various degrees of degradation and the need for different approaches for rehabilitation, environment protection and remediation. Immediately following this withdrawal and like the other states of Western Europe such as Hungary, the Czech Republic, Poland and Germany, the Baltic States appeared to have had an urgent need for an assessment of contaminated sites. Negative effects on the environment and human health were evident, including the pollution of geologic media and degradation of natural resources and landscapes. Major sources of pollution included transport and rocket fuels, lubricants, solvents, galvanic wastes, the remnants of chemical weapons and decontamination substances. Unfortunately, the actions of the Moldavian government and the ruling party were neither consequent nor prompt, thereby being inappropriate to solve these problems. The consequences were revealed to be dramatic. Since the existence of the Soviet Union, policies to create economic military potential was directed only to that zone where the majority of defence enterprises were established. For example, a metallurgical (electro-steel smelting) plant with productivity of approximately around one million tons per year was built to have an annual turnover equal to the total annual budget of the country. As a result of this concentrated industrial capacity and the subsequent demise of many industries, Moldavian society has faced economic difficulties with regards to democratic reforms. After the end of the Cold War, an attempt was made to inventory the impact of brownfields and prepare for field restoration, but the initiative was stopped because lack of access to the militarised zone. It has been the result that many inhabitants are suffering from restricted travel rights and limited access to the active national economy.

1. Introduction

> There are certain queer times and occasions in this strange mixed affair we call life when a man takes this whole universe for a vast practical joke, though the wit thereof he but dimly discerns, and more than suspects that the joke is at nobody's expense but his own.
>
> —Herman Melville

W. Spyra and M. Katzsch (eds.), Environmental Security and Public Safety, 197–205.



a. Road map of Moldova. *b.* Regional map of Moldova.

Figure 1. Maps showing transportation routes and the states of Moldova.

Alas! At last the doomsday has come. The worst-case scenario has become a reality. Nuclear missiles have been launched in response to repeated crimes, disturbances and terrorist outrages. Unfortunately, the automatic operation of the retaliation device possessed by a second nuclear power has triggered a chain reaction leading to the indiscriminate launch of countless nuclear missiles. While each and every place on the globe was enveloped in enormous flashes, all the buildings and compounds were turned to rubble. All the creatures on earth, not only human kind, but all the living things, were also vaporised in an instant. After mountains and forests flamed up, puffing clouds of smoke, they were turned into deserts. Pyramids, instantly transformed into red bricks, began to melt. The terrestrial parts were transformed into bleak deserts, and the water in lakes and rivers were evaporated, leaving only their dry beds as evidence that they had existed. Flames, smoke and dust enveloped the globe. As they dissipated, there appeared a planet of deserts with piles of tiles and pebbles. The dreams and ambitions of human-kind and vestiges of the other creatures that once lived; all the endeavours and the history we made; our beloved ones, with all the memories—all of them were taken from the world, leaving only a burning stench and highly concentrated radioactivity.

Please imagine this scene in your mind. This is we will be confronted with unless we take action immediately. However, we also know the measures to avoid it. These measures require that we reduce our consumption of natural resources and the destruction of the natural environment to sustainable level, thereby allowing nature to return the stocks of natural resources to the level of self–sufficiency. If we can move now, we can save the earth. However, nothing dispirits, and nothing seems worth disputing. What follows are my impressions of the situation in Moldova, expressing the urgency with which I perceive actions must be taken.

The disintegration of the former Soviet Union and withdrawal of the Soviet Army from Moldova has left many military facilities effected, outdated installations and equipment unused and abandoned, sites polluted, munitions abandoned, leading to serious problems and conflicts at the local level. Indeed, this group of problems requires a concerted effort to achieve the conversion of these sites from military to civilian use. The conversion of military sites in Moldova requires approaches consistent with the needs of the civilian market, the destruction of arms and munitions through material recycling, and the rehabilitation of disturbed and contamination lands.

2. The Role of the Environment and Environmental Management Systems in Peace-time Defence Organisations

The management of military activities and of environmental impacts requires, as a corner-stone, a systematic approach. The results of the environmental measures must be known to top management and require an effective system to plan and control enforcement. The cleaning–up of contaminated sites is still a large component of management issues, thought this does not imply that an integrated management approach is always being used. Moldavian environmental management shows serious deficiencies in this regard. There exists no integrated environmental management system (EMS) for the military sector in Moldova. Nationally, only one or two persons are responsible for environmental compliance and enforcement capacity-building. A well-structured supervision system is missing.

Senior staff of the government and military officers are responsible the enforcement of environmental legislation. The need for a concerted and professional approach to the development of EMS standards has increased dramatically over time. The most important steps include:

- the development of an effective institutional framework
- the establishment of an integrated informational system accessible via the Internet and coupled with national databases for the inventory of all kinds of military wastes and sites
- the elaboration of regulations, norms and standards regarding activities specific to the Ministry of Defence

- the development of an effective monitoring system
- the development of a commanders EMS guidebook, describing responsibilities and commitments, and other relevant aspects of environmental management

3. Program for the Rehabilitation and Restoration of Polluted Sites

Up to the present time, thousands of acres remain heavily polluted with organic contaminants and petroleum products following the withdrawal of the Soviet Army from Moldova. The topography, geology, and current uses of these sites vary greatly, as do the types and concentrations of contamination. The extent of contamination and associated hazards, in some cases dangerous to the local inhabitants, has created the need for advanced pollutants identification, characterisation, and remediation technologies.

The main pollutants belong to a small number of types. Fuels and lubricants are petroleum products, *i. e.* hydrocarbons. These products many contain toxic chemical additives. A separate group are the hydrocarbon compounds: dichloroethane, trichloro-ethane, chloro-benzene, among others. These include many solvents such as toluene and other benzene homologues. Trichloro–ethane contamination is also associated with abandoned rocket fuel stocks.

Liquid hydrocarbon substances such as oils, high consistency petroleum products and chloro-hydrocarbon compounds are found in two forms: free and emulsive hydrocarbons. If organic solvents are found in the aureole of contaminating oil products, the petroleum products could be transferred into solution. A negligible part of dissociated forms of organic compounds may be sorbed.

A very serious form of pollution results from the contamination of ground water supplies. The movement of subterranean water can transport pollutants off-site. Pollution dispersion is controlled by the removal of the contaminated medium and through retardation. Retardation takes place at the barriers of geologic medium. The main functional kinds of the barriers are mechanical (filtering), physical, chemical and biologic barriers. The remediation of polluted territories consists of the cleaning of geologic media (soils) of pollutants and the restoration of natural landscapes. Dispersion of pollutants within geologic media depends on its composition and the characteristics of the soil, and on geological factors (infiltration and filtration processes), as well structural and lytological conditions in the contaminated area.

The cleaning of a medium and the restoration of its protective proprieties are carried out *in situ* and through the extraction of its polluted components.

The cleaning with extraction is applicable to underground water and soil resources, though it is very expensive and requires specific technologies and time.

3.1. CONTAMINATED SOILS OF MILITARY SITES IN MOLDOVA

Major problems encountered at contaminated military sites can be grouped into two types, namely the deposition of contaminants in soils and water resources and the spillage of petroleum products.:

1. Deposition of pollutants in soils, underground water resources and loss of soil functions as a result of the activities of the Former Soviet Army in Moldova.
   - loss of biodiversity, (in total only 13.3% of forests remained in Moldova)
   - soil erosion (30.4% annual loss of fertile soil, roughly 18 million tonnes) and landslides, (landslides affects 14% of the territory)
   - the quality of arable land has also been heavily effected by erosion and salinisation
   - 50’000 ha. has been allocated to landfills
   - deposition of contaminated soils
2. spills of petroleum products, including major contaminated areas
   - Site 1. Marculesti, Floresti District: source of pollution is an air base of the Red Army
     - contaminant: oil products
     - media: soil, subsoil and ground water
     - affected area: 130 ha.
   - Site 2. Blijnii Hutor Miltary Air Base
   - Site 3. Iargara, Leova District: oil terminal storage (futher details below)
     - contaminant: gasoline

In August of 1973 at the petroleum reservoir in the village of Iargara, a large accident occurred resulting in the uncontrolled release of approximately 628 tons of gasoline. The contaminant flowed out into the soil and reached the groundwater aquifer, resulting in heavy pollution of the water supplies. The accident was catastrophic for the local inhabitants, as their source of potable water was no longer useful.

At the Iargara site, the area polluted with oil products area is approximately 12–15 ha . The site is situated in the southern part of village of Iragara and on the right side of the Tighech Stream. The level of underground water ranges from 5–7 m on the lower site to 11–12 m on the upper site of the territory. According to the available data, level of the underground water oscillates between 2–4 m .

The situation continues to pose a number of threats. Oil contaminants are able to migrate to different locations and depths, depending on the density of each compound and the local geology. The contaminants continue to pose threats to groundwater and local drinking water. The total cost of the research regarding this site was $US 42'868. The proposed remediation for this site involved the removal of buildings found on the site, and the pumping and treatment of groundwater. Venting and bio-degradation would be two possible approaches to this treatment. The costs of such a remediation project have not been estimated.

Because time has passed since the study of these accident sites were undertaken, the situation at each site has likely changed. There therefore exists the need study of each site once more, giving full consideration for field restoration and contaminants neutralisation. Environmentally sound operations in the military sector must be the vision of the future.

4. Disarmament and Solutions for Military Risk Reduction on the Left Bank of the Dniestr River

Since the disintegration of the Soviet Union and with the withdrawal of Soviet troops from Moldova, thousands of tons of munitions and military equipment have been relocated from Poland, Hungary and Germany and stored on the left bank of the Dniestr River. Many of these munitions are outdated and have been virtually abandoned, as can be seen in fig. 2. Although they remain in storage on military bases and guarded by the military staff of the 14th Army of the Russian Federation, there is obviously an insufficient capacity to safely store and handle these munitions.

Further, following the Cold War, thousands of hectares and sites are contaminated with unexploded ordnance in the left bank of the Dniestr River and the solving of this problem has being a very high priority. In these areas, inert ordnance, non-ordnance objects and debris have been deposited. Many people and domestic animals are wounded and killed each year at this site and many hectares of arable land remain fallow. In support of the remediation of this site, it remains necessary to asses and advance the state of the art of the detection, identification, characterisation, and remediation of unexploded ordnance. Prior to these technical steps, there remains the need to solve the stringent political problems which remained unsolved to present day.

Figure 2. Discarded shells at the Dniestr River site.

5. Ordnance Clearance Technology Measures

The urgent action for the neutralisation of outdated rocket fuel, stocked at military bases of Moldova, has been identified as a high priority for the nation. In support of the need for rocket fuel neutralisation, an extensive assessment review was performed. Approximately 360 tons of strong liquid oxidant *Melanj*, were identified as having been accumulated during the dislocation of Soviet Army forces in the Republic of Moldova.

The term of validity of the oxidant exceeded seven years and it was identified that the fuel was no longer suitable for its original use. However, due to documented leakages, many of the tanks appeared to be empty. Traces on the soil surfaces and specifically the characteristic odour of the oxidant indicate that several leakages with major releases of the highly toxic oxidizer occurred over a long period of time.

Intense evaporation of the oxidant and its frequent leakage as a result of the corrosion of the stainless steel and aluminium storage tanks. These leakages have polluted the area surrounding the storage sites, causing coughing, irritation to the respiratory tracts and difficulty breathing for the personal and inhabitants from areas near to the tanks.

The main objectives of the subsequent study needed to ensure environmental protection and the protection of the inhabitants of the area were defined. The attaining of the respective objective involved an array of actions, among which were the gathering and processing of information, neutralisation and liquidation of noxious substances, implementation of measures of prevention of environmental accidents, raising the awareness of the general public and of the military in the concerned matter, and the development and rehabilitation of territories of military bases affected by noxious substances.

Benefits resulting from this project included:

1. the environmental situation in the military sector and in the entire territory of the Republic of Moldova improved
2. there was the raising of awareness of the local population about the environmental risks and problems
3. conservation, restoration and conversion of affected sites for public needs were undertaken.

Finally, with the financial support of NATO and in order to prevent further contaminations and spills, the volume of rocket fuel mentioned above was removed from the site and transported to a special location for neutralisation. The neutralisation was performed by American specialists. The total project costs were approximately US$ 950’000.

6. Conclusions

Conversion of the defence manufacturing activities are the best way to both enhance the economic situation of Moldova and maintain operational readiness. Previously, eight large enterprises were incorporated in the former defence system of Moldova. These manufacturing facilities must be studied at the present and their usefulness reconsidered in the context of market needs. The whole turnover was in the order of millions of dollars per year and thousands of qualified specialists were engaged for the production of the electronic spare parts for the military industry. Due to the missing export market to Russia and the contraction of the market to include only sales in Moldavia, production has been reduced considerably. According to information made available by the public authorities, the firm SIGMA had 6500 qualified workers in 1987 manufacturing electronic equipment and spare parts for the military sector. Today, the production has decreased dramatically and only 240 workers are currently engaged. There is a low level of production and as a consequence a reduced need to maintain personnel. The existing machinery and equipment are outdated. The production areas are not used efficiently and a modern marketing strategy is lacking. Thousands of people were released on short notice, creating social and economic problems.

Approximately 60 tons of toxic wastes resulting from electroplating processes are being stored and require recycling and neutralisation. Conversion is defined as a transformation from military to civilian uses. Therefore the enterprise administration is searching partners and support for conversion of the existing operations for other opportunities and other products, thereby promoting efficiency. The gaining of experience and knowledge in implementing new technologies urgently requires the understanding and support of the NATO alliance.

INDEX