Depleted or Defeated

How the Bosnia and Herzegovina example should teach us for the future

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Abstract

The Former Repairing Tank Facility at the area Hadzici in Bosnia and Herzegovina was targeted by the NATO forces at the end of 1995. As a result, residues of depleted uranium (DU) ammunition have penetrated to the ground polluting the environment to a great extent.

Succeeding the war, several people established to the area which has been thereafter transformed into a growing industrial site. Therefore, the inhabitants' perception on the potential long-term health threats as well as the view of official authorities on the matter is of great importance. This work tries to understand the current perceptions on these questions and the results unveil some alarming conclusions.

While there is a clear increase of health issues since the attacks, the lack of information and support by the local authorities shifts the inhabitants focus rather on their economic survival than on long-term health matters. At the same time, international organizations still try to raise awareness on the negative impact of DU ammunition usage suggesting the need for global collaborations.

The conclusions extracted by the Bosnia and Herzegovina example expound how critical it is to follow the *precautionary principle* in any future case of possible DU ammunition usage.

Keywords: Depleted Uranium ammunition, inhabitants perception, Bosnia and Herzegovina

Word count: 8140

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Note to the reader:

As a one year as an assistant at the Department of Biophysics, radiology and environmental protection, at Veterinarian faculty, Sarajevo, I gain first information about remnants of depleted uranium ammunition in Bosnia and Herzegovina. I worked on two projects about environmental pollution problems, that were funded by the European Commission, “Management and Remediation of Hazardous Industrial Wastes in the Western Balkan Countries – INDUWASTE” and “Assessment of Environmental Risk for Use of Radioactively Contaminated Industrial Tailings – INTAILRISK”.

Till then, I was more focused on veterinary medicine, as graduated veterinarian, where I worked closely with de-mining dogs at Norwegian People's Aid Training center in Sarajevo.

I was aware that post-war recovery of Bosnia and Herzegovina were more focused on economic development, where environmental problems were not on the list of priorities.

Research into the depleted uranium problem comes as part of my postgraduate studies at LUMES, where social research into this area was missing. Making interviews with international NGO organization that is engaged in banning depleted uranium ammunition, as native Bosnian and closely related to the issue, I assisted visiting team that researching depleted uranium in Bosnia and Herzegovina in 2010. The report could be found at publications made by International coalitions to ban uranium weapons (ICBUW), A Question of Responsibility - the legacy of depleted uranium use in the Balkans.

Even after huge efforts of organizations to stop the usage of depleted uranium ammunition, scientific reports, field cases and devastation of environment caused by this chemical toxic and low radioactive substance, it is still used. Social research into this area could help as a valuable resource for the protection of our environment from further damaging.

1 Introduction

The human kind tend to waste and pollute the natural resources of our planet forgetting the words of Robert Goodland and Herman Daly in 1995 “We do not have time of dreaming to create more living space or more environments such as colonizing the moon or building cities beneath the ocean. We must save the remnants of the only environment we have...”. Accepting that the clean water, fertile soil and the fresh air are not unlimited, one realizes that the natural resources may become the limiting factor of development [Goodland, Daly, 1996]. Such an example is the post war Bosnia and Herzegovina. The war had left the soil and water heavily polluted with materials like depleted uranium (DU) while the natural resources should have a more vital role on the development due to the devastated economic and societal structure of the country.

The general impact of the DU ammunition has been analyzed by several methods and approaches that have even classified them as “materials with uncertain effects” [In a state of uncertainty, www.ikvpaxchristy.nl, 2013]. In first place DU spreads via the dust, and later it residues in soil and water becoming part of the food chain. However, data are incomplete regarding the effect of receiving extreme radiation doses for a few moments or for long-term exposure in DU polluted areas, and the studies cannot still offer a complete picture about the future effects of DU [C. Nuccetelli, M. Grandolfo, S. Risica, 2005]. For instance, epidemiological data reporting increase of cancer in population of Balkan countries and genetically deformations in children born in Iraq have been collected [ICBUW]. Nevertheless, these data are still not sufficient for risk establishment and further scientific input on the radiological and chemical effects of DU [see Fairley, 2008] is required to fully justify and establish the DU ammunition problem. It is also worth mentioning that the increase of cancer in soldiers handling DU ammunitions in the Gulf and Balkan wars [Gulf and Balkan syndrome, Harley, 1999] started a new circle of discussions on how its usage violates the human rights [Parker, 2007].

Investigations in that direction were carried out for the first time in 2002 exhibiting that there is an increased probability of cancer in DU-polluted areas [UNEP, 2003]. It was a coordination of experts from the World Health Organization (WHO), United Nations Environmental Programme (UNEP), and the International Atomic Energy Agency (IAEA). The field studies were conducted in the Balkan countries, including Bosnia and Herzegovina. Part of the report was focused on the region of interest for this paper, the location of the former Repairing Tank Facility in Hadzici. The usage of DU ammunition in Bosnia and Herzegovina war was primarily from the NATO attacks on military targets in 1995. DU ammunition was

used at eleven sites in Bosnia and Herzegovina, as well as on three other sites, the Han Pijesak barracks, the Hadzici tank repairing facility, and the Hadzici ammunition storage. The UN reports approximately 10 800 pieces of fired ammunitions, totaling 2.9 tons of DU, from 5 August 1994 to 14 September 1995, in Bosnia and Herzegovina [UN, 2008].

DU is popular in ammunition production due to its high density (DU is 1.7 times more dense than lead) increasing the range and the penetrative power [Murray, Bailey, Spratt, 2002]. Nonetheless, it is estimated that about 65 to 90 % of the fired ammunition misses their target and is buried from 10 cm to several meters beneath the ground [UNEP, 2003].

1.1 Research focus and sustainability link

Within the scope of sustainable development, any kind of environmental degradation is connected to social, political and economic factors, raising the dilemma to an issue of environmental equity in which equity plays a central role in environmental policy [Carter, 2007]. Those directly affected by environmental problems, as with the effects of the DU ammunition, are often in post-war societies marginalized and left to cope by themselves [Stoet, 2005]. In a post-war period, these states could find themselves politically isolated regarding their environmental damage, as the countries that were part of the war tried to be exempted from the environmental responsibility caused by war activities and policies [Falk, 2000]. However, in the decision-making process, environmental policy is surrounded by uncertainties. They call for the application of the precautionary principle [Carter, 2007].

Unfortunately, precaution for damaging environment can be diminished by economic or political decisions, or simply removed because of ignorance. Integration of economic, social and environmental factors in policies, planning and management levels influences the actions of all societal actors such as individuals, governments and the industrial sector, and have an implication for “efficient and sustainable development”, as declared by the UN in their declaration on Environment and development from the Rio conference, 1992, and Agenda 21, as their action plan. Intergenerational equity, that is derived from the Bruntland report, as the definition of sustainability itself, “sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [WCED, 1987]. This represents our acknowledgement of future generations' rights with our taking responsibility for their well-being. Societies in which there is less concern for the environment cannot bring a sustainable future. Awareness of environmental deterioration often comes late; generally, we become worried when it is clear there is an impact on

human health. Permanent environmental pollution, as it is in the case of DU ammunition, questions intergenerational equity, and triggers the political decision-making system.

1.2 Objectives, aim and research questions

The public opinion should shape the demeanor of the local politicians as well as the attitude of the international bodies and the future decision-making system. For that reason, the present work examines the level of the inhabitants' perception on the DU pollution aiming to understand how people living in directly affected areas (see Figure 1) realize the DU ammunition problem. In addition, the role of the non-governmental organizations calling for DU weapons ban is studied. They propose the application of precautionary principle as the necessity in regulating further environmental and health problems, also questioning the intergenerational equity with nonexistence of any legal action regarding DU ammunition.

This research therefore has two objectives:

- The first objective is to increase the post-war area inhabitants' awareness on the environmental and public health effects of DU ammunition by exploring the perception of all stakeholders on the matter. Their perception is compared with the opinion of the NGO and radioecology experts as well as with the official governmental viewpoint on DU presence in Bosnia and Herzegovina.
- The second objective is to get insights of the local regulations and legislations on the environmental problems caused by DU as well as to better understand the International legislation and regulation that characterizes the DU ammunition usage.

The case study was carried out through literature review and interviews with the various stakeholders.

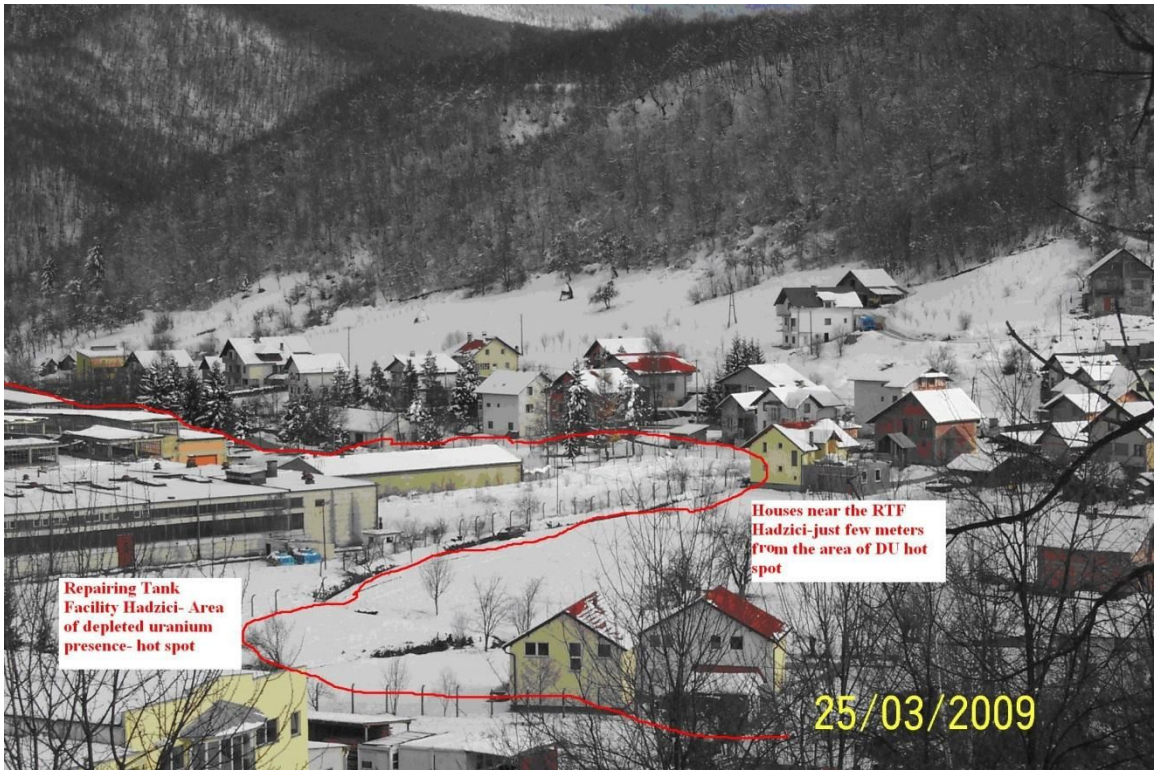

Figure 1. Repairing tank facility and settlement nearness (A.Miholjcic, 2009)

2 Background

The usage of DU in armories involved in the war in Bosnia and Herzegovina is primarily from the NATO attacks on military targets in 1995. NATO was targeting the Tank Repairing facilities of the former Yugoslavian army in the Hadzici area, aiming to end the war in Bosnia and Herzegovina. Hadzici is a small municipality of 22 379 inhabitants belonging to Canton Sarajevo in Bosnia and Herzegovina covering an area of 27 326 hectares. [official government site; Canton Sarajevo Statistics, 2008] Approximately 1000 of the inhabitants live close to the attacked area and there are major concerns regarding the environmental pollution and the public health. The main threat to the inhabitants' health is the lack of information regarding the use of DU ammunition. In addition, it was only in 1999 that the US officially recognized the use of DU ammunition during that NATO attacks in Bosnia and Herzegovina. That is 4 years after the attacks.

The public awareness was mainly raised after scientific findings regarding the DU effects on military personal and on the environment and population of areas that it was used. The corrosion of ammunition pieces increases over time, and DU migration in the soil becomes easier. [Jia et al, 2006, Schimmack *et al.,* 2005, 2007] After visiting 14 locations in Bosnia and Herzegovina between 12 and 24 of October 2002, UNEP confirmed the existence of DU in soil, plants and water samples, at 3 of the locations, with almost 300 points of contamination [UNEP 2003; UN, the General Assembly, 2008]. The mission was conducted together with WHO and IAEA experts 7 years after the DU contamination. UNEP experts examined the soil as well as water samples from streams passing through the area, from water plants, and fresh drinking water. They also examined lichens, mosses and bark samples, taken as bio-indicators that could show level of radioactive contamination. Two areas were heavily impacted by DU on water and soil, the Former Tank Repair facility in Hadzici and the Zunovnica barracks, both belonging at the Hadzici municipality.

Along with the soil and water pollution, air pollution is also critical according to the hazard assessment. [Royal society, 2001] Inhalable DU particles of sizes 0.1-100 μm found in the dust directly reaching the lungs. In this case, the radiation on the lung tissue is permanent, as the particles remain trapped in the lungs. The genotoxicity caused by the DU contaminated dust and by aerosols developed immediately after the attacks become an important correlating factor between the lung cancer with DU. In October 2009 International Agency for Research on Cancer (IARC) reaffirmed that all materials emitting alpha

radiation within the body are carcinogens. [Lancet Oncology 10, no.8 (2009) 751] DU consists of both radiological (alpha particles) and chemical (metal) components. [Miller et al. 2002]

2.1 Uranium vs. Depleted Uranium and its use in ammunition

Uranium is a natural element existing in Earth crust, soil, seas and oceans. It can be found in high concentration in granite rocks, as well as in food, water or even in the bones, liver and other tissues of the human body. [WHO] U238 is the most dominant form, i.e. atomic weight, of the three that are present in nature: (a) 99.27 % U238, (b) 0.72 % U235, and (c) 0.0054 % U234, DU is produced after U235 is extracted from U238 for nuclear fuel purpose. [WHO] DU half-life is estimated to be more than 4.5 billion years.

DU low radioactive wastes are mainly uranium fluoride or in the form of "yellow cakes" that contain about 80% of uranium oxide. Reconversion into the metal form is done in facilities in Brazil, India, Canada and UK. The next phase, i.e., processing of the uranium metal is performed in factories in France, USA and Russia. Finally, it is fabricated into DU ammunition in facilities in France, UK and USA. [WISE]

DU metal is a final product with excellent characteristics finding usage in civil and military applications. In civil applications, DU is oriented on the production of medical equipment (shielding from X-ray radiation), airplanes counterbalance (used mostly in the past), and it is used as a chemical catalyst. When it became attractive resource for military applications and its mass production increased, data for possible health or environmental effects were not still available. One reason is that DU was not yet considered a dangerous contaminating material.

The military usage resulted to uncontrolled release of DU to the environment. After hitting the targets, ammunition is transformed into particles of 0.1 to 10 μm diameter [Fairlie, 2009] moving over the air with the dust and contaminating the water. Plants uptake it from the soil, permanently polluting the environment. Ammunition that miss the targets, remain buried into the soil, being a potential threat to the ground water contamination [Jia *et al.*, 2006, Murray 2002, Schimmack *et al.* 2005, 2007, UNEP, 2003].

2.2 DU contamination and limits

DU contamination is related to:

- External radiological contamination, with no significant impact on human health.

- Internal radiological contamination, that is a major threat to human organisms. It remains in the body for longer time irradiating soft tissues such as lungs, kidney cells, blood or even the bones.

The radiological contamination is due to alpha radiation influencing living organisms. Although alpha particles are big enough to be stopped with a paper sheet, thus being a minor external contamination danger, they become extremely dangerous for internal contamination when DU is spread through the air.

DU can impact people's health in two ways (a) as toxicant and (b) as radionuclide. The general WHO recommended limit for DU concentration in drinking water was initially less than 15 μg per liter. This limit was proposed in 2004 based on experiments on animals. In 2012 there was derived a new guideline based on epidemiological human studies. The limits for DU concentration was then increased to 30 μg per liter [WHO Guidelines for Drinking-water Quality, World Health Organization, 2012]. The samples collected from the area under investigation had a natural consistency of Uranium less than 10^{-5}-10^{-3} mg per liter of drinking water hence resulting to 0.01-1.00 mg per year. This translates to a radiation dose less than 1 μSv per year which is within the radiation limits that each person can absorb yearly. For comparison, the worldwide values range from 1-10 μSv per year. [Depleted uranium in Bosnia and Herzegovina, Post conflict environmental assessment, UNEP, 2003]

2.3 Researches on DU impact

Several methods and approaches were used for determining the DU effects, studying the impact down from the production process up to the final users. Uranium miners as well as military workers and civilians that were exposed to DU ammunition have been part of such research. All studies resulted to alarming data relating the increase of different types of cancer due to DNA mutation with long-term DU effects. [Durakovic, 2001, 2003, Hindin R., Brugge D., Panikkar B., 2005, Miller *et al*, 2007, Periyakaruppan *et al*, 2007] Additionally, laboratory experiments conducted on animals to study the renal system response to toxic dosage. [Zimmerman *et al.*, 2007]

A research contacted by the Institute for Genetic Engineering and Biotechnology in Sarajevo confirmed that chromosome aberrations were observed, but the sample was not sufficient to justify the statistical findings. [“Micronuclei frequencies in peripheral blood lymphocytes of individuals exposed to depleted uranium” Arhiv za Higijenu rada I Toksikologiju 56, 2005]

Researches also studied the DU fragments leachability in soil and their presence in biological and water samples. [Schimmack, *et al*, 2005, and 2007, Jia *et al*, 2006] Furthermore, the DU decontamination process from soil samples was analyzed using several methods and materials. [Choy, Korfiatis, Meng, 2006]

While researches were focused on health effects and studied data from the official statistic registry and from the Cancer Registry (CanReg4) of Federation of Bosnia and Herzegovina showing an increase in cancer illness occurrence in the Hadzici area after the war, there was performed no social researches in the area thus the inhabitants' perception on the DU pollution and its social effect have not yet been studied.

3 Methodology

The aim of this study is to explore how inhabitants of a single community in Bosnia and Herzegovina perceive the DU pollution and health effects in the post war period in their living area, as well as the view of health authorities, local environmental NGOs and governmental bodies. Hence, this research can be classified as "case study providing evidence at single location" [Bryman, 2008, p.35] by using "unstructured approach to data collection in which participants' meanings are the focus of attention and investigate a specific set of issues through the more structured approach of quantitative research" [IBID, p.622]. Aiming to analyze the opinions derived from semi-structured interviews with the local community, Ministries of Health and environmentalists from international NGO's, this research "emphasizes words rather than quantification" [Bryman, 2008, p.366].

3.1 Ontological consideration

The ontological consideration in this research is following the fact that "social phenomena and their meanings are continually being accomplished by social actors" [Bryman, 2008, p. 19] and that it is required "the active involvement of people in reality construction" [IBID, p.21]. Therefore, the primary focus of this study was on the inhabitants' perception since they should be considered as the key stakeholders of the DU effects in their living area.

3.2 Epistemological consideration

From epistemological standpoint, this research discusses the participants' experiences on phenomena related to DU existence in the area aiming to understand how DU pollution is experienced by those directly affected [Bryman, 2008, p.15]. The subjective reality provides a genuine knowledge and is of great importance since "phenomenon of human reality gain access to the people's common-sense thinking and hence interpret their actions and their social world from their point of view" (IBID, p.16).

3.3 Research strategy

3.3.1 Data sources

The data have been collected from two main sources:

A. From field study interviews with inhabitants, scientific experts and NGO experts.

B. From literature reviews.

A. Field study interviews

Unstructured interviews [Bryman, 2008, p.438] have been performed in the area directly affected by DU, i.e. at the former Repairing Tank Facility area, and the interviewees answered freely on social, economic and environmental issues and how they affect their post war life. The main intention was to urge the interviewees to share and gain knowledge by sharing their own challenges on similar experiences. As Kvale states in his chapter on interview research and their history, "conversations are an old way of obtaining systematic knowledge" [Kvale, 2007].

Additionally, individual, partially structured interviews were conducted in an area of one kilometer diameter around the former Repairing Tank Facility. The interviews were split in focused groups and basic information, such as age, sex, employment, level of education, were also collected. According to Bryman, interviewing focused groups "can be helpful in the elicitation of a wide variety of different views, in relation to a particular issue" [Bryman, 2008, p.475].

Interviews with experts such as University staff and international NGO officials were performed to obtain a detailed picture on the relationship between DU radioactivity and the long-term effects in the local community.

Furthermore, a representative from the international coalition for Banning Depleted Uranium Ammunition was also interviewed to gather more information regarding the official approach on already DU affected areas like Bosnia and Herzegovina. A major focus of this interview is on the communication modality regarding sensitive political subjects and their interaction with non-governmental bodies and the society.

B. Literature review

For the literature part of the research, books, articles, reports, statistical data and other official documents were used as sources in order to study the DU ammunition usage and impact on the environment and human health. The documents were chosen based on Bryman's recommendations: authenticity, credibility, representativeness and meaning [Bryman, 2008, p.516].

The UNEP 2003 report was the most important source of quantitative information providing indicators for future research regarding possible groundwater contamination and health issues in the area. Public Health Center data were collected from the internet statistical base for the years 2004-2007 as well as from official documents. Data from other sources were also used to study the cancer occurrences in the

Canton Sarajevo between 1995 and 2000. The literature research also includes the study of published articles on recent experiments regarding the DU impact on water contamination as well as on cancer epidemiological observations.

In addition to the literature review that compliments the field study interviews, photographs were also used as "field notes" to assist the reader to acquire a better perception of the inhabitants settlement [Bryman, 2008, p.519].

3.3.2 Selection of interviewees

The interviewed inhabitants were divided into 4 main groups. The first group includes inhabitants that lived in the hot-spot area. The second group consists of inhabitants that lived in the same municipality but outside of the site. The third group were stuff of the water plant facility and inhabitants of Hadzici. The fourth and final group concerns a family that runs a chicken farm at the area of Misevici. Misevici is not in direct contact with the hot-spot, but the water source is part of the public water system.

The head of Department for Radiobiology and Biophysics with Environmental protection, Professor Dr. Lejla Saracevic, was interviewed in order to obtain a scientific view regarding the DU presence in Hadzici, as well as for gaining an understanding on the radioactivity and radiobiological recommendations around DU.

Gretel Munroe was interviewed as member of the ICBUW Steering Committee and Science Team aiming to receive information about the governmental bodies view on the matter.

3.3.3 Data collection process

The interviews with the inhabitants contacted individually, mainly in their households where family members were also participated in the interview. The language used in the interviews was Bosnian aiming to get as much detailed information as possible, and the questionnaire used as a guideline for the interviews can be found in the Appendix. All interviews were recorded (only audio).

The inhabitants' economic dependency on the municipality was a great obstacle to overpass and the access to each interviewee was achieved only after recommendation and communication from neighbors. Some of the interviewers are kept anonymous as requested.

The university staff was interviewed at the Veterinary Faculty, Department of Radiobiology and Biophysics, using unstructured interview over a basic questionnaire that can be found in Appendix.

The ICBUW stuff replied to a questionnaire (see Appendix) sent via e-mail.

The Public Health Center data were found on their webpage while most of the referenced articles were found through the Lund's university electronic library information navigator.

4 Theoretical frameworks

A sit is stated by the precautionary principle [Barnett, 2001, Stoet, 2005], that is also known as principle 15 and has presented in the U.N Conference on Environment and Development in the Rio Declaration (1992), "*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*". In the case of DU ammunition usage this principle is not applied. The precautionary principle is used by this study as a factor that should guide the global society into sustainable development.

According to Barnett, the principles of peace and justice are visible in the social, economic and cultural rights, as well as in the political and civil rights. The best way for a person to exploit those rights is by participating in the restructuring of its own life in a way that this person will choose. In addition, in human centered environmental concepts, linking the environmental security with the peace directly correlate any environmental problem with the human rights. This is well supported by the 1990 UN general assembly in which "*all people are entitled to live in an environment adequate for their well-being*". Taking into consideration the human rights, lives, and the environment, the environmental security theory could be applied setting the DU ammunition usage as an "environmental problem".

The connection between the environmental security theory and Bosnia and Herzegovina is also expanding to the political capacity for handling environmental problems. According to Stoet, "in order to protect the natural systems in the region [of Bosnia and Herzegovina], it can be reasonably asserted we need strong states; it can also be asserted, however, that states have traditionally been part of the environmental problem, and only reluctantly are they made part of the solution" [Stoet, 2005]. In the post war societies the inhabitants were left to cope with lot of damages while economically weak state could not provide sufficient support.

Along with the theory of environmental security, the present work has also taken into account the state services, laws and policies in order to form a complete evaluation of the services that the ecosystem provides.

5 Analysis and findings

The Former Tank Repair facility is located at the west east valley of Hadzici. The access to public is restricted and fences are used to enclose many houses, barns and buildings (UNEP, 2003). Since 1995 many commercial buildings such as a furniture factory, car repair centers and storages are located within the protected area, but still several other buildings have visible damage from the bomb attacks. Most of the inhabitants around the Former Tank Repair Facility were settled in after 1996 as a huge percentage of the locals had left the area during the war. Some of the current inhabitants are originally coming from Bratunac, 160 km away from the DU residue spot, but were settled in the Hadzici municipality after the peace agreement. The exact numbers of the migrated population is not easy to be found since the last population registries date back to 1991.

But there is evidence from the 2008 UN General Assembly report that between 4500 and 5000 Hadzici inhabitants were settled in Bratunac, from the period of the end of 1995-2000.

5.1 Aspects of DU environmental contamination

5.1.1 Findings regarding water and bio indicators

The natural and depleted uranium differ in terms of expected concentration in soil respectively to radiological and chemical toxicity [Jia *et al.*, 2006].

The possible impact of DU contamination can be divided into two categories:

a) If the DU ammunition hits the target it could be fragmented into small particles, <5μm, that can spread up to few kilometers hence being possible danger for human inhalation and contamination of water, soil and vegetation [Jia *et al.*, 2006]. The concentration spread depends both on meteorological conditions and insects, animals and human activities (ibid).
b) If the DU ammunition misses the target it can be buried into the soil potentially becoming a threat, depending on the corrosion speed and leaching rate [Jia *et al.*, 2006].

Biological indicators as lichens, mosses and barks were sampled and used in this research (IBID) exhibiting values in the range of 0.27-35.7 Bq kg^{-1} for U238, 0.24-16.8 Bq kg^{-1} for 234U, and 0.02-1.11 Bq kg^{-1} for 235U. Due to the surface contribution the uranium concentration in lichen and mosses collected from the soil or rocks were generally higher than those from tree trunk lichens, which were in the range of 7.18-35.7 Bq kg^{-1}, 6.97e-16.8 Bq kg^{-1}, and 0.36-1.11 Bq kg^{-1}, for 238U, 234U and 235U respectively. In

some samples U236 was also found. The above results show that the “uranium levels are higher than in the samples collected at the control sites” [Jia, et al., 2006].

Water samples collected from wells at the former Hadzici Tank Repair Facility “show low 234U/238U activity ratios of 0.913 and 0.581, and the estimated DU fractions in the two samples are 23% and 56%, respectively, indicating the presence of anthropogenic contribution of DU in the two samples”. [IBID] The UNEP report in 2003 also revealed slightly higher levels of DU presence in one of the collected underground water samples from the same area, which, despite being low, was considered as important regarding long term toxicological and radiological impact.

The Department of Radiobiology, Biophysics and Environmental Protection of the Veterinary faculty in Sarajevo has conducted only one study regarding water DU-contamination and it was presented in 2003 at the Croatian Society Symposium for Radiation Protection in Stubicke Toplice. The study resulted that “Radioactivity levels of natural and artificial radionuclides in drinking water, as well as in the water of the nearby brook at the investigated locality, does not show increased values”. At the same time, samples of the soil and gravel mix have shown decrease in U238/U235 ratio from 166.1 to 133.7 which indicates higher DU contamination at the location. Dr. Saracevic stated that these results could represent the measurements at that time, but no continues monitoring were conducted making it hard to evaluate the situation. [see Appendix]

According to experiments made by W. Schimmack, U. Gerstmann, U. Oeh, W. Schultz, P. Schramel in 2005, “mobilization of DU will last for a much longer time than the corrosion”, as they predict “more than thousands of years”. As a conclusion, the DU behavior in the soil is mainly controlled by dissolution of DU from the corrosion products than by the corrosion kinetics. When the same experiment was repeated two years later by W. Schimmack, U. Gerstmann, W. Schultz, and G. Geipel (2007), it was concluded that “it could not be excluded that in the groundwater resulting U238 concentration may still be higher than 15 µg per liter (that is recommendation by the WHO, for toxicological aspect of drinking water)”. The conclusion is based on the increase of leaching rate by factors of more than 100, due to the total amount of leached U238 being 13 mg as compared to 0.03 mg from the first study.

The public health services have the obligation to examine water samples from the area for radioactive substances twice every year. The latest reports show no evidence of DU increase in the drinking water samples [Public Health Centre of Canton Sarajevo].

5.1.2 Environmental protection legislation in Bosnia and Herzegovina

The Bosnia and Herzegovina natural resources are mainly water and forests. While the forests are not in danger from the DU presence, the water contamination should show an essential need for increasing the awareness of the local society thus to transform the regulations and legislations regarding unexpected effects of DU in the area. The complex political situation of the country, having two entities and one district, make it harder to agree on environmental protection issues and to adopt the same regulations Bosnia and Herzegovina state level. This is visible through the low cooperation on the late legislation adoption. An environmental law on the level of Republika Srpska is adopted in 2002 (Sluzbeni glasnik RS 52/02 i 54/02) and in the Federation of Bosnia and Herzegovina in 2003 (Sluzbene novine Federacije Bosne i Hercegovine br. 33 /03, 19.07.2003). Nevertheless, it is still missing the body which should be responsible for the environmental protection at the state level. These data correspond to information by the Regional Environmental Center for Central and Eastern Europe (REC). The main policy document on environmental issues at state level is the National Environment Action Plan (NEAP). In Bosnia and Herzegovina NEAP "provides orientation, but remains at the level of general direction, and has had little effect on the distribution of functions, and the structure of public administration" [UNDP, 2008].

Considering the Article 3 of the Law on Water Protection, the precautionary principle is supported by the statement "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason to postpone measures aimed at preventing environmental degradation" [REC]. Bosnian and Herzegovinian environmental legislations about water highlight in Article 14 of the Law on Water Protection the importance to include the public opinion in planning. Even though these laws exist, it is not easy to transfer them on the field. One of the main reasons is the lack of continuous monitoring that should be linked to the complete food chain. [L. Saracevic, Veterinary Faculty, Department of Radiology, Biophysics and Environmental Protection, Sarajevo]

The policy about the environment and sustainable environment protection is not developed in Bosnia and Herzegovina mainly due to the four levels of authorities, i.e., state, entities, canton and municipality. This fact in combination with the fact that the public participation is weak [IBID] complicate the environmental administration and control [UNDP, 2008]. Another reason could be that "in Bosnia and elsewhere in the Balkans, DU has not been an issue first, perhaps, because governments don't want to go against NATO or the U.S" [G. Munroe]. The latter could also be related to the 1995

Dayton peace agreement in Bosnia and Herzegovina, which would not be possible without US and NATO forces.

5.1.3 International legislation and du ammunition

According to Fairly, there is no international law that defines the policy on usage of DU ammunition but only some classifications and regulations in handling materials that are used for production of the DU ammunition.[Fairly, 2009] The existing regulations mainly concern the DU waste classification as low-level radioactive waste (LLW), as well as the storage procedures that are subjected to the U.S. Nuclear regulatory Commission regulations.[EPA, 2006]

The 2001 report by the Organization for Economic Cooperation and Development (OECD), the Nuclear Energy Agency, and the International Atomic Energy Agency on Management of Depleted Uranium states that "DU from operations of enrichment plants should be stored based on its different forms, including uranium tetrafluoride (UF_4) and uranium oxides (U_3O_8, UO_2, and UO_3), in coated steel containers in external yards, provided that contact with standing water is prevented and that containers are routinely inspected and localized defects leading to corrosion are treated".[EPA, 2006]

As the public awareness and concern is growing, laws like the International Humanitarian law, the UN Declaration on Human Rights, and the precautionary principle have also started to be applied regarding the usage of DU ammunition. According to experts from the International Humanitarian law, the DU ammunition usage is in direct violation of the Humanitarian law principles. In 1996, the United Nations Sub-Commission on the Promotion and Protection of Human Rights found that "the usage of DU ammunition is *incompatible* with the existing humanitarian and human rights laws" [K. Parker].

Parker has pointed four basic principles of the International Humanitarian Laws that were broken with the usage of DU ammunition:

(1) Weapon may only be used in the legal field of battle, defined as legal military targets of the enemy in the war. Weapons may not have an adverse effect off the legal field of battle.

(2) Weapons can only be used for the duration of an armed conflict. A weapon that is used or continues to act after the war is over violates this criterion.

(3) Weapons may not be unduly inhumane. The Hague Conventions of 1899 and 1907 use the terms "unnecessary suffering" and "superfluous injury" for this concept.

(4) Weapons may not have an unduly negative effect on the natural environment.

The strong pressure on the governments by The International Coalition to Ban Uranium Weapons (ICBUW) resulted to a coalition of 112 organizations from 29 nations. ICBUW works on diplomatic and governmental levels towards a worldwide ban on the use of uranium (DU at this point) weapons. While the European Parliament has had four resolutions, with the one in 2008 being as strong as to call for a moratorium towards complete ban on DU weapons, the U.S. do not follow the same direction, according to Mrs. Gretel Munroe member of the ICBUW's Steering Committee and Science Team. The ICBUW Steering Committee have lobbied UN delegates in Geneva and New York City and are also met scientists and governmental offices in the DU affected countries.

On the question "Why even in affected countries is not DU an issue of "highest level" importance?" G. Munroe replied that "DU anti-tank shells are extremely effective weapons and the U.S. Army has not found a substitute for them. Part of the problem with DU is that the public doesn't know much about it overall". Mrs. Munroe explained then that some politicians are trying to broaden the consciousness about the DU issue on different ways, unfortunately still without effect on the other members of the government "The Congressman (see interviews) who is mainly responsible for one piece of legislation went on TV with a rock band to broaden consciousness about the DU issue". Regarding other governments, Mrs. Munroe stated "Belgium is a good example. A group consisting of a Dutch European Parliament member, an Italian Physicist, Ria Verjauw of the Belgian Coalition, and Emmanuel Jacobs, President of EUROMIL (a large European military union) met with two representatives of NATO in late March of 2009. According to Munroe, "the meeting went well, but they had no reports from USA on that issue". Also, as the conclusion regarding the laws on DU, note was made that" ban on DU ammunition is the law in Belgium and which may become law in Costa Rica has to come first probably. The people and government of a country have to realize the harm that DU can do and has to want to cleanup affected areas".

5.2 Results from the inhabitants' interviews

The interviews were performed individually on small focused groups, mainly consisted by family members or neighbors. The results of group I are presented in Table A.1 while groups II-IV in Table A.2.

The 1st group 1 consists of 9 persons living in the "first" zone of contamination, i.e., their houses and fields are almost attached to the contaminated facility (see photos in appendix).

The 2nd group consists of two individuals that live in the urban area of the municipality, not more than one kilometer far from the research area. One of these persons is former doctor at a public health center and has also been used as a source of information on health matters.

Table A.1. Results from the inhabitants' interviews (Group I), Hadzici area, March 2009, (A. Miholjcic)

Inter-viewer group	*Gender*	*Age*	*Education*	*Social status*	*Health status*	*Migrant*	*From*	*Source of information on DU*	*Level of knowledge*	*Level of interest*	*Warried about DU*	*Water usage from*
Inhabitant	M	44		Employed	G	Y	96	Media, work	G	H	No	P/W
Inhabitant	M	17		Student	G	Y	96	Media	L	L	No	P/W
Inhabitant	F	42		Temporary Employed	G	Y	96	Media	L	H	No	P/W
Inhabitant	F	50		Retired	G	Y	96	Media	L	L	No	P
Inhabitant	M	52		Retired	G	Y	96	Media	L	L	No	P
Inhabitant	M	24		Unemployed	G	Y	96	Media, school	L	L	No	P
Inhabitant	M	26		Unemployed	G	Y	96	Media, school	L	L	No	P
Inhabitant	M	70		Retired	G	N	N/A	Media	L	L	No	P
Inhabitant	F	69		Retired	G	N	N/A	Media	L	L	No	P

Table A.2. Results from the inhabitants' interviews (Groups II-IV), Hadzici area, March 2009, (A. Miholjcic)

Inter-viewer group	*Gender*	*Age*	*Education*	*Social status*	*Health status*	*Migrant*	*From*	*Source of information on DU*	*Level of knowledge*	*Level of interest*	*Warried about DU*	*Water usage from*	
Inhabitant	F	66	University	Retired	Cancer	Y	96	Media, work	G	H	Yes	P	
Inhabitant (Sarajevo)	F	62	High school	Retired	G	N	N/A	Media	L	H	Yes	P	
Inhabitant, Producer	M	41	High school	Employed	G	Y	97	Media	L	L	No	P	
Inhabitant, Producer	M	42	High school	Employed	G	Y	97	Media	L	L	No	P	
Inhabitant, Producer	F	38	High school	Employed	G	Y	97	Media	L	L	No	P	
Inhabitant	M	55	N/A	Employed	N/A	N/A	N/A	Media	N/A	L	No	N/A	
Inhabitant	M	57	N/A	Employed	N/A	N/A	N/A	Media	N/A	L	No	N/A	
Inhabitant	M	59	N/A	Employed	N/A	N/A	N/A	Media	N/A	L	No	N/A	

The 3rd group consists of three farmers working in a local chicken farm located in same municipality but not directly attached to the Former Tank Repairing Facility.

The 4th group consists of three workers from the water resource facility in Hadzici. These particular interviews where not planned initially, but they occurred as part of research regarding the origin of the water that is used in the public water facility.

The interviews with the university stuff were performed in end of March 2009. These interviews look to explain in which way the university departments contributed to public information regarding the DU and how they assist on monitoring DU affected areas, as it is recommended by UNEP 2003.

An interview with a member of the science team of The International Coalition to Ban Uranium Weapons (ICBUW), Mrs. Gretel Munroe, was conducted in the beginning of May 2009 aiming to acquire information regarding the involvement of international NGOs in health and environment researches concerning the use of DU ammunition.

5.2.1 Inhabitants view on presence of DU

In the area around the Former Tank Repair Facility of Hadzici the inhabitants live in private houses having smaller or bigger gardens. Many of them produce vegetables and fruits for personal use while one of them has a raspberry plantation for commercial usage. “We have no problems with selling our products, as we made contract with local repurchase station, and their obligation is to make check up on food they buy, latter on as they use it for export or for direct production” is one notion that interviewee #1 had. Accordingly, his main concern is rather the economic sufficiency than the health issues, as shown in Table A.1. It is also noticeable from both tables A.1 and A.2 that the main problems the interviewees are coping with are connected to the social and economic issues. The high unemployment rate (around 25% according to statistical data) and the high grey economy in the area, leave too little space for concerns on health and DU effects. From economical point of view, the DU presence in the area increases the living costs of the inhabitants, mainly due to the water contamination. The inhabitants are forced to buy bottled water while they are also need to find solutions to maintain their private gardens that they use as sources of some extra income.

The farmers consisting group III are not concerned regarding health issues due to DU as they have faith in the government and the local community: “They should provide information if something is wrong with the water or any other contamination. We need certification for our products, hence that certification is a proof that everything is fine”. The inhabitants’ concerns are mainly related to the

radioactivity of DU than to its chemical effects. One of the inhabitants mentioned in the interview that "This is only DU, hence it is not dangerous". As it seems, this was not an isolated opinion but, on the contrary, many inhabitants share the same view.

The main consideration of interviewees in group IV is to keep their job. According to them, the water cannot be DU contaminated since its sources are the mountain Bjelasnica, and other three sources from the surrounding hills that are in use only during the summer months. On the question "What do you think about DU ammunition and possible danger effects?" they responded that "We know only what we heard from the media, but they are not talking much about it now.''

In general, all interviewers had heard about DU with their main source being the media. According to interviewees #1 and #2, "We heard about it through the television, and we saw later on some people investigating the facility area close to our house, but they never introduced themselves or discussed on what they do. We also never got any information about it either from the local municipality or any other institution, like the civil protection services, for instance". It is a common observation from all interviews that people do not concern too much regarding the DU effects, but they would appreciate any further information on the mater.

5.2.2 Inhabitants view on DU health effect

It is noticeable that the people around the affected area are not much concerned regarding the possibility of getting cancer, or any other DU-related health illness.

"We are two older persons, and somehow, even if some danger exists, we will not be alive in the time that it could show up,'' said the interviewee #4, a retired man over 70, that lives with his wife in the area.

Interviewee #2 is from a family with two kids, 16 and 21, and they are not aware of any illness. "For now, we are all healthy, and we have other problems to bother us, high unemployment and insecure economic situation. We know that some threat exists, but there is no evidence in my family about cancer illness or anything similar".

The interviewees #6 and #8, are also young men that are more concerned about higher education and unemployment than on health issues. "We cannot think about that, we are planning to get families, and DU and possible effects are for sure not one of the things we should think while not having a job. We are thinking about how to grow a sufficient economic situation and there is no time for thinking about the distant future".

The interviewee #10, a female cancer patient age 66 with background on health labor, discovered at some point that is possible that she developed cancer due to DU. She noticed that from 1999 to 2005 it became obligatory to maintain statistical data for each new cancer patient in the area. After she retired and became ill, she asked about her status and the statistical data, but the doctor (interviewee #11) responded that they do not keep track on new cancer occurrences any longer. The reasons were not explained.

5.2.3 Findings regarding health issues

The increased number of cancer illness occurrences initially alerted the medical stuff in the Canton Sarajevo area, but the cancer registry was not established before 2004; results are shown in chart 1. Older data from the period 1995-2000 are available by the Sarajevo Tumor Registry and are presented in Chart 2 and Table 2.

The data show that the cancer occurrences are steadily increasing from 1995 to 2009; the cancer occurrences in 2012 are 10.9 times higher than in 1995. A steady decrease is then observed with the cancer occurrences in 2012 being 74.3% of those in 2009.

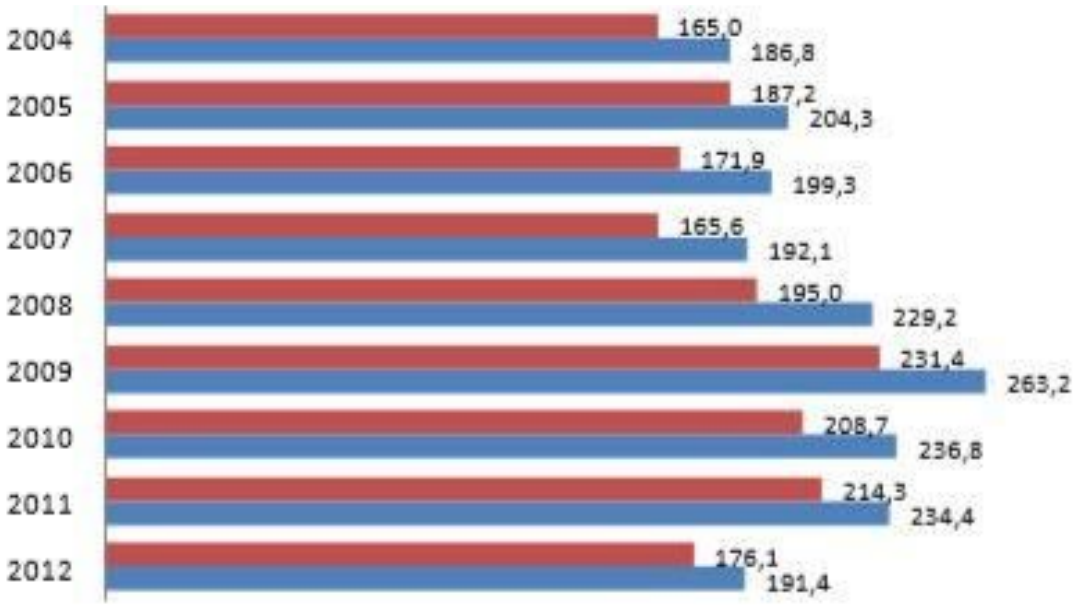

Chart 1. Registered cases of cancer (excl. skin cancer) in Federation of Bosnia and Herzegovina; number of occurrences over 100000 inhabitants for the period of 2004 to 2012; blue bars – men, red bars – women.

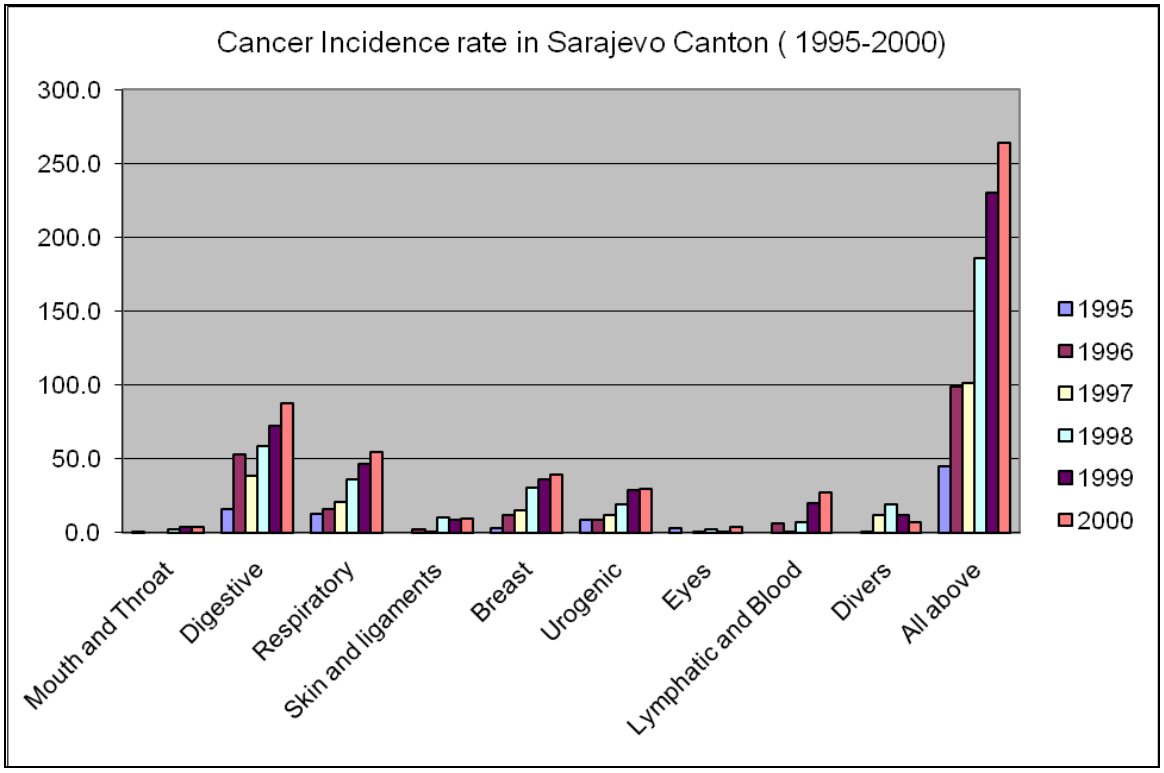

Chart 2. Registered cancer cases in Sarajevo 1995-2000; occurrences per 100,000. Source: Sarajevo Tumor Registry. [Bisby, www.llrd.org]

Table 2. Registered cancer cases in Sarajevo 1995-2000; occurrences per 100,000. Source: Sarajevo Tumor Registry. [Bisby, www.llrd.org]

Tumor Type	1995	1996	1997	1998	1999	2000
Mouth and Throat	**1.1**			**2.1**	**4.3**	**4.3**
Digestive	**16.0**	**53.2**	**38.3**	**58.5**	**72.4**	**87.5**
Respiratory	**12.8**	**16.0**	**21.3**	**36.2**	**46.8**	**54.3**
Skin and ligaments		**2.1**	**1.1**	**10.6**	**8.5**	**9.6**
Breast	**3.2**	**11.7**	**15.0**	**30.9**	**36.2**	**39.4**
Urogenic	**8.5**	**8.5**	**11.7**	**19.2**	**28.7**	**29.6**
Eyes	**3.2**		**1.1**	**2.1**	**1.1**	**4.3**
Lymphatic and Blood		**6.4**	**1.1**	**7.4**	**20.2**	**27.7**
Divers		**1.1**	**11.7**	**19.2**	**11.7**	**7.4**
All above	**45.3**	**99.0**	**101.0**	**186.0**	**230.0**	**264.0**

5.2.4 limitations on obtaining data at the Hadzici area

To accurately validate the data presented above, it would be necessary to include statistical data from the Republic Srpska cancer registry for the period 1995 to the time after the NATO attacks, due to increased internal immigration rates.

It was estimated that about 4500-5000 people was displaced in the Bratunac municipality due to the attacks. According to UN General Assembly studies regarding cancer impact on the mortality rate, the mortality rate of the immigrated population was up to "four times higher compared to the local population". "The mortality rate of the population from Hadzici was up to 2.5 times higher than that of all other displaced populations in the municipality" and "The share of cancer was significant in the total mortality rate and was significantly higher among the residents coming from Hadzici than among other groups". (UN General Assembly, 24. July 2008) Details that could be presented in the case of Hadzici were not available for this research, but this data should be considered for future research.

6 Conclusion and recommendations

The outcome of this study suggests that people living in DU contaminated areas do not necessarily share the concerns of international organizations regarding the health and environmental effects due to DU ammunition usage.

While recent data have shown that the long-term impact on health and environment is of great importance in DU contaminated postwar societies, mainly due to water pollution, inhabitants do not exhibit but very low interest. Their main concern is occupied by the necessity to obtain any sort of economic security while the health issues are, in principle, a long-term consideration. On top of that, people are usually not sufficiently informed by authorities and neither concise information are received by the media.

Organized groups, such as international NGOs, are aware of the DU ammunition usage effects but they are primarily targeting higher level authorities in an effort to bridge communication channels between different organizations like the UN and governments. They intend to reach world-wide governments arguing that the military usage of DU collide with many international laws. It is also observed that postwar local governments find difficulties on handling alone the issue of DU ammunition residue, since it can be difficult for them to finance and support any necessary studies.

It is deemed necessary for all levels of authorities to be better informed regarding the results on health and environment impact aiming to improve or protect as possible. In the case of future usage of DU ammunition, the *precautionary principle* is desirable to be applied unless it will be proven that DU is not a harmful substance.

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Appendices

Appendix 1

Questionnaire for the International Coalition for Banning Uranium Weapons (ICBUW) officials, May 2009

1. What is ICBUW?
2. Please, can you tell me little bit about yourself?
3. What is your attitude about water pollution on long term scale in Bosnia and Herzegovina?
4. How do you think that ICBUW can contribute to the improvement of the situation in already affected areas with DU from ammunition?
5. Which kind of communication you have with scientists or governmental bodies into the countries affected by DU?
6. Which kind of policy you could propose for the issue of the DU usage, as in the civil as the military use?
7. I found lot of criticisms on the UNEP, IAEA and WHO reports that ICBUW made, please can you give me information is it anything changed until first critics ICBUW made?
8. Why depleted uranium issue, even in the affected countries, is not one of the "high level" importance issue?
9. On which way stopping of usage of DU can help to already affected areas?

Gretel Munroe, ICBUW Steering Committee and Science Team Member

1. The International Coalition to Ban Uranium Weapons (ICBUW) is made up of a coalition of 112 organizations from 29 nations. ICBUW works towards a worldwide ban on the use of uranium (DU at this point) weapons. ICBUW's campaign against use of uranium weapons includes a ban on manufacture, testing and transport of all conventional weapons containing uranium. ICBUW also asks for the monitoring and medical care of victims and their compensation as well as environmental remediation of areas where uranium weapons have been used. (See www.bandepleteduranium.org/en/i/70.html).

2. In 1998, a college friend and co-founder of Grassroots Actions for Peace in Concord, Massachusetts, sent me some newspaper articles about depleted uranium. One article, in the **Guardian Weekly**, reported about a young Iraqi woman physician who was a resident in a hospital in Basra. She had kept a journal and her entries included: (as examples only. I don't have the article): August: 4 babies born

without heads. September: 3 babies born without heads. (this is not exact but these figures for whatever month were. There were I think 30 deliveries per month at the hospital).

This article led me to my first Grassroots meeting. Grassroots Actions for Peace has been concerned about the use of DU weapons since their first use in the 1991 Gulf War. Grassroots is located in Concord, MA where in the Southwest corner of the town, Nuclear Metals/Starmet produced DU anti-tank shells for 25 years. In June 2001, Starmet became a Superfund site, that is it was put on a list for the most hazardous sites in the U.S. This came about because of activist groups, particularly CREW (Citizens Research and Environmental Watch). Grassroots was also involved.

Clean-up at the Starmet site will take ten years and millions of dollars. It took about three years for the government and its contractors to decide what to do about the clean-up. The U.S. Army has already spent $7 on aspects of this. As a member of Grassroots, I wrote a paper, now on the ICBUW website, on **Health Effects of Depleted Uranium"** (2nd edition). Several of us from Grassroots testified in the Connecticut State House before the Veterans Affairs Committee, for legislation which was eventually passed, calling for testing of returning veterans for DU exposure and the creation of a health registry in the state of Connecticut. I also testified iin the Massachusetts State House, before the Committee on Veterans and Federal Affairs, for similar legislation which was not passed.

In October 2003, I went to Berlaar, Belgium with Tara Thornton, then Executive Director of the Military Toxics Project which was working with people living near military bases in the U.S., in contaminated areas. Grassroots was a member of the MTP.

We attended a conference in Berlaar which created the International Coalition to Ban Uranium Weapons. There were about a dozen organizations from 6 countries. In 2005, I became a member of ICBUW's Steering Committee and I am a member of the ICBUW Science Team. I am a nutritionist (a Registered Dietitian and a licensed nutritionist in the State of Massachusetts.) I grew up in New York City and am a graduate of Smith College, a woman's college in Massachusetts.

After graduation, I worked for the American Field Service (AFS) for about 3 years. I then taught English As A Foreign Language at an American school in Morocco. On my return, I studied at Harvard University where I earned a Master's Degree in Regional Studies, Middle East. I was in my first year at Harvard when John F. Kennedy was assassinated.

I then earned a Master's Degree at the Harvard School of Public Health in Demography and Human Ecology and after that I worked for two years at the Population Council where I co-authored a

monograph on the use of mobile units in family planning programs. The Population Council is in New York City.

After spending a year taking science courses in Boston mostly at Boston University, including Physics and a nutrition course at the Massachusetts Institute of Technology, I earned a Master's Degree in Human Nutrition at the University of Massachusetts in Amherst.

I had wanted to work in family planning and nutrition but this wasn't possible because of the bureaucratic set-up at health clinics. Massachusetts was also in recession and I took a job as Assistant Dietitian at a state psychiatric hospital in Worcester, Massachusetts. I became Dietitian there after qualifying as a Registered Dietitian. It was a 400- plus bed hospital and there were many geriatric patients. It was an interesting place to work from the point of view of human nature. There were quite a few dedicated people working there.

I also worked at a health center in Boston and as a temporary dietitian at a nursing home in Charlton, Mass. Before I joined Grassroots, and for several years afterwards, I played the recorder. I am married and my husband, whose background is in biology, is a musician.

3. What I know about this subject comes mainly from the UNEP Reports on the Balkans. UNEP has been concerned about long-term effects of DU on groundwater contamination where DU weapons have been used. It is a complicated issue. It depends on the composition of the soil and subsoil and the hydrogeology of the area, the microorganisms present in the soil as well as the pH of the soil. It depends also on the oxidation of DU fragments and the uranium oxides present. Another factor is the depth at which groundwater exists. Given the long half-life of DU, it is a potentially serious problem. It depends on the intensity of the bombing in an area. You probably know that in the Balkans about 90 percent of the shells missed their targets. There is also the possibility that over the years, other battles could be waged in the same area – that is not likely but a possibility – using DU weapons. Of course one problem is that DU shells corrode and after 35 years or so, a fragment is entirely corroded. Even so, DU shells that have burrowed into the ground cannot be found easily if at all, and this could pose a problem for wells, and construction workers would not know of any danger.

W. Schimmack et al., "Long-term corrosion and leaching of depleted uranium (DU) in soil", **Radiat. Environ. Biophys. 46**, 221-237, 2007 – studied corrosion and leaching from DU fragments at the top of columns with vegetation on top and soil, with space for seepage water at the bottom. They used a silt loam soil and a sandy loam soil from the Munich area. There were high concentrations of U238 in the leached water at the bottom of the columns and the researchers stated that more research should be

done on transportation of DU oxides in soil. The corrosion of the DU fragments did not correlate with the leaching rate necessarily so it was hard to predict the future.

4. UNEP stressed over and over in the Balkans Reports that it was important that the local people know about potential or actual DU contamination, its hazards and where it was to be found. Cordoning off areas where contamination or potential contamination exists is not a good long-term solution. Thus far, ICBUW has not gotten into this directly although it is part of our mission that governments should clean up contaminated areas. A time will come when it will be possible for ICBUW to shame countries into considering decontamination, as the Land Mines Campaign has done. Both Belgium and Japan have large coalitions. Belgium has 20 NGO's that were important in the lobbying efforts that helped to bring about the passage of legislation banning DU weapons on Belgium soil. Local ICBUW members could contact and work with local authorities and urge clean-up of contaminated areas. But informing the local people is very important.

Also, photographs taken by the Japanese photo-journalist, Naomi Toyoda, of Iraqis with cancers and infants with birth defects have been shown in various Parliaments – in Finland, Scotland, Belgium and in the Helsinki subways. We hope to bring the photos to more Parliaments and cities.

5. First, ICBUW Steering Committee members have lobbied UN delegates in Geneva and New York City. This spring, the Norwegian Ministry of Foreign Affairs awarded ICBUW funding for three projects, one of which is a survey trip to the Balkans with the aim of researching DU use by NATO forces in the 1990's.

We will be meeting with scientists and government officials. This is a preliminary survey. Also, with regard to question 4, another project to be funded by the Norwegian Ministry of Foreign Affairs will be research into the proliferation, manufacture and trade of DU weapons, and it might lead ICBUW into putting some pressure on governments in relation to DU-contaminated areas.

6. ICBUW's mission is a worldwide ban on the sue of uranium in conventional weapons. We are not aiming at non-military uses of DU. If DU were considered to be very harmful to human health, this might have an impact on some civilian uses. Also, accidents such as the crash of a plane with DU counterweights in Amsterdam some years ago, where local residents and pets became ill, would highlight the dangers of DU. ICBUW's mission is a ban on all military uses of conventional weapons containing uranium. Local ICBUW members also work towards this goal. Showing of the photos mentioned in question 4, in galleries and so forth, would help to raise consciousness about the issue.

7. The UN Resolution that passed in December 2009 asks that the above UN agencies update their research on DU by 2010. Many nations respect these organizations. ICBUW has discussed shortcomings

of WHO and IAEA (to a lesser extent) in its publications – WHO for example has not included peer reviewed scientific papers indicating that DU causes harm. Its 2001 monograph on DU and health is outdated. One paper written about possible harm of DU was suppressed by WHO. But many scientific articles mainly animal and cellular studies, have been published before 2001 and since which WHO has not taken into account. IAEA also has some outdated information about DU on its website. You should know, however, that WHO has a special relationship with IAEA which requires WHO to consult with IAEA on anything related to radiation.

8. The answer to this is partly to be found in question 7. DU anti-tank shells are Extremely effective weapons and the U.S. Army has not found a substitute for them. The John Warner National Defense Authorization Act of 2007 had a section, section 716, which asked the government to do a comprehensive study of the health effects of depleted uranium within a year. Prior to that, there had been 3-4 different pieces of legislation in the U.S. Congress which had not been passed and had varying numbers of co-sponsors. Part of the problem with DU is that the public doesn't know much about it overall. The Congressman mainly responsible for one piece of legislation (not passed) and for Section 716, even went on TV with a rock band, to broaden consciousness about the DU issue.

Three-four reports were published last year as required by Section 716. They were not conducive to considering DU as a threat or as weapons that needed to be banned. The first, put out by the National Research Council in conjunction with the U.S. Army (they had the equivalent of two chapters on the Army's Capstone Study) came to no firm conclusions. They did say that more research needed to be done on veterans with Level II exposure, veterans who spent time cleaning out destroyed tanks etc. which could go on for two hours or more.

Studies have been done on Level I exposed veterans – who were in tanks hit by friendly fire DU-shells – accidental shelling. The Baltimore Veterans Administration under the direction of Dr. Melissa McDiarmid, has done studies on these veterans, but the sample sizes are small (usually around 35 participants) and there is no non-exposed control group. Many of the veterans have embedded

DU shrapnel in their bodies which leads to a higher excretion of uranium in their urine than in veterans whose exposure to DU was through inhalation. Testing for DU in the U.S. is less sensitive than in several laboratories in the U.K. and in Germany. In the U.K., Dr. Randall Parrish has been able to test for DU even when the total urinary uranium is 1 nanogram/Liter. McDiarmid and her team don't test total uranium concentration below 0.001 micrograms per gram creatinine of urine. (A microgram is much larger than a nanogram – it is a millionth instead of a billionth). Also, inhaled DU oxides which are often quite insoluble, may lodge in the deep lung where they may stay for days, months or years, irradiating.

They may get into nearby lymph nodes. Once they become soluble, they may travel to the kidneys and be excreted. The point is, this DU in the lung, won't be present in the urine, and so urine testing does not necessarily indicate the amount of DU in the body. Two veterans in this program have had cancer. One, in the low urine uranium group, came down with Hodgkins lymphoma and another had a benign tumor removed from his arm. This was corroborated by the Research Advisory Committee on Gulf War Illness that wrote one of the 4 reports. However, McDiarmid says that the participants in the studies are healthy and do not show any adverse effects from DU exposure. Although it is difficult, without a nonexposed control group, or a larger sample size, to extrapolate results to other veterans, the Pentagon uses these studies to say that DU isn't harmful.

Another problem with research on DU is that there are no good human studies on DU. There have been surveys of veterans who served in the Gulf War or the Balkans but overall did not develop disease to a greater extent than a similar population that was not deployed to these areas. In Europe, news of peacemakers coming back from the Balkans with cancers etc. in 2001 sparked a lot of media coverage on the issue but that did not happen in the U.S.

The epidemiological studies that we do have, are mostly on industrial uranium workers. See my short paper on epidemiologic studies for a discussion of this. The National Research Council Report (**Review of the Toxicologic and Radiologic Risks to Military Personnel form Exposures to Depleted Uranium During and After Combat**, National Academies Press, Washington, D.C., 2008) pointed out that the dosage used in some animal experiments was high and therefore the results of the studies could not be extrapolated to humans. I discuss this in the short paper as well.

The Research Advisory Committee on Gulf War Illnesses in their report, **Gulf War Illness and the Health of Gulf War Veterans: Scientific Findings and Recommendations**, U.S. Government Printing Press, Washington, D.C., Nov. 2008, found that Gulf War illness was a complex of physical conditions (rather than psychiatric conditions, research into which the Pentagon had funneled a lot of money) but the RAC did not think DU was a prime cause of Gulf War illness. They estimated that the primary causes of Gulf War illness on an anti-nerve gas pill, pyridostigmine bromide, and pesticides; all sodliers were given the pill and used pesticides liberally and there was a lot of literature on both pb and pesticides. There was little or no literature on DU and reporting of DU exposure was very poor in the First Gulf War as soldiers did not know about DU. Furthermore, there was no widespread multifaceted illness in soldiers who had served in the Balkans or in Iraq. Another problem was that there were many toxins on the battlefield in the 1991 Gulf War.

RAC did mention some Canadians who were camped next to the U.S. Army base at Doha, Kuwait, where there was a destructive 24-hour fire in July 1991 in which a lot of DU ammunition was burned. The Canadians later developed symptoms of Gulf War illness as defined by RAC. This was reported in a report by an Ombudsman. The soil at the site of the fire had high amounts of DU ten years after the fire – it was tested by the IAEA. Eight-nine Iraq War veterans who lived for about six weeks in an abandoned train depot, next to a former battlefield (1991). The windows of the train depot were blown out and there were many sandstorms, became ill – as did many others in their troop. However these 8 men were later tested for DU exposure in Germany through **The New York Daily News.** Most of them tested positive – the Army tested them and found no DU exposure. The German lab used very sensitive techniques. Another Iraq War veteran, who had transported destroyed tanks and equipment between Baghdad and Kuwait was also ill and was tested in Germany and tested positive. His daughter, conceived after his return from the Middle East, was born with a deformed hand.

An activist, Joan Walker, who gave a presentation at an ICBUW conference in New York City in October 2007, said that she and another activist had talked to a counselor with the Veterans Administration, located in upper New York state, who said that he had received many calls from Iraq War veterans asking for respirators so they could sleep at night – the V.A. had paid for them for a while but the funding had run out.

The 4 reports published in 2008 are one reason why the press has been silent about DU at least recently. The U.S. has DU contamination problems at Starmet and at another former manufacturing facility, National Lead Industries, although clean up has been completed there as of September 2007, at a cost of $190 million. DU shells were manufactured at NL Industries for five years but other uranium products were made there. Dr. Parrish and his team tested 4 former workers at NL Industries and some residents, up to 4 of whom tested positive for DU – as did all the workers – and they were ill – but this was not a health study.

NL Industries shut down in 1984, so the last exposure to DU for these people had been over 20 years ago (before 1980) and they were still excreting DU in their urine. When Dr. Parris and his team held a press conference about the findings of the testing, in December 2007, there was a lot of local press but no national press present. NL Industries was located in Colonie, New York, a suburb of Albany, the state capital.

Another source of contamination in the U.S. comes from testing sites or former testing sites. In Bosnia and elsewhere in the Balkans, DU has not been an issue first perhaps because governments don't want to go against NATO or the U.S. UNEP's findings are known to the governments, I hope. We, Dr.Katsumi

Furitsu and 1met with a Serbian diplomat in Geneva a year ago and we' with 6ther **ICBUW SC** members met with a young woman diplomat also from Serbia last fall in New York.

I think it all fits together. There has to be a strong feeling that DU causes harm for governments to take action. This depends on the knowledge of the people. **ICBUW** is working on diplomatic and governmental levels. It depends on the member coalitions in the different countries. Belgium is a good example. A group consisting of a Dutch Member of the European Parliament, an Italian Physicist, Ria Verjauw of the Belgian Coalition and Emmanuel Jacobs, President of EUROMIL, a large European military union met with one or two representatives of **NATO** in late March of this year, a meeting that went well.

The European Parliament has had four resolutions, the **2008** one being strong, calling for a moratorium, and working towards a ban on DU weapons. But this was not reported in the U.S. These are some of the reasons why DU has not had a high profile even in the affected countries.

9. A ban on DU, which is law in Belgium and which may become law in Costa Rica has to come first. The people and government of a country has to realize the harm that DU can do and has to want to cleanup affected areas. Such information in the press and among the populace, that DU is harmful, should lead to medical care for the victims and compensation for the victims. However, I don't think this will come about until the hazards of DU are known widely unless there are some government officials who have a very humanitarian turn of mind.

The two reports on epidemiologic studies are: Committee on Gulf War and Health: Updated Literature Review of Depleted Uranium, Institute of Medicine, **Gulf War and Health: Updated Literature Review of Depleted Uranium,** Washington, D.C.: National Academies Press, **2008 (271** pages). What IOM says in regard to each type of cancer or other disease is: "The committee concludes that there is inadequate/insufficient evidence to determine whether an association between exposure to uranium and (in this instance) lung cancer, exists".

However, some studies show that some diseases are linked to uranium exposure but others do not show this. Same committee**, Epidemiologic Studies of Veterans Exposed to Depleted Uranium:** Feasibility **and Design** Issues, Washington, D.C., National Academies Press, 2008 (48 pages).

Appendix 2

Questionnaire for University experts in Radiobiology and Environmental protection Department for Radiobiology and biophysics

1. Did you make any research with soil, water or food samples in Hadzici area? When? Which kind of samples you have used? What results you have?
2. Which kind of methods was applied, and do you think that your laboratory is equipped properly for these examinations?
3. Do you agree that DU in this area could have long-term effects on environment and human health?
4. Which kind of threats you can expect?
5. How water sources at this area is affected?
6. Which kind of cooperation you have with local and state institutions, as with NGO´s or other international organizations, regarding DU in Hadzici area?
7. Do you feel that other institutions doing enough with DU pollution on long term basis? What they could do more?
8. Considering first exposure to the DU with dust inhalation and evidence of increasing cancer in the people exposed to, people displacing to other area and arrivals of new inhabitants, how we can estimate health effects on them?
9. How we can measure toxically and ionizing radiation harms on living organisms?
10. Which pathways DU use during its migration to living organisms?
11. Which doses are in use?
12. Do you have a suggestion of which additional principles in measuring effects should be applied in case of DU, as anthropogenic contaminants?

Appendix 3

Interview with Prof. Lejla saracevic, Department for Radiology, Biophysics and Environmental Protection (Translation from Bosnian to English)

1. Have been performed researches regarding DU in BiH?
    - Not much. Some results can be found in Zbornik HDZZ 2003 (Osiromaseni uranijum u BiH, Zbornik radova petog simpozija Hrvatskog društva za zaštitu od zračenja, Stubičke Toplice, 2003). You can use this citation and more results can be found in Dr. Nedzad Gradascevic dissertation.
2. Do you think that there is a long term threat from DU pollution, for the local area as well as for the whole Bosnia and Herzegovina?

- Yes, not too much, but increased risk.

3. Please specify what is main risk for water contamination?

- The water is the main way of contamination trough the soil, and then to the whole eco chain. That is reason why the water-soil-plants and the animal products need to be monitored.

4. Do you cooperate with local or state institutions, NGO-s or other international organizations regarding the DU presence in Hadzici?

- No.

5. Does your laboratory equipment respond to standards? Is it possible for your department to make exact level of ionizing radiation in soil, water and the rest of eco chain? I am mostly interested in tests you have already performed.

- Yes.

6. Which methods have you used to gain results and if you have some results, where I can find them?

- We used Gamma spectrometry for the analysis. I can give you more information the next time.

7. Do you think that local and state government do enough regarding the DU matter?

- No.

8. Can the increased number of cancer illnesses observed in this area be related to DU presence? Can you tell me how DU can affect in 20-30 years future perspective the persons that had escaped the first wave of contamination? Is the amount of DU on the soil or in plants enough to cause problems on the inhabitants health? How can they be protected?

- We first need to establish sufficient monitoring and then it would be possible to estimate the possible risk. Any other way is simply guessing games.

10. Can you please give a picture of real DU threats on this area? Environmental threats or damage.

- Unanswered

11. What dose are used for measuring the DU damage on live organisms?

- Sv/year

12. In Chemical fact sheets of WHO Guidelines for drinking water quality, 3rd edition, 2004, WHO changed the limits for Uranium presence in drinking water from 0.002 mg/l to 0.015 mg/l. Can you comment on that?

- Uranium is both chemically and radiologically toxic. The metric units are more related to its chemical toxicity. The limits that were suggested by WHO and ICRP changed on lower levels only when it is an extraordinary situation and for shorter periods of time based on several conditions.

13. When you measure the DU toxicity, , how much was taken into account the radiobiological effects?

- When you make risk assessment, you need to take both into account along with other many factors as is time, type, amount and quality of food. In addition, age, sex, and personal health issues should be included.

Appendix 4

Questionnaire used as the guideline for the interview for the residents in Hazdici area that lays close to the repairing tank facility (direct affected area by DU)

1. Age: (a) 18-25, (b)26-40, (c) 40-55, (d) above 55

2. Sex: M, F

3. Do you have children: Yes, No

   I. If yes, how many?

4. How long you live in the Hadzici area?

5. What is your occupation?

6. Do you work close to the area?

7. Have you heard regarding the DU?

   I. If yes, where from did you hear regarding DU?
   (a) media, (b) local government, (c) friends, (d) scientists

8. How much do you think you are informed about it?

9. Do you think that DU residues are important for your future health?

10. Did you receive any additional information from the local authorities about this issue?

11. Do you use the municipal water pipe system, or you have your own source of water?

- **I.** If you have your own water pump, for what usage is the water suitable for?

12. Do you grow your own food on land?

13. Do you pick mushrooms from around the area?

14. Do you believe that the local authorities give substantial attention to this problem?

15. Are you actively involved in raising the awareness about DU in you living area?

16. Do you feel any changes in your life due to DU presence in the area?

17. Are you concerned about your health?

- **I.** If yes, why?

18. Do you have an interest on DU and how does this affect you?

19. Which kind of DU-related problems do you have?

20. What problems do you think are more important (due to the DU pollution in the area)?