ENVIRONMENTAL RESPONSIBILITIES OF THE MILITARY – SOLDIERS HAVE TO BE "GREENER BERETS"

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Abstract: *Military activities are always mean high threat to the ecosystems all over the World. It is clear, that during wartime military operations can cause large scale environmental damages. But armies exist even peacetime, so everyday life of the soldiers can also contain ecological risks. "Warfare ecology" as a relatively new scientific approach tries to cover all parts of the military activities to discover the areas, where armies can become more environmental friendly, let's say: "greener". Another global problem is the climate change, which is very actual, and also touches military. It looks that environmental responsibility of the military point to the same direction from different aspects.*
Authors of this paper collected common needs of warfare ecology and climate change and tried to describe some solutions for the armies to be "greener".

Keywords: military activities, warfare ecology, environment, climate change

1. Preface

In wartime, when an entire nation fights to survive, aspects of environmental protection are not really important. In general, only postwar activities include some comprehensive surveys of environmental, ecological damages and during a long term of restoration period, usually in latter times environmental rehabilitation programs can be found. There are more and more scientific studies suggesting, that in modern warfare, participants have responsibilities even in armed conflicts to protect natural (and also artificial) ecosystems.
History of the mankind in the 20th century in a certain way is a summary on how the humans advanced not only to the dominant species on Earth, but to potential destroyers of the planet. For this century humans already explored, captured and divided the whole planet for their interest. As consequences of changes in economic, political and military capabilities of states former balances lose, new conflicts arose and two World Wars together with a lot of smaller conflicts were fought in order to repartition the planet.
To successfully fight a war subordinated science developed more and more effective and dangerous weapons. Automatic rifles, devastative artillery, incendiary ammunitions and use of aircrafts lifted the destruction onto a new level with increased range and deadly efficiency causing masses of casualties concerning human lives and natural ecosystems.
While there were some impressive initiations from the beginning of the 20th century to reduce or ban the use of extremely destructive weapons (e.g. biological and toxin weapons convention, Geneva, 1925), during the World Wars new types of weapons of mass destruction were developed and deployed, chemical weapons in WWI and nuclear weapons in WWII.

During the research and development of nuclear weapons, scientists of the Manhattan Project already realized, how dangerous the new weapon could be, and described some visions about the catastrophic consequences of its use, but they never imagined that enormous arsenals of nuclear weapons, that were produced and stockpiled in the era of Cold War capable of easily destroying all the living on the planet.
Such facts, that majority of chemical weapons were used during WWI and in Vietnam, and only 2 pieces of nuclear bombs were deployed by the US military in WWII, cannot display the whole environmental and ecological impact caused by the research, development, testing, production, storage and use of these weapons.
In 2008, Machlis and Hanson outlined in Bioscience a new subfield of study titled "Warfare Ecology". The paper was a call to arms for conservationists, policy makers, and scientists alike. The authors rightly suggested that warfare is much more than just an armed, violent conflict, but includes preparations and postwar activities as well. The three stages include a range of activities such as: propaganda, recruiting, training, mobilization, research and development, testing, storage, peacekeeping, civil defense training, disaster relief, operation of military infrastructure (energy and material consumption), military transportation, exercises and restoration efforts. Each of the stages comes with both unique and overlapping ecological impacts. If we want to take care of the environment, we should analyze all parts of military activities to find the key points where better protection of ecosystems can be reached.

2. Periods of military activities

Military activities can be divided for 3 main periods:

- preparations for war;
- war (armed conflict);
- postwar (restoration) activities.

Each stage includes several key elements (such as military, infrastructure, and governance) that influence both warfare outcomes and ecological impacts. Table 1 illustrates the elements and stages of warfare. Stages often overlap, as when war preparations continue during wartime, militaries engage in stability and support operations, or states engage in postwar recovery efforts while preparing for future wars.

Table 1: Stages of warfare (source: Gary E. Machlis, Thor Hanson: Warfare Ecology)

	Stage of warfare		
Key element	**Preparations**	**War**	**Postwar activities**
Civilian	Propaganda, security alerts, civil defense training, militias	Rationing, refugees, casualties, loss of shelter and employment	Relocation, rehabilitation, illness, mortality, civil resistance
Military	Recruiting, conscription, training, mobilization	Campaigns, engagements, battles, casualties, prisoners of war, rehabilitation and treatment	Demobilization, occupation, reintegration, illness, mortality, peacekeeping
Materiel	Research and development, testing, manufacturing, strategic materials, stockpiling, positioning	Bombing, small-weapons firing, missiles, mines, supplies (petrol, ammunition, spare parts)	Unexploded ordnance, weapons disposal, cleanup, factory conversion
Infrastructure	Planning, energy and raw material supply, construction, maintenance, homeland security	Ports, supply depots, forts, bases, camps, hospitals, roads, emplacements	Reconstruction and recovery, decommissioning, base closures, economic restoration
Governance	Propaganda, policy, strategy, defense treaties, economic sanctions	Propaganda, civil control, alliances	Treaties, territorial exchange, reparations, war-crime trials
Diplomacy	Espionage, alliances, negotiations, sanctions, peacekeeping	Espionage, alliances and coalitions, negotiated surrender, cessation	Prisoner-of-war exchanges, occupation treaties, economic assistance treaties

Landscape-scale studies of warfare preparations have examined the ecological impacts of military training. Truck, tank, and heavy-vehicle exercises have long-term effects, tracked-vehicle training can interact with other land uses (such as grazing) to create complex successional patterns. Live-fire training often leads to the accumulation of pollutants; white phosphorus (a common illuminant found at artillery impact areas) has been linked to mortality and reduced fertility in waterfowl and to secondary poisoning of raptors.

Regional- and global-scale research on warfare preparations includes studies of nuclear weapons testing and manufacture. The effects of low-level radioactivity are equivocal, but the exposure is clearly global: fallout from peak weapons testing in the 1950s has been measured in Antarctic ice cores, tropical tree rings and ocean sediments also.

In addition, military industry is very active even in peacetime, and production of weapons, military vehicles and other equipment causes large scale environmental pollution. Not only production, but peace time activities of forces also means a lot of energy consumption, and they need great amount of fossil energy sources for these.

Table 2 shows some selected examples of ecological impacts relevant to warfare ecology:

Table 2: Select examples of ecological impacts relevant to warfare ecology, by stage and scale (source: Gary E. Machlis, Thor Hanson: Warfare Ecology)

	Stage of warfare		
Scale	**Preparations**	**War**	**Postwar activities**
Landscape	Cratering, soil compaction, soil erosion Unexploded ordinance, accumulation of pollutants Compromised human, plant/animal health Habitat and biodiversity protection/ maintenance of disturbance heterogeneity	Cratering, soil compaction and contamination from weapons deployment Destruction of crops and arable land Habitat destruction Biodiversity loss Tactical oil spills and defoliation Wildlife colonization of craters/disturbed habitats Increased human mortality Malnutrition, disease Increased poaching and deforestation, protected-area encroachment	Long-term alterations in land use/ settlement patterns Continued contamination/health risks from ordnance, landmines, depleted uranium Long-term groundwater pollution Biodiversity/habitat conservation in buffer zones "Swords to plowshares" conversion of military sites to conservation areas Restoration/cleanup of battlefields, damage to training areas, and tactical damage (oil spills, landscape alteration)
Regional	Radionuclides in regional plants/animals, soils/water Compromised human health	Increased extraction of "lootable resources" (diamonds, minerals, timber, wildlife products, etc.) Socioeconomic disruption and damaged infrastructure Increased fish/wildlife stocks from declines in commercial activity Regional-scale contamination of reserves Increased dust storms Widespread forest mortality from tactical defoliants	Long-term health effects from weapons deployment Degraded ecosystem services Regional contamination from large-scale impacts (oil spills, river pollution, widespread mines) Creation of "peace parks" along disputed borders and buffer areas Lingering socioeconomic disruption/loss of resource management
Global	Fallout measured in tree rings, ice cores, ocean sediments Carbon emissions	Increased demand for natural resources Nuclear winter Biological weapons fallout Carbon emissions	Transfer of military technologies to civilian use (geographic information systems, remote sensing, satellite imagery)

During armed conflicts, protection of the environment is not a key issue. Masses of soldiers, vehicles and equipment marching on lands and seas can harm local wildlife. Large scale fires, explosions, oil spills, other chemical contaminations in the environment can cause catastrophic consequences for the animals and for whole ecosystems. Potential threat and possible use of weapons of mass destruction always means a theoretical scenario about complete devastation of large territories. And besides the use of WMDs, there are other sources of risks to the environment: modern industry uses enormous amount of hazardous materials often concentrated in small places. So presence of a factory producing or storing dangerous substances in a conflict area means a potential chemical weapon. Accidental or intentional attack and harm of hazardous

stockpiles can produce large scale chemical emission to the environment (as it happened during the Balkan conflict in the 1990s).
Nuclear proliferation raises the possibility of even more far-reaching effects. Climatologists suggest that atmospheric particulates from as few as 100 small, urban-centered detonations would cause widespread global cooling, the long-discussed "nuclear winter" with catastrophic impacts beyond the initial blast-related mortality.
At the landscape scale, most postwar ecological research has focused on cleanup methods, outcomes, and the potential for converting military sites to other uses. Presence of toxic and hazardous wastes often complicate the future of military sites. An analysis of cleanup efforts in post-Soviet Estonia noted heavy metals, contaminated groundwater, and radioactive waste at former Soviet Army installations. Cleanup costs at US military installations (including nuclear weapons sites) are estimated to run as high as $1 trillion. Regional-scale studies have examined postwar environmental and health effects of wartime actions. Following the Vietnam War, researchers documented soil erosion, altered faunal communities, and the permanent loss of forest and mangrove cover in areas exposed to herbicides. Defoliants affected Vietnamese civilians through altered settlement and agricultural patterns, chronic gastrointestinal problems, liver damage, and birth defects; the results of long-term studies of US servicemen suggest links between defoliant exposure and diabetes, as well as several types of cancer.

3. Military responsibilities concerning Global Climate Change

There is also a relatively new aspect that can be connected to warfare ecology: problems created by the global climate change concerning the military. The connection between the military and the climate change is a complex issue. On one hand, military, as one of the biggest environmental polluters, is partly responsible for the whole global process. On the other hand, carrying out military operations in changing environment is a great challenge. So we can say that military activities are causes of climate change and climate change causes more and more problems and difficulties for military. It is clear for now, that consequences of climate change affect military operations on the strategic and tactical planning and execution levels, military personnel, equipment, infrastructure and training.
The questions of the deployment of military forces under the changed climatic conditions and the relationship between climate change and military security are areas that have not yet been researched in detail. The importance of the question has already been recognized as the importance of the assessment has been mentioned by several experts at several places. We will set forth some marked opinions below.
As respected military experts of the United States (retired generals) see it global warming represents a serious hazard to the security of the United States. The study is titled "National Security and the Threat of Climate Change" and is dealing with the risks that – as a result of warm up – affect the security interests of the United States.
According to military experts climate change would unambiguously help extreme forces and terrorism in politically unstable regions. The study relies on the forecast of climate reports according to which global warming will cause serious storms, drought and floods, and the melting of the glaciers and the Arctic and Antarctic ice cover will increase the level of the oceans. One consequence can be massive migration that could cause tension and conflicts on state borders while the other is the increasingly intensive deployment of international rescue corps, including the forces and assets of the army. Concurrently fights could break out for drinking water reserves.
According to the authors what follows from these scenarios is that a lot more complex tasks await the U.S. armed forces. They also point out that it is difficult for the military

forces to adapt to the changed circumstances considering the dimensions, existing assets and permanent bases of these forces. As an example they present the changes that took place in the region of the North Pole that have already reshaped part of the shipping routes therefore the protection of the interests of the United States here would require significant naval capacities.
The effect of extreme weather (heat, intensive precipitation) also poses serious threat to advanced arms systems and military bases. As an example the report mentions the U.S. base on Diego Garcia. Its operation is made more difficult by the further rise of the sea level (more than a meter by now) and would render it impossible in the worst case. In 1992 Hurricane Andrew damaged one of the air bases in Florida to such an extent that it does not operate till today. In 2004 Hurricane Ivan took out Pensacola air base for almost a year.
Extreme weather and extreme climatic conditions have an impact on military operations as well. Several operations had to be postponed or cancelled in the Iraqi war because of sandstorms, the lifetime of technical equipment decreased and repair costs increased significantly. Sandstorms made the transport of reserves more difficult which primarily jeopardized fuel supplies. In a war where 9 million liters of fuel was moved on the theatre of war every day each weather anomaly has endangered or is endangering the success of operations.
Assessments agree that armed forces will play a bigger role in the future in handling disaster situations that will develop as a consequence of climate change.
Because of cross-border effects of disasters cooperation must be raised to a level that exceeds the current one. This is the only way of cooperation to utilize existing abilities effectively and this is the only way forces or assets available at other places can be quickly accessed.
Rescue and relief operations must be implemented in areas with extreme weather, difficult climatic conditions and in an environment with different culture. For this reason abilities such as water supply, air transport capacity, civil-military cooperation, specific preparedness, special technical assets and rapid response become more important.
With regard to the fact that supply convoys are very vulnerable it is worth considering reducing the number of them. Based on recent operational statistics someone gets injured or dies in areas of operation in one out of every 24 convoys. Convoys are currently protected by 120-130 soldiers equipped with considerable armament.
"Less fuel, smaller exposure", experts say and are thinking of alternative renewable sources of energy such as wind and solar energy. To this one needs to know that more than 85% of the energy consumption of the military bases in Kuwait, Iraq, Afghanistan and Djibouti is used for cooling the living and working tents as well as the communication equipment. As the continuous cooling of them is a matter of vital importance other economical solutions must be found. One of the methods is to insulate the tents through which energy loss can be reduced by 45%.
Special tools were developed to support the activities of certain corps in the operational areas. Such an improvement is the application of photoelectric tools applied on the surface of the otherwise insulated tents. Various portable electronic devices are supplied and charged by them. If necessary, they can also be used for charging the batteries of the info communication and weapon control equipment of the given subunit, the rechargeable batteries and the increasingly used fuel cells. The development work on the so-called "smart grids" used in military camps – primarily in the U.S. and in Great Britain – is currently in progress. These make it possible to connect different electricity

generating equipment (such as diesel generators, solar cells, wind generators) to a common grid and operate them in a fuel-efficient way.
The fuel consumption of vehicles is also a serious challenge. The conflict of "lighter vehicle – less consumption – less protection" can be resolved by the new complex technologies that point to a lighter armor that still provides adequate protection. As military vehicles with hybrid drives gain ground more and more this would also provide considerable savings.
US military plans to reduce its energy consumption by 10-20% in the coming years which could result in very significant savings when considering the annual costs (11 billion dollars in 2005 and 14 billion in 2008). The goals concerning the application of renewable energy resources and the efficiency of energy consumption were specified in separate provisions for the various services. Thus in the case of land forces a reduction of 25% of the fossil energy consumption is targeted by 2015 compared to the 2003 level, and by 2025 25% of the entire consumption must be covered by renewable resources. A separate pilot program was launched for the air force concerning the application of biofuels although it is likely that the increased use of second generation biofuels (of cellulose origin) is expected in this field.
Recent computer simulations and studies of reconnaissance agencies equally reached the conclusion that in the coming 20-30 years food shortage, water supply crises and catastrophic floods should be taken into account in vulnerable regions, especially in African countries south of the Sahara, in the Middle East and in South and South-East Asia which would require American humanitarian help or military response. The National Defense University modeled the consequences of a huge flood in Bangladesh which would result in several hundreds of thousands of people flocking to neighboring India. A regional conflict would develop, infectious diseases would spread and there would be serious damages to the infrastructure.
Till now debates on global warming focused mainly on ways of substituting fossil fuels, the reduction of greenhouse gas emissions and on how to encourage negotiations on preparing the international climate convention. By today, however, more and more policy-makers have reached the conclusion that the increasing temperature, rising sea levels and melting glaciers directly endanger national interests. If the United States does not take the lead in reducing the fossil fuel consumption of the world and together with that in reducing the emission of gases causing global warming than the country must urgently deal with the global environmental, social, political and even military crises that could take shape – according to those who are in favor of this idea.
Hillary Clinton, Secretary of State, as a senator urged that the Congress takes into account the aspects of climate in strategic planning. The climate model of the Department is based on the weather programs of the U.S. Navy and Air Force as well as other governmental climate researches. The Pentagon and the State Department are studying the problems arising out of the dependence on foreign energy sources for several years but only now started to include the consequences of warming in long-term planning. The Pentagon added a climate chapter to the four-year defense program and the State Department is also preparing a similar chapter in its own parallel program. Although military and reconnaissance planners are aware of the challenge posed by climate change for several years only the Obama government started to handle it as a key issue.
The National Intelligence Council under which U.S. reconnaissance agencies harmonize reached the conclusion last year that the storms, droughts and food crises will create several emergency situations. The unavoidable relief operations may heavily burden the

U.S. military transport and support capacities and could reduce the strategic depth required for combat operations. All those affect international power relations, too.

4. Decrease ecological footstep of the military

It has been already revealed, that warfare ecology is in lack of scientific studies especially that are cross boundaries of discipline and scale. Comprehensive use of ecological models to integrate multiple warfare impacts at the ecosystem level would also have a great importance.

If we want real results, military should act quickly and in a very practical way. Most of the possibilities to be more environmental friendly lay within peacetime activities. The everyday life of the military contains a lot of elements that can be upgraded, and there are some suggestions in the followings to take into consideration. And there are a few points that can be useful during armed conflicts also.

4.1 Military operations:

Main goals are: *decreasing energy consumption and emissions, increasing effectiveness and flexibility.*

Concerning the satisfaction of operational energy needs extended use of renewable energies would be a great step forward. Energy production, distribution, storage and regulation must be developed together with advanced water supply, water treatment and reduction, reuse and recycling of wastes. Advanced power utilization also preferred, e.g. Hydrogen Fuel Cells have a lot promising military application.

Less energy consumption besides its environmental advantages can save lives during operations, because fuel convoys are one of the most vulnerable targets (there are examples for US military in Afghanistan).

4.2 Military equipment:

Main goals are: *decreasing energy consumption and emissions, increasing operational range and effectiveness.*

Climate change affects both the research, development and procurement of new equipment, and the operation and maintenance of existing equipment. It is essential to take some tendencies into account during operation and R&D of military equipment. More economic (and sustainable) use of energy resources needed (change of structure to degrease costs and CO_2 emission), and also important, that consequences of climate change can cause increasing corrosion and degradation.

As already mentioned, security of fuel is essential during operations, so decreasing fuel consumption has a key importance. Because of this, R&D should focus on:

- Biofuel,
- Fuel cells,
- Hybrid vehicles,
- Electric engines.

For example, advantages of hybrid vehicles are the followings:

- Increased operating range,
- Increased power,
- Less fuel consumption,
- Reduced noise,
- Less exhaust gas emission,
- More flexible running.

4.3 Military infrastructure:

Main goals are: *energy rationalization and decreasing emissions.*

These can be accomplished by the development of heating and lighting systems, complete building energetic reconstruction with heat insulation and ventilation systems, wide use of renewable energy sources (main photovoltaic solar panels), economical use of drinking water and the utilization of rainwater. Table 3 shows the possibilities of the use of renewable energies for buildings.

Table 3: Possible active devices for building energy

	Heating	Electrical	Power density	Additional energy	Moving parts	Mobile application
Solar cell	*no*	*yes*	*low*	*no*	*possible*	*possible*
Solar collector	*yes*	*no*	*low*	*possible*	*yes*	*possible*
Solar dish	*possible*	*yes*	*high*	*no*	*yes*	*possible*
Shading devices	*yes (cooling)*	*no*	-	*no*	*possible*	*possible*
Geothermal heating plant	*yes*	*no*	*medium/ high*	*yes*	*yes*	*no*
Geothermal power plant	*possible*	*yes*	*medium/ high*	*no*	*yes*	*no*
Heat pump	*yes*	*no*	-	*yes*	*yes*	*possible*
Heat exchanger	*yes*	*no*	-	*yes*	*yes*	*possible*

References

[1] Jurgen Brauer: *War and nature*, AltaMira Press, Plymouth, 2011, ISBN 978-0-7591-1206-3, p. 233.

[2] Gary E. Machlis, Thor Hanson: *Warfare Ecology*, BioScience 58(8):729-736. 2008.

[3] http://bioscience.oxfordjournals.org/content/58/8/729.full, 30.09.2014.

[4] Craig McClain: *Warfare Ecology*, http://deepseanews.com/2009/03/warfare-ecology/, 30.09.2014.

[5] Auer, R.M., Raukas, A. 2002. *Determinants of environmental clean-up in Estonia. Environment and Planning* C: Government and Policy 20(5), 679-698.

[6] Westing, A. H. (1984b). Herbicides in war: past and present. In: *Westing, A. H. (ed.). Herbicides in War: the Long-term Ecological and Human Consequences*, pp. 3-24. Taylor & Francis, London.

[7] *National Security and the Threat of Climate Change*. http://securityandclimate.cna.org/ 16.08.2014

[8] http://www.mti.hu/cikk/143248 15.06.2014.

[9] Miller, Klaude A.-Draker, David L.: *Combat Support Brigade*. Engineer, January-March 2006, page 11.

[10] Ferenc Kovács - András Béla Oláh: *Possibilities and aspects of the energy reconstruction of facilities managed by the hungarian defence forces*, in László Földi, József Padányi (editors): Effects of climate change to military activities, p. 270, Nemzeti Közszolgálati Egyetem, HUNGARY 2014. ISBN 978-615-5305-25-2,