VOLUME 11, NUMBER 2 February 2003

Science FOR Democratic Action

AN IEER PUBLICATION Also published as Énergie et Sécurité • [illegible] • [illegible] No. 24

Precision Bombing, Widespread Harm:

Environmental and Legal Concerns About "Precision Bombing"

CREDIT: PANCEVAC, SOURCE: UNEP, "THE KOSOVO CONFLICT: CONSEQUENCES FOR THE ENVIRONMENT & HUMAN SETTLEMENTS," ONLINE AT www.grid.unep.ch/activities/kosovo/report.pdf

Smoke cloud over Pancevo, April 1999.

BY SRIRAM GOPAL AND NICOLE DELLER[1]

Editor's note: *On November 5, 2002, the Institute of Energy and Environmental Research released a report that raised legal and environmental concerns about NATO's so-called precision bombing of Yugoslavian industrial plants in 1999. The report, titled* Precision Bombing, Widespread Harm: Two Case Studies of the Bombings of Industrial Facilities at Pancevo and Kragujevac During Operation Allied Force, Yugoslavia 1999*, warns that bombing civilian industrial facilities can lead to contamination that is very difficult to clean up and may violate international humanitarian law. IEER's research, summarized in this article, also raises important questions relevant to future conflicts, including a possible war on Iraq. For references, please see the full report.*[2]

This study was triggered by concerns over the health and environmental impacts of modern war. Our main goal in addressing this issue was to examine whether the use of precision weapons (weapons designed to hit a precise target, with little or no collateral damage) is synonymous with precision damage. Is damage limited to the announced objective of the bombing? And if not, what are the environmental and legal implications from the indiscriminate destruction resulting from successful precision bombing strikes?

On March 23, 1999, the 19 countries of the North Atlantic Treaty Organization (NATO) authorized air strikes against Yugoslavia. Operation Allied Force began the following day. The campaign marked the second time that NATO had engaged in an offensive operation in its 50-year existence.[3]

During Operation Allied Force, vital parts of the industrial infrastructure of Yugoslavia were deliberately targeted and bombed by NATO forces. This had a two-fold effect on the local civilian population. First, vital facilities, like wastewater treatment facilities, were rendered inoperable. Second, the persistent pollution created by the destruction of the facilities was left to fester for months and may affect large numbers of civilians over a widespread area in coming years.

Environmental Impacts

Our report examined some of the environmental effects of the bombings during the 1999 NATO-Yugoslavia War, primarily in two case studies. These two specific cases of NATO bombings are examined in order to look at the type and range of environmental damage resulting from precision bombing. We selected the cases according to the following criteria:

- a specific geographically precise target was chosen well ahead of the bombing run;
- the bombing run successfully destroyed the target in question, with little direct blast damage to facilities not intended to be damaged;

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PRECISION BOMBING

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▶ direct casualties among NATO forces, as a result of the bombing runs, were zero and immediate civilian casualties were low.

Our case studies were informed by the United Nations Environmental Program Balkans Task Force (UNEP/BTF), which had studied the two chosen sites: the industrial facilities in Pancevo and the Zastava factory in Kragujevac. These are two of the four sites that UNEP designated as environmental "hot spots" as a result of the bombings.[4]

Our limited research effort encountered significant unforeseen problems. Yugoslavia has been in political turmoil for most of the past decade and gaining access to hard data proved much more difficult than was initially anticipated. Additionally, the lack of access to information was not limited to Yugoslavia. A request was made by IEER to the U.S. Department of Defense under the Freedom of Information Act to get information on the targeting criteria used during Operation Allied Force. In response, we received 42 blank pages marked "declassified" but otherwise completely devoid of information. Even the names of the facilities for which information was requested were not on the pages. Our subsequent appeal to the Department of Defense was turned down. Furthermore, in 2002, the U.S. General Accounting Office, the investigative arm of the U.S. Congress, prepared an analysis of the 1999 bombing campaign in Yugoslavia that remains classified by the U.S. Department of Defense.

Pancevo

Pancevo is an industrial town with a population of about 80,000 to 90,000 located in the province of Vojvodina in the republic of Serbia, which was part of the former Federal Republic of Yugoslavia. It is located 20 kilometers (about 12 miles) northeast of the capital, Belgrade (population 1.2 million), at the confluence of the Tamis and Danube rivers. The industrial complex covers about 290 hectares (about 716 acres) and lies to the south and southeast of Vojlovica, a major residential area in Pancevo. The complex is home to what are identified as the HIP Azotara chemical fertilizer factory, the HIP Petrohemija petrochemical plant, and the NIS Oil Refinery. The three factories employ 10,000 people and, as such, represent the major employers for the entire Pancevo area. Directly to the south of the industrial complex lie several small villages.

The petrochemical plant and the oil refinery are linked to the Danube via a 1.8-kilometer channel into which treated wastewater is released. The fertilizer factory uses an adjacent drainage canal. Before the conflict, wastewater from the petrochemical plant and refinery was treated by a two-step process (separation and biological treatment) before being released into the wastewater channel. This facility was considered the most modern and effective wastewater treatment facility in the former Yugoslavia.

A drinking water extraction plant lies just upstream of Pancevo's industrial site on the Danube River near the point where the Tamis River meets the Danube. This drinking water extraction point serves the majority of people in the area around Pancevo. However, a significant number of people (about 5% in town and 10% in surrounding villages) use private wells for drinking water, crops, and gardens.

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Science for Democratic Action

Science for Democratic Action is published four times a year by the Institute for Energy and Environmental Research:

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We gratefully acknowledge our funders whose generous support has made possible our project to provide technical assistance to grassroots groups working on nuclear weapons-related issues, and our global outreach project.

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Editor: Lisa Ledwidge

PRECISION BOMBING

FROM PAGE 2

The area around Pancevo's industrial complex suffered from chronic pollution even before the 1999 bombings. For example, at the petrochemical plant, chlorinated solvents (e.g., trichloromethane, tetrachloromethane, trichloroethane, dichloroethene, trichloroethene, and others) that are often associated with PVC (polyvinyl chloride) production as unwanted by-products, were found in both soil and groundwater samples. At the refinery, oil pollution existed prior to the bombings. In addition, there is evidence of a previous mercury spill that was far larger than the one that resulted from the NATO bombings, and of previous polychlorinated biphenyl (PCB) contamination in the waste channel. Finally, there was a major 1,2-dichloroethane spill some years before the conflict. All of these factors hindered attempts to evaluate the impacts of the contamination that resulted exclusively from the bombings.

The bombings of the facilities in Pancevo occurred over a period of several weeks and were critically disruptive to life in Pancevo. After the initial bombing of the petrochemical complex in April 1999, an estimated 40,000 people left the city; 30,000 of them returned only after the bombings had ended in June. In addition, a temporary ban was placed on fishing in the Danube River near Pancevo until the fall of that year. Further, Serbia's Ministry of the Protection of Human Environment recommended that no produce grown in the areas around Pancevo be consumed as there was a good deal of rain that washed soot and other matter from the fires in Pancevo onto surrounding agricultural areas.

The petrochemical plant was bombed on April 15 and 18, 1999. There are four major environmental issues directly associated with the NATO bombings of HIP Petrohemija petrochemical plant.

1. On April 18 a vinyl chloride storage tank was hit by a NATO bomb, burning the 440 metric tons of material stored in it.[5] An additional 20 metric tons of this known carcinogen that was being stored in rail cars for transport also burned. It should also be noted that there were two vinyl chloride storage tanks on-site, one empty and one full; only the full tank was destroyed.
2. When 1,2-dichloroethane storage tanks were indirectly damaged from the bombing, 2,100 metric tons of the chemical spilled, half being released onto the ground and the other half into the wastewater channel.
3. The chlor-alkali facility was heavily damaged and this released 8 metric tons of metallic mercury into the environment. Most of this (7.8 metric tons) was spilled on the surface of the site while the remaining 200 kilograms leaked into the waste channel. Most of the material that was spilled onto the soil was recovered, but that is not the case for the mercury that was spilled into the channel.
4. The wastewater treatment plant that was used by the oil refinery and the petrochemical plant was seriously damaged during the conflict. The damage was caused by the sudden influx of material into the plant exceeding its capacity. As of April 2001, almost two years after the end of the bombing, the treatment plant was running only at 20% capacity. The major recipient of all these pollutants has been the wastewater channel that feeds into the Danube River, the major waterway in the region.

The oil refinery was the most heavily bombed site of the three NATO targets located in Pancevo's industrial complex. It was bombed several times in April 1999 and as late as June 8, 1999. Many storage tanks and pipelines were destroyed as a result of the attacks. Approximately 75,000 metric tons of crude oil and oil products burned and 5,000 to 7,000 metric tons leaked onto the soil and into the sewer system. The spills resulted in 100,000 square meters (10 hectares) of contaminated soil within the refinery complex.

Like the petrochemical plant, the fertilizer plant HIP Azotara was bombed twice, on April 15 and 18, 1999. Factory staff informed UNEP/BTF inspectors that there was great concern over the storage tank that held 9,600 metric tons of ammonia prior to the bombings. Were this tank to have been struck by a bomb, it would have released enough ammonia to kill many people in the surrounding area. The HIP Azotara factory did not possess the capability to transfer the ammonia to another location. As a result, fertilizer production was increased in the early days of the bombings (which began on April 4, 1999) in the hope that this would deplete the amount of ammonia left in storage. By the time of the first attack, the amount of ammonia left in storage was approximately 250 metric tons. The stored ammonia was intentionally dumped directly into the wastewater canal to prevent it from being released into the atmosphere after an explosion. This was done after the ammonia tank was indirectly hit by debris from a separate explosion. In addition to this release of ammonia, 200 to 300 metric tons of calcium ammonium nitrate, phosphates, and potassium chloride leaked or burned as a result of storage tanks being damaged during the bombing (the ratio of leaked material to burned material is not known). Finally, railway cars carrying 150 metric tons of crude oil were also hit and no attempt was made to extinguish the fires.

The tables in the centerfold on pages 6 and 7 illustrate the type of pollution that resulted, at least partially, from these releases. Unfortunately, it is impossible at this point to arrive at definitive conclusions regarding the impact these releases will have on

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DEPLETED URANIUM MUNITIONS

The use of depleted uranium (DU) munitions by the United States and its allies in the 1991 Gulf War and again during the NATO-Yugoslavia war has been one of the most controversial of the questions of long-term health and environmental effects of these wars, if not the most controversial. DU is used to make munitions because uranium is a hard, dense metal. DU munitions are radioactive, but they are not nuclear bombs and do not derive their lethality from nuclear reactions. DU is composed almost entirely of uranium-238, which is not fissile and cannot sustain a chain reaction, though it can be fissioned with fast neutrons.

While some have dismissed it as being of little consequence, others have claimed the use of DU munitions is a principal cause or even the principal cause of the variety of ailments that have afflicted Gulf War veterans as well as Iraqi people, especially children, living in areas where there are residues of DU. By extension, questions have been raised about health and environmental effects in Yugoslavia/Kosovo regions where these munitions were also used.

A detailed study of DU, while initially envisaged as part of our study of modern war, turned out to be well beyond our resources. We had to narrow the initial scope of our work from modern war to case studies of precision bombing of two facilities in Yugoslavia. Even in that area, it was very difficult and expensive to complete a meaningful scientific study.

The dismissive school has tended to treat the issue of DU munitions as a simple matter of extending to the battlefield what is known about exposure to alpha radiation and gamma radiation from studies of uranium factory workers or from animal and human experiments of uranium exposure that have been done over the decades. I do not belong to this dismissive school.

The battlefield use of DU munitions is a complex scientific, medical, and legal question. For instance, Dr. Rosalie Bertell has pointed out that DU munitions in flight would burn at very high temperatures, giving rise to fine particles that would have physical and chemical characteristics of ceramic, unlike any uranium compounds, including oxides, found in factory environments where uranium is processed.[1] Ceramic-like DU would be mobilized far more slowly than these other physical-chemical forms of uranium. The biological half-life of ceramic DU particles in the body—that is, the time in which half the inhaled or ingested or incorporated DU would be eliminated from the body—would then be far greater than anything that is now used in radiological dose calculations specified by national or international scientific, regulatory, or advisory bodies. This means that breathing in DU derived from burning munitions would cause a far higher radiation dose than the same amount of DU breathed in, say, in a factory where DU is being chemically processed. Indeed, if the ceramic particle hypothesis, which appears scientifically reasonable to me, is borne out, such DU particles may be expected to behave more like the metal DU shrapnel that is lodged in the bodies of some Gulf War personnel that has been acknowledged by the Pentagon and others to be a problem.

Due to the gamma radiation emitted by DU, personnel having routine or frequent exposure to DU, due to handling of shells for instance, should be treated as radiation workers and properly badged so their doses can be monitored. Unfortunately, such armed forces personnel are not treated as radiation workers, depriving them and their families of an essential source of information about health risks to which they have been and are being exposed.

Battlefield use of DU munitions in Iraq was accompanied by exposure to a variety of other possible sources of health damage, including experimental vaccines, toxics arising from oil field fires, and traces of chemical weapons. In the case of Iraqi children, these problems would be compounded by poverty due to U.S.-led sanctions and to Saddam Hussein's suppression of the Shias, who form the majority in the region where most DU residue is found. A lack of medical treatment and diagnosis would further complicate the problem of detecting the causes of the various diseases that have afflicted both Gulf War veterans and people in the southeastern part of Iraq. U.S.-British bombing of the region since December 1998 adds to the complex picture. Needless to say, the circumstances for independent study are even more difficult in Iraq than they are in Yugoslavia.

The synergisms between a form of uranium with a long biological half-life, a variety of non-radiological exposures, and, in the case of Iraqi children, a host of other troubles, present a truly formidable problem. It appears that the entire range of symptoms and diseases that have been reported could not have been caused solely by exposure to DU. But DU could well have been a contributing factor. The study of synergisms is a complex and neglected issue even in the relatively controlled circumstances of exposure in a factory. The circumstances that prevailed during the 1991 Gulf War in the case of veterans, and during and after that war for the Iraqi people in the region, created a situation where IEER felt that we could not make a useful contribution to the debate beyond the kind of statements made here, some of which I have made in public since these questions first arose.

DU consists mainly of uranium-238, the most common isotope of uranium found in nature. It is a radioactive material that is essentially a waste arising from the manufacture of bombs and from civilian nuclear power. Per unit weight it is about 60 percent as radioactive as natural uranium. Besides being radioactive, uranium is toxic to the kidneys as a heavy metal. DU munitions may very well be illegal under international law because they threaten generations far into the future. In any case, the use of DU in munitions creates risks for generations far into the future and should be outlawed.

In sum, as regards the causes of the health problems, the radiological and many non-radiological aspects of the threats to health and the environment that were present during the Gulf War and its aftermath as well as the NATO-Yugoslavia war must be considered together. The former may be more important in some cases, as for instance, in the case of DU shrapnel lodged in people's bodies; the latter may be the central factor in other cases, like people living near bombed chemical factories; there may be a varying combination of factors in yet others. There may also be diseases or symptoms in which DU is a minor factor or not a factor.

Human beings and ecosystems respond to the ensemble of insults that are being heaped upon them. But our knowledge of these combined effects is still in its infancy. The sums of money needed to resolve these issues would be modest relative to the sums that are being used to wage war and make the tools that rain death from the skies. That they have not been forthcoming is a sad and terrible commentary on where the political will of the powers that be lies today and where it has been for some time past. — Arjun Makhijani

1 Rosalie Bertell, "Host Response to Depleted Uranium," November 2000, on the web at www.iicph.org/docs/host_response_to_du.htm. DU derived from recycled uranium (i.e., uranium that has been irradiated in a reactor) contains small amounts of some fission products (notably technetium-99) and some transuranic radionuclides (like americium-241 and plutonium). These may cause a significant contribution to the total dose to workers during processing of the DU into metal. Most of these impurities would be removed during processing and therefore, in general, tend not be present in significant amounts (relative to total uranium radioactivity) in finished munitions.

public and environmental health. Monitoring programs and health assessments have begun, but these programs are in their initial phases and the data that has been gathered up until this point has not been made available to the public.

Kragujevac

Kragujevac (population 150,000) is an industrial town located in central Serbia and home to the Zastava industrial complex. The complex is actually made up of dozens of smaller companies and it produces everything from heavy machinery to cars and trucks to hunting rifles. At one point, the plant manufactured heavy equipment and arms for the military, but according to factory management that was not the case at the time of the bombings. Before the onset of economic sanctions (which began in late 1991 and continued until September 2001), this was one of the largest industrial facilities in the Balkans and consequently the factory played a huge role in the lives of the city's inhabitants.

The Zastava factory was bombed twice, once on April 9 and again on April 12, 1999, and was hit by a total of 12 bombs.[6] The power station, assembly line, paint shop, computer center, and truck plant all sustained heavy damage or were completely destroyed. As a result, production came to a standstill. Total damage to the complex was tallied at one billion deutsche marks (about US$500 million), according to factory officials. In the year after the bombings, the Milosevic government spent US$80 million to restore production to the car factory. The car factory now has a workforce of about 4,500. At its peak, the workforce was as large as 30,000. At the beginning of 2001, 28,000 cars and 1,400 trucks were planned to be produced that year. This is double the number of vehicles produced in 2000, but much less than from the 180,000 vehicles it produced in 1989. The decrease in production can be attributed to several factors including the break-up of Yugoslavia and the sanctions placed on the country during the Milosevic regime.

Transformers at two locations in the Zastava factory, the paint hall and the power station, were damaged and PCB oil leaked into adjacent areas. In the paint hall, an area used to paint automobiles after they have been assembled, approximately 1,400 liters (2,150 kilograms) of pyralene oil, a transformer oil containing a mixture of trichlorobenzenes and PCBs, leaked onto the floor and into waste pits containing 6,000 cubic meters of wastewater. The transformer in the power station was located near a rainwater drain. Therefore, some of the oil likely leaked into the Lepenica River via the sewer system, but it is not possible to say how much. In addition to these two areas directly affected by the bombings, there are several drums of contaminated sand in the waste storage area that were taken from the gravel pit beneath the transformer in the power station after the bombings. Many drums of waste unrelated to the bombings, which have not been carefully labeled and whose condition is deteriorating, are also stored here.

In the three days after the bombings, the city's Institute for Public Health took 21 water samples around Kragujevac. Toxic chemicals were detected in the samples on the first and second days, but none were detected on the third day. These data were not made available and so we do not know what specific toxins were analyzed. People in the area are worried about possible contamination because some wells in the area were not tested for PCB contamination. There is no evidence to suggest that there was any direct input of PCB into the groundwater pathway. However, flooding that occurred during July of 1999 may have spread pollutants in the waterways to surrounding low-lying agricultural areas.

As a result of a decade of conflicts, lack of openness, economic recession, and other problems in postwar Yugoslavia, it is difficult to make reliable conclusions about the environmental conditions in Kragujevac. Fortunately, the contaminated areas within the factory have been dealt with, as these areas presented the greatest threat to worker health. Inhalation is a major pathway of PCB exposure in occupational settings. The cleaning of the waste pits and the removal of contaminated concrete greatly reduces the amount of worker exposure.

Given the numerous uncertainties and a general lack of data as to how much pollution was released into the environment surrounding the Zastava plant, it is impossible to arrive at any conclusion other than to say that a comprehensive sampling and monitoring mission is urgently needed.

Legal Issues

International law recognizes that "In any armed conflict, the right of the Parties to the conflict to choose methods or means of warfare is not unlimited."[7] The international laws that apply to our analysis of the 1999 NATO use of force in Yugoslavia include the 1949 Geneva Conventions and the Geneva Conventions' Additional Protocol I. All of NATO's member states have signed and ratified the 1949 Geneva Conventions and are bound by their terms.[8] As for Protocol I, all NATO states were members at the time of the bombings except the United States (which is a signatory), France (which joined the treaty in 2001), and Turkey (which has not signed it).

Another source of law relevant to this conflict is customary law. Customary law is based on general and

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TABLE 1: SUMMARY OF POLLUTANTS RELEASED (BURNED, LEAKED OR SPILLED) AS A RESULT OF THE 1999 BOMBINGS IN PANCEVO

Substance	Location	Amount Released (metric tons)	Emission Route
Ammonia	HIP Azotara	250	Waste channel
Calcium ammonium nitrate, phosphates, potassium chloride	HIP Azotara	200 to 300	Most burned, some into channel
Crude oil	HIP Azotara	150	Most burned, some into channel
1,2-dichloroethane	HIP Petrohemija	2,100	50% to channel, 50% to soil
Ethylene and propylene	HIP Petrohemija	1,900	Intentionally burned
Hydrochloric acid	HIP Petrohemija	130	Soil and waste channel
Mercury	HIP Petrohemija	8	7.8 metric tons to soil, remainder to channel
Sodium Hydroxide	HIP Petrohemija	100	Soil and waste channel
Vinyl chloride	HIP Petrohemija	460	Burned
Crude oil and derivatives	NIS Oil Refinery	80,000	75,000 metric tons burned, remainder spilled onto soil

Note for all tables: Pollutant concentrations represent pre-and post-bombing aggregates since it was not possible to separate the two.

For more information and sources of tables 1-5, please see the report, *Precision Bombing, Widespread Harm,* on the web at www.ieer.org/reports/bombing/index.html.

TABLE 2: OIL PRODUCTS RELEASED AS A RESULT OF THE BOMBING OF THE NIS OIL REFINERY IN APRIL 1999

Substance	Estimated Release (metric tons)[a]
Crude Oil	56,300
Fuel Oil	7,500
SCC Gas[b]	6,700
Motor Gasoline	4,500
Gasoline	1,500
Jet Fuel	1,200
Aromatics (e.g. benzene, toluene, and xylene)[c]	400
Diesel	350
LPG (Liquified Petroleum Gas)	200
Other[b]	1,900
Total Crude Oil and Oil products burned/leaked	80,000

a. Attempts were also made to find the ratio of leaked product to burned product for each of these categories. However, the only response given by factory officials was that approximately 75,000 metric tons of "oil products" burned.
b. Many unsuccessful attempts were made at trying to identify the compounds in these two categories. The term SCC is often used as an abbreviation for "Standard Classification Code," an identification number assigned to each specific petroleum product. It could also be a typographical error as the term FCC (fluid catalytic cracking) is used to describe gasoline that has undergone a specific type of refining process.
c. These compounds are often used as petroleum additives during the refining process.

TABLE 3: GROUNDWATER POLLUTION AT HIP PETROHEMIJA

Substance	Maximum concentration (micrograms per liter, µg/l)	U.S. EPA Maximum Contaminant Level (MCL) (micrograms per liter, µg/l)	Factor by which MCL is exceeded
1,2-dichloroethane	7,500,000	5	1,500,000
Vinyl chloride	70,000	2	35,000
1,1,2-trichloroethane	48,000	5	9,600
Dichloromethane	26,500	5	5,300
Trichloroethylene	16,500	5	3,300
Chloroform	100,000	80	1,250
1,2-trans dichloroethylene	85,600	100	860
1,1-dichloroethylene	5,500	7	790
1,2-cis dichloroethylene	29,200	70	420
Tetra-chloroethylene	374	5	75
Chlorobenzene	343	100	3.4
1,1 dichloroethane	95,600	N/A	N/A
1,1,2,2-tetrachloroethane	2,220	N/A	N/A
Tetrachloroethane	40,000	N/A	N/A

Note: Measurements taken in May 2000. N/A denotes that there is no established MCL for that particular chemical. The MCL is the maximum permissible level of a chemical or radionuclide contaminant in water that is delivered to any user of a public water system. MCLs are enforceable standards set by the U.S. Environmental Protection Agency. It is appropriate to use this as a basis of comparison because the EPA has concluded that the MCL is the level at which the public would not be put at unnecessary or unacceptable risk.

TABLE 4: GROUNDWATER POLLUTION AT THE NIS OIL REFINERY

Substance	Maximum Groundwater Concentration (micrograms per liter, µg/l)[a]	U.S. EPA Maximum Contaminant Level (MCL) (micrograms per liter, µg/l)	Factor by which MCL is exceeded
1,2-dichloroethane	66,900	5	13,380
Benzene	9,100	5	1820
Ethyl benzene	5,330	700	7.61
Toluene	4,820	1,000	4.82
Xylenes	11,500	10,000	1.15
PHCs[b]	109,000	N/A	N/A

a. Measurements taken in February 2000.
b. PHC is an abbreviation for petroleum hydrocarbon. There is no regulatory standard for total petroleum hydrocarbons in the United States.

TABLE 5: ESTIMATED GROUND-LEVEL AIR CONCENTRATIONS OF SELECTED POLLUTANTS FROM THE NIS OIL REFINERY FIRES

Substance	Estimated Maximum Concentration (micrograms per cubic meter, µg/m³)	U.S. EPA Air Quality Standard[a] (micrograms per cubic meter, µg/m³)	Factor (range) by which EPA standard exceeded
Particulates	100 to 400	65	1.5 to 6.2
Sulfur dioxide	200 to 800	365	Below standard to 2.2
Nitrogen oxides	50 to 200	100	Below standard to 2.0
PAH[b]	5 to 20	N/A	N/A

a. U.S. EPA ambient air standards are simply used as a basis of comparison. The standards are designed to protect public health, including the health of "sensitive" populations (e.g, asthmatics, children, and the elderly). These are 24-hour averages, limits where the average air concentration over a period of 24-hours cannot exceed the established limit. The conditions in Pancevo could have lasted from a few hours up to a few days depending upon location. It is also important to note that these are not actual measurements, these are calculated estimates done by UNEP/BTF. The standard given for nitrogen is specific to nitrogen dioxide and it is unclear how the nitrogen oxides would have partitioned in the atmosphere. The standard given for particulates is that of small particulates (less than 2.5 micrometers in diameter). The standard for larger particulates (less than 10 micrometers in diameter) is 150 micrograms per cubic meter.
b. PAH is an abbreviation for polycyclic aromatic hydrocarbon

consistent state practice that is followed out of a sense of legal obligation. Customary laws are particularly relevant to this discussion because many of the rules that are codified in the Geneva Conventions and Protocol I are considered customary law; and a state may still be bound by customary laws even if it has not agreed to be a party to the relevant treaty.

Analysis of Treaty Terms

The 1949 Geneva Conventions prohibit states from destruction of property unless it is made "absolutely necessary by military operations." Military necessity is itself a vague term, and states have much latitude to argue that as long as an action reasonably furthered their strategies, then it was a military necessity.

"Military Objective" Requirement.
Protocol I codifies the principal of discrimination, which requires parties to "at all times distinguish between the civilian population and combatants and between civilian objects and military objectives and accordingly [to] direct their operations only against military objectives." Whether the bombings in Pancevo and Kragujevac comply with these terms hinges on the determination of the military objective. What military objective existed in the case of these bombings? One could certainly argue that the oil refinery was providing fuel for military operations, but is this also true of a car factory, petrochemical plant, and fertilizer plant? In interviews, officials in Kragujevac and Pancevo indicated that their plants did not have any direct strategic military value.

The specific criteria by which targets in Yugoslavia were selected have not been released to the public. As noted, the request by to the U.S. Department of Defense for documents outlining the military objective in targeting these plants was denied. The general criteria for U.S. Air Force targeting policy is as follows:

> A target must qualify as a military objective before it can become a legitimate object of military attack. In this context, military objectives include those objects that by their nature, location, purpose, or use make an effective contribution to military action, or whose total or partial destruction, capture, or neutralization offers a definite military advantage. The key factor is whether the object contributes to the enemy's war fighting or war sustaining capability. Consequently, an identifiable military benefit or advantage should derive from the degradation, neutralization, destruction, capture, or disruption of the object.[9]

The Air Force admits that "controversy exists over whether, and under what circumstances, other [civilian] objects…can properly be classified as military objectives." The main factor in determining an object's status is whether "the object makes an effective contribution to the adversary's military action."

Using these criteria, the U.S. Air Force determines objects such as oil depots to be legitimate military targets.[10] However, it also states that "[f]actories, workshops, and plants that *directly* support the needs of the enemy's armed forces are also generally conceded to be legitimate military objectives." (Italics added.) The facts supporting the targeting rationale need to be made public in order to ensure that civilian monitoring of military activities can take place. Serious questions remain about the legality of the bombings of Pancevo and Kragejuvac that cannot be adequately resolved until such facts are known.

"Feasible Precautions" Requirement.
Article 57 of Additional Protocol I requires states to "take all feasible precautions in the choice of means and methods of attack with a view to avoiding, and in any event to minimizing, incidental loss of civilian life, injury to civilians and damage to civilian objects." "Feasible" has been interpreted as "[t]o take the necessary identification measures in good time in order to spare the population as far as possible." Whether these precautions were taken is another factual inquiry that has not been satisfied.

Environmental Protections

In addition to these provisions that are balanced against military necessity, Protocol I offers more specific protections for civilians, their property and the environment. One provision most relevant to the protection of the environment is Article 35 which prohibits the use of weapons that would by their nature cause "superfluous injury or unnecessary suffering" and means of warfare that "are intended, or may be expected, to cause widespread, long-term and severe damage to the natural environment."

Unfortunately, Protocol I does not define what constitutes "widespread, long-term, and severe." These terms also appear in a treaty on environmental modification (ENMOD),[11] and were later interpreted for the purpose of that treaty. Although these definitions were not intended to apply to Protocol I, they can offer some guidance:

(a) 'widespread': encompassing an area on the scale of several hundred square kilometers;

(b) 'long-lasting': lasting for a period of months, or approximately a season;

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(c) 'severe': involving serious or significant disruption or harm to human life, natural and economic resources or other assets.[12]

Attacks on industrial facilities such as those described in our report appear to be prohibited applying these criteria. Damage was widespread because air pollution that resulted from the bombings in Pancevo traveled up to hundreds of kilometers to Xanthi, Greece. The effects are long-lasting because the half-lives of some of the chemicals in question are on the order of decades. Finally, the effects of the attacks could be considered severe because of the economic disruption that resulted from the bombings and the potential damage to waterways around and adjacent to the facilities.

Protocol I also flatly prohibits attacks on a list of works or installations that contain dangerous forces: dams, dykes and nuclear electrical generating stations, "if such attack may cause the release of dangerous forces and consequent severe losses among the civilian population." (Article 56) This provision also prohibits attacking other military objectives located at or in the vicinity of these works that would pose these same risks. Chemical plants are not listed among the protected works or installations, so the bombings would not violate these terms. However, the principle underlying this provision is to protect installations containing dangerous forces, and a strong argument can be made that the chemical plants pose a danger similar to the named facilities because, in some cases, the persistence and health risks from chemicals are comparable to, for instance, radionuclides. If attacking chemical plants creates the same risks as attacks that are specifically prohibited under the treaty, it is likely that they would be considered widespread, long-lasting and severe, and thus violate other treaty provisions mentioned above.

The Pancevo bombing may also have violated Article 56 because it posed some risk to a nuclear power plant located in a non-combatant country, Bulgaria. Six nuclear power reactors are located in Bulgaria at the Kozloduy station, which is downriver from Yugoslavia along the Danube. The potential exists for operational problems if contaminants in the Danube interfere with the condenser cooling systems of the power plant. The risk of disruption of nuclear power plant operation and the elevated potential for an accident as a result of spilling oil into the Danube was known at the time. IEER raised the issue in a press release on May 11, 1999, while the bombing was going on.[13]

Analysis of Customary Law

Although our analysis shows that the bombings likely violated several terms of Protocol I, the United States, which was the principal executor of the bombings, has not ratified the treaty, and thus is not bound by its rules. These restrictions only apply to the United States if they can be also considered as protections guaranteed by customary law.

The United States has acknowledged that many of the general protections of civilians are customary law, however, it does not regard Protocol I's environmental protections as such. Despite U.S. objections, these environmental protections are widely regarded as customary law. The environmental provision of Protocol I was reiterated in a 1980 treaty on certain conventional weapons;[14] environmental protections during armed conflict were codified in the statute creating the International Criminal Court, and were acknowledged as an existing norm by the International Court of Justice.

For the United States to remain unbound by a customary law, it must have consistently objected to the existence of the rule, which the United States might argue that it has done. However, in some instances, customary laws become sufficiently universal that they develop into a type of peremptory norm to which a state cannot object.[15] It may be premature to consider the norm to have reached this 'peremptory' status. It is clear, however, that a shift of understanding has occurred in recent years that due consideration must be given to protection of the environment during warfare. We believe that the United States, as the leading economic and military power, should hold itself to these standards, and should adhere to the prohibition of weapons and means of warfare expected to cause severe damage to the environment.

Another consideration in holding NATO countries accountable for damage caused in the bombings in Pancevo and Kragujevac is that, at the time, 16 of the 19 NATO members were parties to Additional Protocol I. Assuming that the United States was the principal perpetrator of the bombings in Pancevo and Kragujevac, those NATO members that directly or indirectly assisted in these bombings may be liable under the theory of aiding and abetting to the extent that they were aware of the U.S. actions.

The authority for NATO's use of force

Apart from the specific issues of the methods of warfare, the bombings in Yugoslavia raised a broader question of whether NATO had the authority to use any type of force in Yugoslavia. NATO's air campaign over Yugoslavia was criticized by several parties as an unlawful use of force because it had neither been authorized by the UN Security Council, nor was there any armed attack on the NATO states that would justify individual or collective self-defense. According to the UN Charter, those are the only two circumstances in which use of force is permitted. At heart, the

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"justification" for the intervention was not legal but humanitarian: even if international law did not permit the use of force, it was tolerated because the actions were designed to address a grave humanitarian crisis. There may be value in a system that does not force states to sit idly in the face of such crises, but there is also an interest in preserving restraints on the use of force so that the international system established to maintain security is not eroded.

Recommendations

IEER's recommendations regarding the legal and environmental impacts of modern war are summarized below. We direct them at NATO, the U.S. government, and concerned nongovernmental organizations and individuals.

1. The entire issue of bombing civilian facilities to accomplish military objectives needs to become the subject of a rigorous public inquiry. Such an inquiry must consider immediate and long-term environmental and health damage that could be inflicted on a country or in neighboring countries that share ecosystems with the countries at war.
2. Environmental cleanup of past bombings of civilian industrial facilities, like Pancevo and Kragujevac, needs to be expedited so as to close the time gap between the conflict and remediation.
3. Information regarding Pancevo and Kragujevac and other bombings of civilian industrial facilities should be available to the public for legal review.
4. Until such time as the United States recognizes the legal prohibitions on environmental damage during wartime, which have been adopted by all but one other NATO country (Turkey), the United States should conduct no bombings of civilian industrial facilities containing any dangerous substances likely to be released into the environment.
5. Extensive and on-going monitoring programs should be established to ensure that the cleanup in Yugoslavia is effective and that sources of pollution do not remain in the environment.
6. The cleanup process in Yugoslavia should be more transparent.

1. Nicole Deller, J.D. is a legal research consultant to IEER, and is co-author and principal editor of *Rule of Power or Rule of Law? An Assessment of U.S. Policies and Actions Regarding Security-Related Treaties* (New York: Apex Press, 2003).
2. Sriram Gopal and Nicole Deller, *Precision Bombing, Widespread Harm: Two Case Studies of the Bombings of Industrial Facilities at Pancevo and Kragujevac During Operation Allied Force, Yugoslavia 1999*. Takoma Park, Maryland: Institute for Energy and Environmental Research, November 2002. On the web at www.ieer.org/reports/bombing/index.html.
3. NATO's first offensive operation was Operation Deliberate Force, which was conducted in Bosnia from August 29 to September 14, 1995.
4. The other two hot spots are Novi Sad and Bor. Novi Sad, a city of one million, is home to a major oil refinery where bombings led to the spilling into the soil/onto the banks of the Danube river and burning of thousands of tons of oil upstream of the city's municipal water extraction point. Bor is an industrial site that serves a variety of industries, including a copper mine, smelting plant and an oil depot.
5. One metric ton is 1,000 kilograms, which equals 2,205 pounds.
6. According to UNEP reports, the bombings occurred on April 9 and 12. According to factory representatives, they occurred on April 9 and 10.
7. Additional Protocol I of the Geneva Conventions, Article 35 (1); also recognized as a principal of customary law.
8. For the United States, treaties are the supreme law of the land along with the Constitution and federal laws. (Article VI of the U.S. Constitution, 1787).
9. United States Air Force. *Air Force Pamphlet 14-210: USAF Intelligence Targeting Guide*. Falls Church: U.S. Department of the Air Force, 1998, p. 12.
10. For example, a theater objective in Iraq during the 1991 Gulf War was to sever Iraqi supply lines by destroying key electrical grids and oil storage.
11. The Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques. Geneva, 18 May 1977. Available from www.unog.ch/disarm/distreat/environ.pdf.
12. These definitions are not part of ENMOD but are part of the negotiating record included in a report to the UN General Assembly in 1976. See www.icrc.org/ihl.nsf/WebFULL?OpenView&Start=59.
13. "NATO Bombing in Balkans Could Result in Widespread Ecological Disaster, Environmental Group Warns." May 11, 1999. Available from www.ieer.org/comments/yugo/pr051199. Also see "Ecological and Health Implications of NATO Bombing in Yugoslavia" and "Nuclear Dangers in Light of the Balkan Crisis," both in *Science for Democratic Action*, volume 7 number 4, July 1999.
14. The Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects, Geneva, 1980. Available from untreaty.un.org/ENGLISH/bible/englishinternetbible/partI/chapterXXVI/treaty2.asp.
15. A clear example of a recognized peremptory norm is the prohibition of genocide. No state can practice genocide even if it has objected to the prohibition as binding customary law.

North Korea, the United States and Nonproliferation

In 1985, North Korea ratified the Nuclear Nonproliferation Treaty (NPT) as a non-nuclear weapon state. Under the terms of the NPT, North Korea was prohibited from manufacturing or acquiring nuclear weapons or other nuclear explosive devices and was required to accept safeguards as set forth in an agreement with the International Atomic Energy Agency (IAEA) to ensure against diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.

North Korea entered into a safeguard agreement in 1992. Subsequent IAEA inspections suggested that North Korea had not made a full declaration of the fuel rods containing plutonium that it had withdrawn from the graphite-moderated reactor.

In the early 1990s, North Korea completed a new reprocessing line that gave it the capacity to separate plutonium, which led to greater concern on the part of the IAEA. The total amount withdrawn from the reactor in the late 1980s outside of safeguards may contain enough plutonium for one to two nuclear bombs, but to date, there is no firm information on (1) whether this plutonium has been separated, (2) whether enough plutonium has been separated to make a nuclear weapon, and (3) whether one or more nuclear weapons have actually been fabricated.

In 1993, North Korea refused to allow the IAEA to inspect its nuclear facilities and in March 1993, announced its withdrawal from the NPT. The United States and North Korea began high-level negotiations and arrived at a preliminary understanding as early as June 1993. North Korea suspended its withdrawal, and inspections resumed. A new breakdown ensued in 1994, when North Korea refused to allow inspectors to investigate certain nuclear facilities. Talks with the United States continued and ultimately resulted in the 1994 Agreed Framework.

The principal question raised by the recent turn of events has been what the United States can do to ensure compliance by North Korea. Of equal importance, both to the specifics of the Korean situation and for the continued relevance of the NPT, is what can the United States do to ensure compliance with its obligations?

For more information on North Korea, the United States, and nonproliferation, see "Compliance Assessment of North Korean and the U.S. Obligations under the Nonproliferation Treaty and 1994 Agreed Framework" on the IEER web site at www.ieer.org/reports/treaties/nkorea.html.

TIMELINE

1980-1987: North Korea builds a nuclear reactor, which is gas-cooled and graphite moderated, ostensibly for power but which can yield a theoretical maximum of 15 kilograms of plutonium every two years – about three nuclear bombs worth.

1985: North Korea ratifies the NPT.

1989: North Korea withdraws some fuel rods from the reactor. It may have as much as one to two nuclear bombs equivalent of plutonium as a result of reprocessing these fuel rods.

1992: IAEA inspections begin and North Korean declarations are found to be false.

EARLY 1990s: North Korea acquires reprocessing capacity, i.e. the capacity to separate plutonium from irradiated fuel.

1993: North Korea threatens to withdraw from the NPT. In June the US and North Korea sign an agreement in principle that is formalized in 1994. North Korea does not withdraw.

1994: Agreed Framework signed. North Korea shuts down reactor and suspends construction of two others then in progress.

MID-TO LATE 1990s: North Korea begins to acquire capability to fabricate uranium enrichment centrifuges. US provides aid but normalization of trade and security guarantees are not forthcoming.

1998: North Korea tests a medium-range missile.

LATE 1990s: Nuclear reactor construction progress stalled. New disputes with the United States.

1999: North Korea agrees to suspend missile testing.

DECEMBER 2001: US Nuclear Posture Review names North Korea as a possible target, in violation of the Agreed Framework.

JANUARY 2002: President Bush names North Korea one of three countries in the "axis of evil."

LATE 2002-EARLY 2003: North Korea uranium enrichment efforts revealed, with possible cooperation of Pakistan. US suspends fuel oil shipments and states that the Agreed Framework must be revisited. North Korea states intention to restart reactors, throws out IAEA inspectors and takes down inspection cameras, announces immediate withdrawal from the NPT and makes threats of war if the UN or the United States imposes sanctions.

Excerpted from the briefing paper, "Compliance Assessment of North Korean and U.S. Obligations Under the Non-Proliferation Treaty and 1994 Agreed Framework," by Nicole Deller, Arjun Makhijani, and John Burroughs (January 24, 2003). On-line at www.ieer.org/reports/treaties/nkorea.html

Sharpen your technical skills with Dr. Egghead's Atomic Puzzler

Dr. Egghead and his cat, Alpha, have been appointed to a United Nations inspection team (you didn't know that felines could be members of UN inspection teams, did you?) that is examining industrial facilities in a hypothetical country that have been repeatedly bombed. They have developed four mathematical problems based on the data they have gathered during their investigation. Can you work them out? Answers to the two additional questions can be found in the main article that begins on page one.

1. During the bombings, a mercury tank was struck and 400 kilograms of mercury were spilled into a nearby waterway. The maximum contaminant level for mercury set by the U.S. Environmental Protection Agency (EPA) is 2 micrograms per liter (µg/l). Assuming even distribution of the mercury, how much water would it take to dilute this amount of spilled mercury to acceptable limits? *(Hints: There are one million micrograms (µg) in one gram (g). There are 1,000 grams in one kilogram (kg).)*
2. The mercury content of the groundwater beneath the destroyed tank was measured to be 450 µg/l. By what factor does this exceed the EPA maximum contaminant level?
3. In a separate section of the factory, groundwater was contaminated by a spill of 1,2-dichloroethane. In the 18 months following the bombing, the contaminant plume had migrated 250 meters. What is the rate of migration in terms of meters per year (m/yr)?
4. An oil refinery near the industrial complex was also bombed and 50,000 metric tons of oil burned. Assuming that 30 grams of sulfur dioxide are produced for every kilogram of oil burned, how much sulfur dioxide would be generated in the fire (in metric tons)? *(Hint: one metric ton is equal to 1,000 kg.)*
5. True or false: The United States has ratified Additional Protocol I to the Geneva Convention.
6. The first offensive operation ever conducted by NATO was:

   a. Vietnam c. Bosnia
   b. Kosovo d. Iraq

Answers to Atomic Puzzler from SDA vol. 11 no. 1, November 2002:

1. a) 8% b) 1.5% c) 5.1% d) 4 e) 16
2. a) 9.5% b) 2.5% c) 6.6% d) 19 e) 14
3. a) 28% b) 14% c) 22% d) 40 e) 57

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