

## Chapter X

# The Environmental Threat of Military Operations

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**T**he Gulf War created one of the largest single man-made disasters in history, oil fires greater in number than all previous well fires added together, and slicks more than two to three times the size of the world's previously largest oil spill. Damage to the coastal and desert ecology of southern Iraq, Kuwait, and Saudi Arabia—from the fires and spills, from military fortifications and land mines, from attacks on oil and petrochemical installations, and then from intense operations by two of the largest tank armies ever assembled—produced widespread destruction and disrupted a fragile balance. Routine movements and encampments produced solid waste on a huge scale. Oil fires produced historically unequaled emissions of hydrocarbons. An otherwise vibrant and fertile Euphrates River valley was damaged by a breakdown of irrigation and agricultural systems, and continues to deteriorate due to ongoing Iraqi ecocide practices in response to insurgency.<sup>1</sup>

Environmental damage provoked a torrent of speeches, legal briefs and journal articles, conferences and meetings; intense lobbying by environmental and humanitarian organizations; was the subject of proposals for a “Fifth” Geneva Convention and other new protections; was discussed extensively in the Sixth Committee of the United Nations General Assembly in 1991 and 1992; deliberated by an International Committee of the Red Cross (ICRC) Experts Group; on the agenda at the United Nations Council for Economic Development (UNCED); considered in the U.S. Government’s review of Iraqi war crimes; and included in the Pentagon’s final report to Congress on conduct of the war. “Data” about the oil spills and fires even has its own place on the Internet.

On the surface, all the huffing and puffing has produced little. Before the war, the Bush Administration in National Security Directive 54 (NSD-54) designated destruction of Kuwait’s oil resources as one of three “unconscionable acts” (along with the use of chemical and biological weapons and acts of international terrorism) for which the Iraqi leadership would be held personally responsible. President Bush’s eleventh hour letter to Saddam Hussein forcefully threatened a “terrible price” in retaliation.<sup>2</sup>

Governments such as Jordan were early doomsayers about the environmental threat, agitating strongly for action after the war. But politics intruded and they

subsequently retreated, not wanting to condemn their resilient and powerful neighbor. Nor did Kuwait or Saudi Arabia formally “charge” Iraq. Neither wanted to further fan the flames, nor potentially open up their own half-hearted clean-up efforts and environmental practices to greater outside scrutiny.

Yet war crimes have not been pursued and since Operation Desert Storm, U.S. Government lawyers (and those of most other developed nations) have argued that the problem is neither scope nor shortcomings in international law but compliance and enforcement of existing law.<sup>3</sup> International “political-strategic” considerations thus take priority over protection of the environment. In this regard, it could be said that advances of the last two decades in environmental accountability have been superseded by a version of “supreme national interest.” Which is to say, if a credible scenario for reverberating environmental destruction on a global scale could be postulated, then likely the conduct of warfare would take precedence over the potential widespread harm.

The environmental calamity and lack of formal legal action in the Gulf War may thus seem an odd context in which to claim that environmental protection has advanced, yet the true story of the war is one of a high degree of sensitivity to environmental destruction by both sides, and at least by one, significant self-imposed constraints, many corresponding to the very restrictions that Coalition government lawyers eschew. The environmental issue was “used” by both sides in a cynical way, but public visibility of the environmental dimension of warfare was also highly influential. Though Iraq’s destruction went unpunished, if there is a silver lining, it is that it and other environmentally destructive practices that Pentagon lawyers otherwise condone have essentially become “outlawed” in common practice.

For the American side, much of the history regarding political constraints on air power and ground operations remains shrouded in secrecy. The reason seems obvious: Government lawyers and military planners have little interest in seeing public expectations codified as new combat doctrine, policy, or law.

I remember having an argument with a military lawyer in 1992 as to whether the U.S. Marine Corps even used napalm in the air war. The lawyer asserted that they did not, and I told him that I had Marine Corps documents specifying how many and by which airplanes. His denial is instructive about the real impact environmental and humanitarian considerations have on US military operations. Though napalm is not an “illegal” weapons *per se*, its employment for particular purposes probably no longer is possible without provoking negative publicity. So public announcements of its use are suppressed, even denied.

Napalm was “tried” as a weapon in the Gulf War, as were fuel air explosives, mostly to aid in the breach of Iraqi defenses and to overcome minefields and fire trenches. For these purposes, the weapons did not make much of an impression, and their value to commanders in comparison with other weapons did not exceed

the potential public outcry that might have resulted from their use, particularly as anti-personnel weapons (even against enemy soldiers).

The use of napalm is just one example of where the gap between political/public-relations constraints and “legal” constraints seems to be growing. The result can be strange justification for the “need” to bomb targets that are otherwise politically stigmatized. Take dams for instance. Though legitimate targets,<sup>4</sup> because of their potential for unleashing enormously destructive forces on the civilian population, they acquired political sensitivity through the Korean and Vietnam wars, so much so that their attack is generally restricted even in U.S. military doctrine.<sup>5</sup>

The bombing of Iraqi dams was suggested early on as a punitive measure, potentially in response to the use of chemical weapons, but was rejected.<sup>6</sup> No prohibitions *per se* against hitting hydroelectric power stations collocated at dams were incorporated into Operation Desert Storm rules of engagement. Nevertheless, military lawyers argued that in such attacks, dams and dikes would have to be avoided “for humanitarian/political reasons.” Little more arose on the subject until after the war. Then the same lawyers counseled that dams and dikes *should be bombed in future conflicts*, lest the option to bomb them be lost in some legal prohibition that merely follows common practice.<sup>7</sup>

The cases of napalm and dams are instructive. For regardless of official “legality,” there are a set of weapons and targets that now seem to be particularly “controversial,” receiving a disproportionate degree of attention in the news media, and within the humanitarian community. Weapons include napalm, fuel air explosives, depleted uranium, cluster bombs, anti-personnel mines, riot control agents, incendiaries, and blinding lasers. Targets that have acquired negative reputes, mostly because of adverse human or environmental effects, include water, dams, nuclear power plants, electrical power, oil and petrochemical facilities, as well as other civilian utilities.

It is important to establish from the beginning that the environment does not just mean trees, or birds, or water. It is the natural surroundings that support human life. Within the intricacies of international law and practice, environmental protection is increasingly and inextricably a part of human rights law: “It is now recognized that personal growth and happiness—fundamental human rights—cannot be achieved in a severely damaged environment.”<sup>8</sup>

Some theorists in the military—prophets of “information” or “parallel” warfare—assert military benefit behind the reverberating impact of destruction of interconnected systems. Yet loss of electricity (or computer networks) is not just relevant for its speculative second- or third-order potential to disable air defenses and command and control. The first order effect on water purification and distribution, and the resulting environmental and direct harm to human health, is of greater consequence.

In this paper, I examine more closely three environmental issues which bear upon the conflict between the ethic of protection and military necessity. In the case of oil fires and spills, I argue that the lack of international action to hold Iraq responsible weakens the existing standards of protection. I argue that the reason for lack of action on the part of the United States is that responsibility for the oil damages proved more complicated than the popular charge of "environmental terror" suggested. In the case of destruction of electricity, I argue that the concept of "collateral damage" needs to be expanded, given the ability of military technology to limit direct but not indirect effects of destruction on systems indispensable for the survival of the civilian population. I then look at the set of stigmatized weapons and speculate that their reputation is born not just of particular cruelty or suffering, but because of a sense of their "toxicity" and long-term damage. The emotional debate regarding the "Gulf War syndrome" should prove instructive with regards to the many unknowns and risks that lurk behind new technology. In fact, the public conscience seems a finer gauge of the "legality" or "desirability" of new weapons than does the formal review process undertaken by Pentagon lawyers.

#### Spills, Fires, and Dilution of International Law

Environmental damage in the Gulf War occurred both as a result of acts of deliberate destruction and malice, and as an unintentional byproduct of military activity. The vast majority of the fires and spills were the result of Iraqi sabotage of Kuwait's oil industry. But Coalition military action contributed.<sup>9</sup>

In December 1990, Iraqi engineers detonated six oil wells and ignited basins of oil in Kuwait, practicing procedures for the subsequent larger scale destruction. Iraq then packed wellheads with plastic explosives, linking them together with electrical and mechanical detonators. On 21 January, less than a week after the start of the air war, 60 wells in and around Al Wafrah in southern Kuwait were exploded. At about the same time, refineries and storage tanks at Mina ash Shuaybah and Mina Abd Allah, on the coast south of Kuwait City, were also set ablaze. On the eve of the ground war, on or about 22 February, Iraq started to detonate the remaining wellheads, the majority centered in the Al Burgan oil field south of the Kuwait International Airport.

In all, Iraq destroyed 732 wells,<sup>10</sup> 20 oil and gas gathering stations,<sup>11</sup> and damaged four refineries,<sup>12</sup> as well as downstream oil facilities such as gathering manifolds, tank farms, pipelines, and offloading facilities. Two of four natural gas booster stations were also damaged. Of the 732 sabotaged wells, 650 were set aflame, and 82 were damaged sufficiently to cause them to gush oil uncontrollably.<sup>13</sup>

Fires, as well as large amounts of oil exposed to the natural environment, created noxious gases and massive amounts of inhalable particles. At the height of the fires, the amount of soot emitted was estimated at 5000 tons per day, the equivalent

of 46 million heavy-duty diesel trucks, roughly nine times the number in the United States, driving at 30 miles per hour.<sup>14</sup> The last well fire was extinguished on 6 November 1991. But that is not the end of the story.

What really happened in the rapidly moving and confusing war? On the first morning of the air war, U.S. Navy planes bombed an Iraqi oil platform and loading terminal in the northern Gulf at Mina Al Bakr, evidently creating the first oil slick. On the seventh day of the air war (23 January), U.S. Navy aircraft struck the Iraqi tanker *Amuriyah* while underway in the northern Gulf, as it was refueling a *Winchester* class air-cushioned landing craft. The resulting secondary explosions destroyed the tanker. That same day, an *Al Qadisiyah*-class tanker moored on the coast of Kuwait was also destroyed by French aircraft. Two days later, two oil slicks were reported in the Gulf, one in the vicinity of where the *Amuriyah* was sunk, and the other at the Sea Island terminal off the coast of Kuwait. Intelligence analysts believed the second slick had been started by Iraq, and oil from the terminal quickly extended down the coast of Saudi Arabia.

On 25 January, U.S. Navy units engaged an Iraqi mine-laying vessel near the Sea Island terminal, setting a part of the terminal and surrounding water afire. Another oil slick was identified further north on the Kuwait coast on 26 January. It was evidently the result of Coalition bombing of the Ras al Qulayah naval base and surrounding facilities. Oil continued to leak from the Mina Al Bakr terminal and the *Amuriyah* tanker nearby. On 27 January, U.S. Navy aircraft engaged two additional tankers riding high in the water northeast of the Bubiyan Island channel. Both tankers were struck and one was later reported aground and leaking oil on the north bank of the Khorr Abd Allah. A pipe on the southern tip of Bubiyan Island, originating in the Rawdatayn oil field in northern Kuwait, was also observed leaking oil, evidently from Coalition bombing. The tanker *Hitin* was reported on fire at the Mina Al Ahmadi north pier on 28 January. On 2 February, intelligence observers reported that a slick emanating from the northern Gulf was growing larger; origin unknown.

I go through this somewhat confusing and highly abbreviated chronology because the official story looks very different. What the public heard during the war was that around 19 January, Iraq opened valves at the Sea Island terminal, pumping oil directly into the Gulf. Soon after the start of allied military action, moored Iraqi tankers south of Kuwait City also supposedly began discharging oil into the Gulf. There is no mention of their being bombed, or of other tankers being targeted. The Saudi oil storage facility and refinery at Al Khafji, just south of the Kuwaiti border, was shelled by Iraqi artillery, and it began to leak oil. Saudi oil platforms were damaged by drifting Iraqi sea mines. Later, Iraqi tankers anchored northeast of Bubiyan Island also began expelling oil, but again no mention of the attacks by Coalition aircraft. Damaged Kuwaiti refineries and oil tanks along the coast are not

revealed. Many of these were the objects of aircraft bombing and intense naval gunfire. The combined spill was eventually, estimated at 7-9 million barrels.

The considerable fallout from the oil-fire smoke plume immediately effected public health, and ultimately damaged significant land and water areas. Because the plume remained between 1500 and 13,000 feet, and was never detected above 18,000 feet, the global spread in the upper atmosphere was minimized. Nevertheless, smoke had a regional climatic effect—area surface temperatures were below normal by as much as 10 degrees Fahrenheit in 1991. There was a decline in agricultural productivity in the region, as well as increased animal mortalities due to ingestion of oil-tainted vegetation. Oil continued to leak into the Gulf from a number of sources until late May or early June, adding as much as one-half million barrels beyond the end of the war. Eventually, oil fouled 400 miles of Saudi coastline, inundating salt marshes and tidal areas with oil, and killing marine life and diving birds.

There is little evidence that Coalition attacks on tankers or oil targets balanced military necessity against whatever environmental damage might occur. But the bombing of tankers was an internally controversial matter. Indeed, while some planners and commanders outside the Navy argued that tankers were off limits, the top Navy commander argued that they were as legitimate as electrical power or other civilian utilities.<sup>15</sup>

In the end, Iraqi environmental destruction dwarfed the various U.S. contributions, but war crimes were not pursued for various forensic reasons, and the full story of the destruction of oil could not be told for fear of implicating the United States. Pentagon lawyers asserted that the 1977 Environmental Modification Convention (the ENMOD Convention),<sup>16</sup> and 1977 Additional Protocol I to the Geneva Conventions<sup>17</sup> “were not legally applicable in the Persian Gulf War.”<sup>18</sup> What is more, they concluded that even had Additional Protocol I been in force, the damage would not have applied because it did not reach the required legal threshold.<sup>19</sup> The U.S. Government even stated in its environmental report to Congress that Iraqi actions “were probably done to slow or prohibit an amphibious landing of Coalition forces in Kuwait and Saudi Arabia,”<sup>20</sup> thus giving credence to future justifications of environmental destruction as having military purpose. However, as all the evidence shows, the Iraqi actions were acts of pure destruction where the military implications were secondary or even inadvertent. The Iraqis knew that they were destroying the environment. Indeed, there is evidence to indicate that they thought that their actions would have an even greater impact.

### Destruction of Electricity and Redefining Collateral Damage

Before the Gulf War, destruction of electrical power production in warfare had been pursued with varying effects yet with identical results: The nullification of electrical energy was a minor, if not inconsequential, incumbrance to military

operations. Though some argue that the Gulf War was a significant departure from previous experiences, the military impact seems to be no different than World War II, Korea, or Vietnam. Sufficient damage was done to the national grid to essentially cause a nationwide blackout within a week of the U.N. deadline, but military capabilities powered by central electrical grids were also the object of intense direct attack and they were degraded mostly because of that direct bombing, not because they lost power. Coalition electronic warfare and countermeasures efforts, and suppression of enemy air defenses (SEAD) directed against modern electronic accoutrements of war were also unprecedented in their scope and intensity, further diminishing the unique and circumscribed impact (“non-lethal”) of destroying electrical power.<sup>21</sup> Though the destruction of electricity was pursued honestly as a means to effect Iraq’s air defenses and command, control, communications, and intelligence (C3I), and may have helped to paralyze Iraqi armed forces, the civilian impact outweighed the military benefit.

Iraqi electricity was largely cut throughout the country starting from the first night of the war (17 January) and production did not resume until the late March-April time frame. Iraqi officials state that allied bombing knocked out 75 percent of the country’s electrical generating plants. Unanticipated by air planners,<sup>22</sup> the civilian life-support system was brought to a halt, and everything from heating and air conditioning; to water supply, purification and sewage treatment; to medical care was interrupted. In March 1991, United Nations envoy Martii Ahtisaari reported on the civilian effects of electrical bombing:

The role of energy in Iraq is especially important because of the level of its urbanization (approximately 72 per cent of the population lives in towns and cities), its industrialization, and its prolonged, very hot summers.

Ahtisaari’s U.N. field mission found that, “all previously viable sources of fuel and power (apart from a limited number of mobile generators) . . . are now, essentially, defunct . . . . Additionally, there is much less than the minimum fuel required to provide the energy needed for movement or transportation, irrigation, or power generators to pump water and sewage.” Iraq’s biggest recovery problem in the post-war period was the destruction of its energy and power resources—“an omnipresent obstacle to the success of even a short-term, massive effort to maintain life-sustaining conditions in each area of humanitarian need.”<sup>23</sup> “Iraq in recent years had become a high-tech society dependent on electric power generation for irrigation, medical services, communications and industry,” another early field report concluded.<sup>24</sup>

Electrical bombing proved one of the most controversial aspects of Gulf War bombing,<sup>25</sup> and the Defense Department, in its Final Report to Congress on the

Conduct of the Gulf War, explained the purpose and reasoning behind the attacks. The destruction of electricity, it said,

had a cascading effect, reducing or eliminating the reliable supply of electricity needed to power NBC weapons production facilities, as well as other war-supporting industries; to refrigerate bio-toxins and some CW agents; to power the computer systems required to integrate the air defense network; to pump fuel and oil from storage facilities into trucks, tanks, and aircraft; to operate reinforced doors at aircraft storage and maintenance facilities; and to provide the lighting and power for maintenance, planning, repairs, and the loading of bombs and explosive agents. This increased Iraqi use of less reliable backup power generators which, generally, are slow to come on line, and provide less power. Taken together, the synergistic effect of losing primary electrical power sources in the first days of the war helped reduce Iraq's ability to respond to Coalition attacks. The early disruption of electrical power undoubtedly helped keep Coalition casualties low.<sup>26</sup>

It was a laundry list of potential and postulated effects, but not a report of observed or provable impact.

From the beginning, the military recognized the intimate connection between destruction of electricity and the livelihood of the civilian population. "Because of our interest in making sure that civilians did not suffer unduly," General Norman Schwarzkopf stated on 30 January, "we felt we had to leave some of the electrical power in effect, and we've done that."<sup>27</sup>

Air war planners made attempts to limit the overall impact of shutting down the electrical system on the civilian population, focusing targeting on distribution as opposed to generation subsystems, and limiting the amount of destruction at harder to repair generating facilities. Because of confusion in the target guidance and the normal fog of war, the limitations were not followed. In addition, planners were wrong in their assumption of rapid U.S. or international intervention because of Iraq's defeat to repair the utility. The effect on the civilian population was unprecedented.

The Gulf War Air Power Survey (GWAPS) concluded that nullification of electrical power was achieved with "remarkably little collateral damage."<sup>28</sup> Collateral damage, here defined as incidental and unintended civilian casualties sustained in the course of attacks, was indeed extremely low. Ignored, however, is the far more injurious secondary collateral damage caused by *accurate* attacks. The air war spared Iraqis from the indiscriminate effects of urban bombing, yet efficiently disabled society's support systems, with the attendant short- and long-term impact. Civilian harm was compounded by the fact that civilians were otherwise spared the direct effects of bombing in the highly discriminate "strategic" bombing campaign. The result magnified the electrical effect.

Electricity is so important to modern societies that attacks that could have severe effects on the noncombatant population should be prohibited. The U.S.



government accepts as customary law, as codified in Additional Protocol I, the prohibition on the deliberate starvation of civilians, and the intentional destruction of food, crops, livestock, and other objects indispensable to their survival. The U.S. also does not object to Article 54 of Additional Protocol I which protects “drinking water installations.”<sup>29</sup>

But these restriction do not extend to destruction of installations that could result in identical secondary effects. Thus, the destruction of dual-purpose power grids are not restricted from attack. The ICRC list of categories of objectives of “generally recognized military importance” created in 1956 included:

installations providing energy mainly for national defense . . . plants producing gas or electricity mainly for military consumption.<sup>30</sup>

The U.S. defended the right to attack integrated power grids as legitimate targets throughout the negotiation of the Additional Protocols.<sup>31</sup> U.S. negotiator Ambassador George Aldrich noted that “of course we knew about power grids and of course we were not going to agree to a provision that prohibited attacks on key elements of power grids.” Aldrich says attacks are allowed on power stations—including nuclear reactors—that service central grids because the grid itself is an example of “regular, significant and direct support of military operations” as defined under Additional Protocol I.<sup>32</sup>

Yet proof of “definite military advantage” required by the customary law definition of Article 52 of Additional Protocol I is difficult. Writing recently in *The Journal of Strategic Studies*, a former “Checkmate” Gulf War planner concludes that while the destruction of the Iraqi electric grid

almost certainly had a significant impact on several key Iraqi subsystems, the specifics are still unknown. Until we get much greater access to Iraqi officials and documents we will not know how badly the loss of the electric grid hurt the Iraqi C3 network, its NBC research and development complex, or air defense system.<sup>33</sup>

The author argues in the forthcoming “Power Failure: Destruction of Electricity in the Gulf War,” based upon extensive research in Iraq, that in fact destruction of electricity had negligible military advantage for the United States.

Indeed, destruction of any target must also be shown not to be “excessive” in relation to whatever military advantage is being sought. Destruction of civilian electrical power generation is thus a violation of the prohibitions in customary international law against “any military operation which is not directed against a legitimate military target or which can be expected to cause incidental death, injury or damage to civilians that is clearly excessive in relation to the direct military advantage of the operation.”<sup>34</sup>

### Toxicity on the Battlefield

The Gulf War witnessed the most extensive and widespread use of submunitions in the history of conflict, the first combat use of depleted uranium weapons, and large-scale mining both on land and at sea. The result was a significantly increased explosive ordnance disposal and battlefield remnants problem.<sup>35</sup> Ironically, while Iraqi use of mines and the land mine problem has received the majority of attention, cluster bombs were far more injurious and damaging, and depleted uranium far more emotionally and symbolically important.

Cluster bombs and land mines (often called “grenades” in ground-delivered weapons and “bomblets” in air-delivered weapons)<sup>36</sup> are nothing new, and they hardly received the attention in the Gulf War reserved for smart weapons. Most people are even unaware of what submunitions are, let alone that they constituted a quarter of the weapons dropped by aircraft. Some 61,000 were expended, totaling some 20 million bomblets (Table 1).<sup>37</sup>

**Table 1**  
Air-delivered Cluster Bomb Expenditure in the Gulf War

Type	Effect	Number Expended			
		Air Force	Navy	Marines	
United States					
CBU-52/58/71	Frag	21,696 <sup>a</sup>	0	0	
CBU-59	APAM	0	0	186	
CBU-78	Gator	0	148	61	
CBU-87	CEM	10,035	0	0	
CBU-89	Gator	1,105	0	0	
Mk20 Rockeye	AA	5,345	6,814	16,014	
<u>Subtotal</u>		38,181	6,962	16,261	61,404
Allied		RAF			
BL-755		8			
CBU-87		387			
<u>Subtotal</u>		395			
<u>Total</u>					61,799 <sup>b</sup>

AA: anti-armor with poor fragmentation and incendiary capability; APAM; anti-personnel/anti-materiel; CEM: Combined effects munitions (light anti-armor and anti-personnel); Frag: incendiary/fragmentation bomblet with no anti-armor effect; Gator: air-delivered magnetically fused heavy anti-tank and tripwire anti-personnel mines.

<sup>a</sup> Sources vary on the number of CBU-52/58/71 cluster bombs expended, some stating 17,831. The higher official number was chosen; see GWAPS, Vol. III, Part I, at 234 & 256.

<sup>b</sup> Does not include a complete count of allied use of cluster bombs, particularly French and Saudi. The BL-755 is a British-manufactured cluster bomb.

Sources: U.S. Department of the Air Force, Gulf War Air Power Survey (GWAPS), Volume III, Part I, p. 235, Volume IV, Part I, p. 65, Volume V, Part I, pp. 550-552; House of Commons, *Preliminary Lessons of Operation Granby* (July 1991), p. 86.

Modern submunition weapons consist of two main types—those delivered by aircraft, and those by surface artillery or rockets.<sup>38</sup> Weapons carrying submunitions disperse them over a large area, thereby increasing the impact area of an attack. The large number delivered in a dispenser increases the density of explosives in a target area, with submunitions designed to strike every few feet or so. An artillery or rocket barrage, or an air attack, typically can disperse thousands of submunitions within a small space, a common target area in planning roughly being an area 100x50 meters. Obviously, an attractive feature for militaries is that the submunitions are inexpensive given the area of destructive potential in comparison with unitary explosives.

Even though weapons are being designed to be more and more “reliable,” because submunitions are used in such large numbers, “reliability” as it relates to unexploded ordnance and environmental damage on the battlefield (and in civilian locations when cluster bombs are chosen for an urban attack) has actually declined (within the context of otherwise discriminate attacks). As the use of smaller and smaller munitions increases, more and more numbers are expended in battle. The large number of weapons, individually less expensive, intentionally more expendable and simply designed, creates more of a lingering problem. Small, inexpensive electronic fuses are more prone to malfunction under severe conditions.

In the Gulf War, cluster bombs delivered from medium and high altitudes experienced “excessively high dud rates.”<sup>39</sup> Despite contact fuses and secondary firing systems, an enormous number failed to detonate, particularly when landing in soft sand and shallow water or mud. Ground-delivered (*e.g.*, artillery or rocket) submunitions also experienced high dud rates. Estimates vary from the conservative 2-5 percent claimed by manufacturers, to up to 23 percent observed in acceptance and operational tests, to an average of 10-30 percent observed on the ground after the war in Iraq and Kuwait.<sup>40</sup> Even a conservative five percent estimate means that some 2.2 million unexploded bomblets were left behind, almost half from air-delivered bombs.

With the proliferation of remotely delivered submunitions, both air and ground delivered, emplacement of mines by the individual soldier is increasingly a less important theater operation in high technology warfare. Air-delivered cluster bombs and scatterable artillery-, helicopter-, or rocket-delivered submunitions will predominate in the future. There are a number of implications from this “advancement:” placement is by necessity more random, more driven by short-term considerations on the battlefield given the flexibility of the weapon.

Well over one million anti-tank, anti-personnel, and sea mines were emplaced by Iraq in the Gulf War. In terms of clean up, the difference between cluster bombs and mines is that grossly insufficient procedures and requirements exist to recover unexploded bomblets scattering the battlefield. With ground- and air-delivered

submunitions, there are no restrictions and the very nature of the weapons often defies precise mapping of their expenditure.

During the Cold War, the military was less concerned about submunition placement and dud rates because weapons were developed to defend against a Soviet offensive in Western Europe, one which would not have required U.S. soldiers to occupy "submunition-contaminated" areas.<sup>41</sup> With the large scale use of submunitions in a rapidly moving offensive battlefield, such as the Gulf War, however, friendly hazards were immediately felt. One government study concluded that during Operation Desert Storm at least 25 U.S. military personnel were killed and others were injured by submunitions fired by their own forces.<sup>42</sup> Troops with the U.S. 1st Armored Division, for example, said that the principal threat they faced was "unexploded ordnance believed to have been left over from . . . earlier American bombardment."<sup>43</sup> The situation was so critical that large scale use of cluster bombs by aircraft was restricted during the ground war for fear of friendly casualties<sup>44</sup> and, in some instances, "ground movement came to a halt because units were afraid of encountering unexploded ordnance."<sup>45</sup>

In the immediate aftermath of Operation Desert Storm, unexploded submunitions killed or injured more than 100 soldiers and military explosive disposal specialists.<sup>46</sup> Post-war injuries to U.S. soldiers from unexploded ordnance on the battlefield, particularly because of the excessive "dud rate" of ground-launched submunitions, became so serious that Congress requested that the General Accounting Office (GAO) investigate manufacturing, purchasing and handling.<sup>47</sup>

The military effectiveness of submunitions varies, but it far from clear that either ground- or air-delivered submunitions, or land mines, have advantages that outweigh the human and environmental impact. Aerial cluster bombs proved ineffective in the armor attack role during the Gulf War, and with the emergence of a wide variety of precision anti-tank weapons, they seem less and less attractive weapons for such attacks in the future (particularly where U.S. forces have to operate). Use of cluster bombs against urban targets, given the constraints of restricting collateral damage and civilian effects, seems counterproductive. Indeed, cluster bombs used in strategic bombing attacks proved a bit of a nuisance. Given their properties of small explosions and broad dispersal, they greatly complicated battle damage assessment as the noticeable impact on stationary targets (as opposed to larger explosives of 500-2,000 pound class) was difficult to assess via reconnaissance.

There are circumstances in which the use of cluster bombs might be beneficial in terms of limiting collateral and reverberating damage. In the Vietnam War, for instance, cluster bombs were used to attack anti-aircraft artillery guns that had been placed on embankments and dikes in the north. The guns could be suppressed without doing harm to the irrigation and water control structures.

The large scale use of Iraqi mines also proved more of a nuisance than a decisive military instrument. Mines, in order to be effective against modern forces, need to be maintained and protected by covering fire, and are therefore not as attractive for large scale use by sophisticated militaries as are submunitions. In fact, the new generation of scatterable mines (delivered from artillery, aircraft and ground dispensers) which entered arsenals in the 1980's will likely replace hand-sown mines in the future. These can be mass emplaced in mobile or tactical settings, and employ influence sensors and electronic timers.

When submunitions and mines are evaluated for their military effect in many missions—particularly given the emergence and success of smart weapons—or when their use is measured against the collateral effects, they are far less attractive. The effects are immediate and measurable. In the case of depleted uranium (DU) as an anti-tank weapon, the effects are more subtle.

Depleted uranium is used in armor penetrators, both in bullets shot from aircraft (and ship-based gattling guns) and in tank ammunition.<sup>48</sup> Because of uranium's density and physical properties, it is attractive as an alternative to tungsten or other more expensive metals. In the Gulf War, about 14,000 DU tank rounds were consumed (4000 fired in combat) and 940,254 30mm DU bullets were fired by A-10 aircraft.<sup>49</sup> The health and environmental risks remain unclear; the U.S. Army itself states that there is a "need for more data on potential health and environmental consequences associated with the chemical and radiological characteristics of DU."<sup>50</sup> A January 1993 GAO report found that the Army did not have a comprehensive DU battlefield management plan.<sup>51</sup>

As a result of medical screening at the end of the war, some 35 soldiers were found to have traces of uranium in their urine. Approximately 22 soldiers may have retained embedded DU fragments. Early in reporting on the so-called "Gulf War syndrome," DU was identified as a possible contributing factor to the unexplained illnesses being reported by veterans (and was the subject of considerable Iraqi propaganda).<sup>52</sup> Though no one now believes that DU is ultimately causal, the Army admits that the long-term health effects have not been well defined,<sup>53</sup> and the proliferation of DU weapons to other nations will undoubtedly increase whatever risks do exist.

The latest thinking on the "Gulf War syndrome," in fact, is that a syndrome as such does not exist. A comprehensive U.S. Department of Defense survey of 10,000 veterans and family members found no link to biological or chemical weapons, environmental pollutants, hazardous chemicals, depleted uranium, oil well fires, vaccines, or diseases unique to the desert. Undoubtedly, at least amongst the veterans groups and a segment of the population, Gulf War syndrome will join missing in actions (MIAs) in Southeast Asia or even UFO's as grand "cover-ups" of the government. Yet it is the long list of potential or even suspected toxins that is interesting. Far more work is needed to understand the emergence of new

technologies or the interaction of certain substances uniquely found on the battlefield in terms of the human and natural environmental impact.

Though environmental “modification” has been a subject of discussion for many years, newer technologies may actually be increasing the attractiveness of use of the environment for warfare. Despite U.S. denials, enough documentation exists to indicate that the Iraqi-perpetrated oil conflagration and the creation of significant amounts of smoke had a significant impact on U.S. air operations, Iraqi intentions or not. Laser-guided bombs and other sensor-dependent weapons (*e.g.*, television, electro-optical, and infrared) are severely constrained by atmospheric conditions. In the Gulf War, many laser-guided weapons were unable to acquire targets because of adverse weather conditions (*i.e.*, rain and fog), and optical guided weapons were definitely constrained by the smoke of oil fires. The conditions were both natural and man-made. For instance, smoke pots were used to obscure targets and had an effect on target acquisition and bombing.

In addition, night vision devices are dependent on a certain environmental condition. That is, it has to be dark. In the Gulf War, oil well and trench fires, even fires caused by routine bombing, caused havoc with night-vision devices. The combined effect was obscuring nearly all natural ambient light, which night-vision devices need for illumination. By contrast, too much light causes a sort of “blooming” effect.<sup>54</sup> Perhaps in the face of night attacks, a future countermeasure would be the large scale creation of certain types of illuminations that would not expose friendly forces.

As “smart” weapons become more commonplace, perhaps the countermeasures to smart weapons guidance systems—including modifying atmospheric conditions<sup>55</sup>—will be an important part of a nation’s defense. Thus the weapons/counter-weapons battle, coupled with more discriminate precision weapons and urban bombing constraints, as well as new concepts of information (“systemic”) warfare, could serve to make the potential for devastation or disablement of civilian systems, with inadvertent environmental damage, even worse in the future.

It may be important to reaffirm the original intent of the ENMOD Convention,<sup>56</sup> to strengthen the disarmament effect in the face of advances in military technology, as well as to more rigorously define environmental damage that might (or should be) applicable. Yet advances in military technology were not even discussed at the 1993 ENMOD Convention review conference.<sup>57</sup>

### Legal Protections for Environmental Destroyers?

A number of international agreements have been developed over the years with the very goal of limiting damage to the environment during war. Until the 1970s, treaties relating to the conduct of war focused on humans and their property. Provisions of the laws of war dealing with military necessity and proportionality

related to the environment, but then attitudes began to change and environmental consequences began to be questioned as something other than the otherwise inevitable accompaniment of military action.

Though armed conflict is always a tragedy for the environment, in the Gulf War, there was a perception prior to Operation Desert Storm that the venue for war, and the intensity of modern weapons, would mean that the war would be more environmentally destructive. But since global calamity did not occur, and the war's end was not defined, the environment was made subordinate to the political needs of the victorious States.

Some would think that the environmental destruction that did occur might serve as a catalyst to bring the various agreements, laws, and proposals under review. But this has so far not been the case. There has been a lot of procedural wrangling, yet with the snuffing out of the last oil fire, and the shift of television's gaze away from the Gulf, interest in any real change also was extinguished.

In civil society, a nation is now, in theory, to be held responsible for the environmental damage it causes. But we have not yet arrived at the point of any punishment for actions during warfare, let alone any clarity as to the illegality of the acts perpetrated. Over the years, a lack of enforcement against Iraqi use of chemical weapons and other grave breaches may have signalled to the Ba'athist Government that "international law" is a matter for posturing and propaganda, and not action.<sup>58</sup> When napalm or others weapons are used experimentally or cynically as examples to avoid restrictions in international humanitarian law, similarly the message to other nations is that the secrecy surrounding them and their use might be proof of their worth, as well as signs of American duplicity in its compliance with international law.

The destruction of Kuwait's oil resources and Iraq's electrical production were both done intentionally, both with precision. The juxtaposition of the two is merely to illustrate that one is clearly "illegal" and the other is not. The massive oil spills and oil fires polluted air, land, and water, threatening fisheries, ocean ecology, and public health. The bombing of electricity started a cascade of misery for the Iraqi civilian population, severely affecting irrigation, water treatment, sanitation, and agriculture. The boundary between "property damage" as specified in the law of war and natural (*e.g.*, environmental) damage is increasingly thin.

Most in the humanitarian and environmental community have argued that the *scale* of the oil spills and fires constitutes a breach of international law. However, to focus solely on scale leaves unresolved the main issue of contention between the military establishment and the humanitarian community, the presumption of military necessity. Regardless of scope, there is no evidence that the performance of Iraqi military forces was degraded by the loss of electricity. This is not to say that there was no effect, it is just that it is difficult to assert that a calculation of the destruction of the civilian utility can be shown to have "definite military

advantage.” Despite numerous annoyances, the oil spills and fires also did not create any definable military advantage for Iraq.

None of this is to set up a counter-legal analysis. The codified law is useful to set the parameters that might constrain military operations to improve protections for the civilian population and the environment. Yet it is the political and public opinion constraints that are much more important in terms of cutting edge technologies or new situations. On close examination, the record of the Gulf War shows that when military leaders or Washington decision makers restricted destruction, they did so largely to avoid adverse public opinion, not because technicalities in the law were the issues of concern.

Greater awareness of environmental “stewardship” and pollution prevention by soldiers and commanders has created an obvious ethos of responsibility for long-term effects of operations, and a receptiveness to limitations.<sup>59</sup> There is no doubt that the very nature of modern society—urbanized, industrialized, increasingly dependent on electrically-driven amenities—makes it more vulnerable to disruptions. “A strategic center of gravity for most States beyond the agrarian stage is the power generation system,” Colonel John A. Warden, the air war principal designer, wrote after Operation Desert Storm. “Without electrical power, production of civil and military goods, distribution of food and other essentials, civil and military communications, and life in general becomes difficult to impossible. Unless the stakes in the war are very high, most States will make desired concessions when their power generation system is put under sufficient pressure or actually destroyed.”<sup>60</sup>

The Gulf War thus should portend the kind of damage we might see in the future. Mass destruction weapons did not kill masses, precision weapons did. The successful and precise destruction of intended targets had a devastating effect on the civilian population, one more reminiscent of bombing associated with old-style urban attacks and not a squeaky clean smart war. Environmental calamity on a global scale seems to have been avoided, but the very efficiency of harm, and the lingering impact of such a short conflict, should portend the potential for war’s greater potential for destructiveness.

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### Notes

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1. Though the full explanation and cause of the drying of Iraq’s southern marshes remains unclear, and U.S. interest in the subject is as much anti-Saddam as pro-environment, it is another important ecological cost of the Kuwaiti invasion; see CIA, “The Destruction of Iraq’s Southern Marshes,” IA 94-10020/NESA 94-10021/RTT 94-10054 (Aug. 1994).

2. On 9 January 1991, Secretary of State James Baker told Iraqi Foreign Minister Tariq Aziz in Geneva that “we will not allow any attempt to destroy Kuwaiti oilfields;” *INA Reports Minutes of Aziz-Baker Meeting*, FBIS-NES-92-009, 14 Jan. 1992 at 27. “Let me state . . . that the United States will not tolerate . . . destruction of Kuwait’s oil fields and installations,” President Bush wrote to Saddam Hussein. The letter stated that the acts would require the “strongest possible response” from the United States, one that would make the Iraqi leader and his country “pay a terrible price;” The text of the letter is contained in SIFRY & CERF, *THE GULF WAR READER* at 178-79. See



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discussion of NSD-54 and the resulting response to the environmental damage in ARKIN, *TARGET IRAQ: A DOCUMENTARY HISTORY OF AN AIR WAR* (forthcoming, 1997).

3. "A general consensus exists that there is adequate protection for natural resources and the environment in the law of war as now codified; what is required is a greater respect for the law of war, and an awareness of the potential effect particular military operations or means and methods of warfare many have on the environment;" Department of Defense, Report to Senate and House Appropriations Committees in response to Senate Report 102-154, 19 Jan. 1993 at 8.

4. International Committee of the Red Cross (ICRC), *COMMENTARY ON THE ADDITIONAL PROTOCOLS OF 8 JUNE 1977 TO THE GENEVA CONVENTIONS OF 12 AUGUST 1949* at 667.

5. See Parks, *Air War and the Law of War*, 32 Air Force L. Rev. 202-18 (1990). The Air Force manual on the laws of armed conflict, written before the 1977 Additional Protocols, specifies that the selection of a dam as a target is "a matter of national decision at appropriate high policy levels;" Department of the Air Force, *International Law—The Conduct of Armed Conflict and Air Operations*, AFP 110-31, 19 Nov. 1976 at 5-11.

6. Soon after taking up his position as head of the Special Planning Group, Brig. General Glosson proposed that three dams—two on the Euphrates and one on the Tigris—be bombed if Iraq used chemical weapons; ATKINSON, *CRUSADE, THE UNTOLD STORY OF THE PERSIAN GULF WAR* (1993) at 86.

7. U.S. Central Command (CENTCOM) Legal Lessons Learned, Joint Uniform Lessons Learned System (JULLS) Number 31861-06100, Title: Legality of Targeting Dams and Dikes (18 Mar. 1991).

8. Bouvier, *Protection of the Natural Environment in Time of Armed Conflict*, Int'l Rev. of the Red Cross, 567-578 (Nov-Dec 1991).

9. ARKIN, *supra* n. 2 at ch. 13.

10. Kuwait's four fields consisted of some 2000 wells, some 1300 of which were active and producing on 1 August 1990. At the time of Iraq's invasion, about 850 of the 1300 producing wells (including wells in the Kuwaiti-administered portion of the Neutral Zone) were involved in pumping oil. Reports have varied as to the number of wells sabotaged, with the Kuwaiti Petroleum Company reporting in September 1991 that 749 wells were damaged, with a total of 610 fires. Most of wells (circa 450) were in the greater Burgan field (Maqwa, Ahmadi, and Burgan) south of Kuwait City; 60 were located in the Minagish, Umm Gudair, and Wafrah fields in southern Kuwait; and 100 were located in the Rawdatayn, Sabriya, Bahra, and Ratya oil fields in northern Kuwait.

11. Twenty of 26 gathering stations that separate oil, gas and water recovered from underground reservoirs were damaged or destroyed. The upstream facilities of the oil collecting and distribution system consist of an additional main station and 23 substations at Wafrah.

12. Kuwait had three refineries, at Mina Al-Ahmadi, Mina Abd Allah, and Mina ash Shuaybah. The refinery at Mina Al-Ahmadi was slightly damaged. The refinery at Mina Abd Allah was significantly damaged, evidently both from sabotage and from Coalition bombing. Mina ash Shuaybah received minor damage. A fourth refinery at Mina Az Zawr, owned by Saudi Arabia, was totally destroyed.

13. Some of the flowing wells were ignited because the release of sulfur dioxide was less toxic than hydrogen sulfide gas emitted from the crude wells.

14. U.S. Congress, Senate Gulf Pollution Task Force, *The Environmental Aftermath of the Gulf War*, at 23.

15. Center for Naval Analysis, "A View of Desert Shield and Desert Storm as Seen From COMUSNAVCENT," at 5-12.

16. Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, 1977, 31 U.S.T. 333; *reprinted* in 16 I.L.M. 88 (1977).

17. Protocol I Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (1977), *reprinted* in 16 I.L.M. 1391 (1977).

18. U.S. Department of Defense, *FINAL REPORT TO CONGRESS, CONDUCT OF THE PERSIAN GULF WAR*, Apr. 1992, at 606.

19. "During that treaty's negotiation, there was general agreement that one of its criteria for determining whether a violation had taken place ("long-term") was measured in decades. It is not clear the damage Iraq caused, while severe in a layman's sense of the term, would meet the technical-legal use of that term in Protocol I. The prohibition on damage to the environment contained in Protocol I were not intended to prohibit battlefield damage caused by conventional operations and, in all likelihood, would not apply to Iraq's actions in the Persian Gulf War;" *FINAL REPORT TO CONGRESS, supra* n. 18 at 625.

20. Environmental Protection Agency Interagency Task Force, *REPORT TO THE CONGRESS, UNITED STATES GULF ENVIRONMENTAL TECHNICAL ASSISTANCE, FROM JANUARY 27-JULY 31, 1991, Under PL 102-27, Sec. 309*, at 4.

21. Most of the discussion here comes from Chapter 9: Electrical Surgery, in ARKIN, *supra* n. 2; Arkin, *Power Failure: Destruction of Electricity in the Gulf War* (forthcoming).

22. Air Force theorists never considered the impact of their destruction on water distribution, purification, and sewage; Department of the U.S. Air Force, *Gulf War Air Power Survey* [hereinafter GWAPS], Vol. I, Part I, at 117. One former 'Checkmate' officer writes that after CNN reported that electricity and water were off in the Rasheed

Hotel, planners were surprised. Ironically, it seems like this had been overlooked by the air campaign planners. This author vividly recalls polling the 'Checkmate' staff the first night of war and discovering that no one had realized that with the loss of electricity the water supply would also fail. Later discussions with personnel who were in the 'Black Hole' in Riyadh at that moment indicated they were also caught by surprise.

Kuehl, *Airpower vs. Electricity: Electric Power as a Target For Strategic Air Operations*, 18 J. of Strat. Stud. 265 (Mar. 1995) at n. 57.

23. Report to the U.N. Secretary-General on humanitarian needs in Kuwait and Iraq in the immediate post-crisis environment by a mission to the area led by Mr. Martti Ahtisaari, Under Secretary-General for Administration and Management, S/22366 (20 Mar. 1991).

24. Physicians for Human Rights, *Press Statement: Iraq Mission April 3-10, 1991*, at 3 (15 Apr. 1991).

25. In particular, see Harvard Study Team, *Harvard Study Team Report: Public Health in Iraq After the Gulf War*, May 1991; International Study Team, *Health and Welfare in Iraq After the Gulf Crisis: An In-Depth Assessment*, Oct. 1991; FINAL REPORT TO THE CONGRESS, *supra* n. 18; GWAPS Summary Report, and Vols. I-V; and ATKINSON, *supra* n. 6 at 30-31 & 37-38.

A year after the war, the internal debate appeared in the news media. See, for example, *Defeat of Iraq Sparks Debate on Which Air Role Was Crucial*, 27 *Aviation Wk & Space Tech.* 60-65, Jan. 1992; Gordon, *Pentagon Study Cites Problems With Gulf Effort*, *The New York Times*, 23 Feb. 1992, at A1.

Two reports written by Air Force officers examine electrical targeting in a critical way: Griffith, Jr., *Attacking Electrical Power*, School of Advanced Airpower Studies (Air University), Thesis, 1993 (later to appear in *ESSAYS ON STRATEGY XI*, (Petrie ed. 1994) at 183-223); and Kuehl, HQ USAF, Directorate of Plans, Strategic Planning Division, *Airpower vs. Electricity: Electric Power as a Target for Strategic Air Operations*, (1993), later published *supra* n. 22.

26. FINAL REPORT TO CONGRESS, *supra* n. 18 at 150. See also *id.* at 125, 127 & 612 for further discussion of the justification for bombing electricity.

27. USCENTCOM News Briefing, General Schwarzkopf and Brig. General Glosson, Riyadh, Saudi Arabia, 30 Jan. 1991. See also DOD News Briefing, Lt. General Kelly, 11 Feb. 1991, 4:05 PM.

28. *Supra* n. 25 GWAPS, Vol. II, Part II, at 342-43.

29. U.S. Department of the Navy, *Annotated Supplement to The Commander's Handbook on The Law of Naval Operations*, NWP 9 (Rev. A)/FMFM 1-10 (1989), para. 8.1.2.

30. *Supra* n. 4 at 632-33.

31. Aldrich, *New Life for the Laws of War*, 75 A.J.I.L. 780 (1981): "Proposals to add other items to the list [of prohibited objects of attack under Article 54] such as communication systems or food distribution and fuel reservoirs were rejected by the conference, as such items are often, if not always, important military objectives."

32. Aldrich, *Progressive Development of the Laws of War: A Reply to Criticisms of the 1977 Geneva Protocol I*, 26 *Va. J. Int'l. L.* 706 (1986). See also Department of the Air Force, *International Law—The Conduct of Armed Conflict and Air Operations*, AFP 110-31 at 5-16 (19 Nov. 1976).

33. Kuehl, *supra* n. 22, at 258.

34. The language is taken from the Statement by Robert B. Rosenstock, United States Representative to the Sixth Committee of the 46th Session of the United Nations General Assembly, in the Sixth Committee, on Item 140, Exploitation of the Environment as a Weapon, Oct. 22, 1991 (Press Release U.S.U.N. 65-(91)).

35. Drones, Iraqi surface-to-air missiles (SAMs) falling back to earth, cluster bomb casings, jettisoned ordnance and fuel tanks, all contributed remnants on the battlefield and to urban collateral damage. It was debris that had greater visibility if for no other reason than that intentional damage from attacks was otherwise so circumscribed.

36. In this paper, ground- and air-delivered submunitions, as well as hand-sown ones (mines) are collectively referred to as submunitions, particularly since the subject mostly relates to their effects on the civilian population. This is in agreement with U.S. military doctrine which defines a scatterable mine as "a mine laid without regard to classical pattern and which is designed to be delivered by aircraft, artillery, missile, ground dispenser, or by hand;" Joint Chiefs of Staff (JCS), "Joint Doctrine for Barriers, Obstacles and Mine Warfare," Joint Pub 3-15, at GL-8 (30 June 1993).

37. Combined with another 13.6 million ground-delivered submunitions, the total number of individual cluster bomb-related explosives delivered on Kuwait and Iraq was some 34 million. The overall number is calculated on the basis of some 100,000 artillery projectiles, 10,000 Multiple Launch Rocket System (MLRS) rockets, and 60,000 air delivered cluster bombs. The number of submunitions carried by each weapon is 72 per dual-purpose improved conventional munition (DPICM) 155mm projectile, 644 per MLRS rocket, 247 per Mk20 Rockeye, 220 per CBU-52, 650 per CBU-58, 717 per CBU-59, 650 per CBU-71, 60 per CBU-78 (45 anti-tank and 15 anti-personnel mines), 202 per CBU-87, and 94 per CBU-89 (72 anti-tank and 22 anti-personnel mines).

38. Over ten types of submunitions were used by Coalition forces in the Gulf War—155mm and 203mm artillery projectiles, MLRS rockets, and aerial-delivered cluster bombs (Rockeyes, and CBU-52, -58, -71, -87, -89 "cluster bomb units" as well as British and French cluster bombs).

39. *Supra* n. 25, GWAPS, Vol. II, Part I, at 261. See also GWAPS, Vol. IV, Part I, at 222.

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40. US military officials estimate that three to five percent of their artillery projectiles and bombs failed to explode, although soft sand may have increased the rate up to one-third in some areas. The GAO found that as many as 23 percent of MLRS rocket submunitions failed to explode during acceptance testing; US Congress, General Accounting Office (GAO), "Operation Desert Storm: Casualties Caused by Improper Handling of Unexploded U.S. Submunitions," GAO/NSIAD-93-212, at 4 (Aug. 1993).

One U.S. Army expert estimates 15 percent of submunitions did not detonate—"Sometimes you get 50 percent duds;" Brady, *Kuwaitis dying from old menace: unexploded bombs*, Fort Worth Star-Telegram, 12 Jan. 1992 at 1. According to another report on unexploded ordnance, "Reports from Kuwait have said that around one third of submunitions failed to explode due to landing in soft sand;" Nash, *RO in Kuwait: The Big Clean-Up*, Mil. Tech., at 59 (July 1991). One U.S. expert was quoted as saying that "at least 600 bombs, rockets and artillery shells dropped or fired every day of the war will have failed to explode and thus constitute a continuing hazard somewhere in the war theater;" Ringle, *After the Battles, Defusing the Debris*, The Washington Post, 1 Mar. 1991 at B1. See also Hedges, *With a Bang! Bang! Bang! War Cleanup Goes On*, The New York Times, 15 Oct. 1992 at A12; Atkinson, *Doing a Bang-Up Job: With Cautious Gusto, Troops Explode Iraq's Munitions*, The Washington Post, 26 Mar. 1991 at A9.

41. GAO, "Operation Desert Storm: Casualties Caused by Improper Handling of Unexploded US Submunitions," op.cit., at 4.

42. *Id.* The GAO investigation solely related to the Army's experience with its own M42, M46 and M77 artillery and rocket-delivered submunitions. According to *EOD Alert*, Marine Corps Gazette, (Jan. 1994) at 9, 30 U.S. soldier deaths and 104 injuries were caused by unexploded ordnance.

43. Jehl, *Pool Report with the 1st Armored Division*, (released by the Defense Department), Los Angeles Times, 25 Feb. 1991.

44. "Large quantities of cluster bombs were never used after the start of the ground war because of the rapid advance of allied forces and the fear that they would encounter undetonated bomblets;" U.S. Congress, General Accounting Office (GAO), "Limitations on the Role and Performance of B-52 Bombers in Conventional Conflicts," B-252126, at 61 (22 June 1993).

45. GAO, "Operation Desert Storm: Casualties Caused . . .," n. 40 at 9. As The Washington Post observed on 3 March, "units of the Army's 1st Cavalry Division that had suffered no combat casualties in their unopposed drive through southern Iraq have seen several of their soldiers killed or wounded by bombs or mines in the area they are holding;" Branigan, *Gruesome Examples of Horrors of War Abound in Iraqi Desert*, The Washington Post, 3 Mar. 1991 at A34.

46. Sloyan, *US Bomblets Killed 14 Americans in Gulf War*, Newsday, 19 Sept. 1991 at 4. See also *Growing Death Toll in EOD Operations*, Jane's Def. Weekly, 20 June 1992 at 1061; Brady, *Kuwaitis dying from old menace: unexploded bombs*, Fort Worth Star-Telegram, 12 Jan. 1992 at 1.

47. The request was made by Senator Chris Dodd (D-Conn.) after reservists from a Connecticut army unit were injured by submunitions. See *Little Bombs, Big Questions*, (Editorial), Hartford Courant, 5 Jan. 1992 at C2; Wagner, *Army Completes Probe of Desert Storm Deaths*, Hartford Courant, 3 Dec. 1991 at C9.

48. DU is also used as counterweight components of aircraft elevators, landing gear, rotor blades and radar antennae; ballast in satellites, missiles and other craft; armor plate, and in small quantities, as a catalyst in some mines.

49. U.S. Department of the Air Force, Table, "A-10 Operation Desert Storm Munitions Expended," n.d. (1991).

50. U.S. Army Environmental Policy Institute, "Health and Environmental Consequences of Depleted Uranium use by the U.S. Army," Summary Report to Congress, at 2 (June 1994).

51. U.S. Congress, General Accounting Office (GAO), "Operation Desert Storm: Army Not Adequately Prepared to Deal With Depleted Uranium Contamination," Jan. 1993, GAO/NSIAD-93-90.

52. See Arkin, *The Desert Glows—With Propaganda*, Bull. of Atomic Sci. (May 1993).

53. U.S. Army Environmental Policy Institute, Summary Report, *supra* n. 50 at 4-56.

54. Kane, *Night Vision Goggles and Desert Storm*, Marine Corps Gazette, at 42 (Feb. 1992).

55. The military clearly recognizes the constraints of operating smart weapons that are unable to counter natural and man-made atmospheric effects. In the future, new weapons and sensors such as the inertially aided munition (IAM), the sensor fuzed weapon (SFW), synthetic aperture radar (SAR), millimeter-wave (MMW) radar, gas laser radar (LADAR), and brilliant anti-tank (BAT) submunitions seek largely to neutralize the effects of bad weather and limited visibility.

56. *Supra* n. 16.

57. Before the ENMOD, and leading up to the negotiations, the U.S. Government (July 1972) renounced the use of climate modification techniques for hostile purposes, even if development was proved to be feasible (and desirable) in the future. The original Congressional Resolution (1973) calling for an international agreement referred to prohibition of activity "as a weapon of war." The bilateral talks agreed to by Presidents Brezhnev and Nixon in July 1974 took on an even broader mandate, namely "to overcome the dangers of the use of environmental modification techniques for military purposes." The resulting convention narrowed the original scope considerably.

58. Adam Roberts speculates that “from the international community’s failure to react to the original attack on Iran in 1980, from its failure to do anything much about Iraq’s use of gas, and from its actively continuing trade even in weapons, Saddam Hussein may well have learned the lesson that he could ignore international institutions and law, including the laws of war, with impunity;” Roberts, *The Laws of War in the 1990-91 Gulf Conflict*, Int’l Sec. at 140-141 (Winter 1993/94).

59. Some of the environmental concern seems contrived, such as the Clinton Administration’s creation of a Deputy Under Secretary of Defense for Environmental Security in May 1993. Similarly, the Pentagon’s 1994 draft “non-lethal” weapons policy defines non-lethals as “discriminate weapons that are explicitly designed and employed so as to incapacitate personnel or materiel, while minimizing fatalities and undesired damage to property *and the environment*,” without defining why such limitations are desirable or required. *See* Office of the Assistant Secretary of Defense (Special Operations/Low-Intensity Conflict), Memorandum, Subject: Draft Non-Lethal Weapons Policy, 21 July 1994 (emphasis added).

60. Warden, *Employing Air Power in the Twenty-first Century*, in *THE FUTURE OF AIR POWER: IN THE AFTERMATH OF THE GULF WAR*, (Shultz & Pfaltzgraff eds. July 1992) at 64.