

Environment and health:

5. Impact of war

Jennifer Leaning

War has marked human experience since the beginning of recorded time, and the demands of war have in many ways shaped and advanced the practice of medicine.^{1,2} Rhodes³ estimated the immense scope of war-related mortality in the 20th century and demonstrated the increasing fraction of civilian deaths. Levy and Sidel⁴ recently reviewed the broad public health consequences of preparing for, coordinating and cleaning up after contemporary wars. War rivals infectious disease as a global cause of morbidity and mortality. In the 1980s health professionals' concern about the effects of war on the environment⁵ was focused on the sweeping ecological consequences of nuclear weapons.⁶ In the 1990s the Gulf War and the Kosovo experiences demonstrated the environmentally destructive capacities of conventional weapons.⁷

There remain enormous gaps in our knowledge about the relationship of war and health. Understanding is constrained by the lack of recorded information and the comparative absence of continuing systematic field research undertaken from within any one discipline. Work is underway to explore how environmental stress and resource constraints may contribute to conflict,^{8,9} but the topic lies outside the scope of this review.

The environmental impacts of war can be understood by examining the magnitude and duration of effects, involved ecosystems in specified geographic locations, the use of individual weapons systems, the results of particular production processes and the cumulative combined effects of specified military campaigns. From this perspective, 4 activities can be seen as having prolonged and pervasive environmental impact with significant consequences for human populations: production and testing of nuclear weapons, aerial and naval bombardment of terrain, dispersal and persistence of land mines and buried ordnance, and use or storage of military despoliants, toxins and waste.

Production and testing of nuclear weapons

Nuclear weapons technology was developed during World War II and expanded as an industrial enterprise of vast scope and complexity in the Cold War between the United States and the Soviet Union. Nuclear weapons technology continues to dominate concerns regarding potential hazards to the environment.¹⁰ Radioactivity, released into the environment in many phases of production and testing processes, poses a serious threat to the health of biological species, including humans. Assessment of this threat begins with estimating the amount of radiation released, itself a difficult task, and then evaluating health risks on the basis of what can be found in epidemiological studies of exposed populations and ecosystems over time. These studies are based on relatively small samples and look at areas affected by above-ground tests,¹¹⁻¹⁵ areas near nuclear weapons production and storage facilities¹⁶ and areas used for radioactivity tests.¹⁷ These studies raise concern in terms of human health effects, costs of environmental cleanup and continued environmental contamination.¹⁸⁻²³

Massive amounts of radioactivity have been released in the last half of the 20th century from the nuclear weapons testing programs of all the main nuclear powers. The testing phase of nuclear weapons included 423 atmospheric tests (conducted from 1945 to 1957) and about 1400 underground tests (from 1957 to 1989). The total burden of radionuclides released from these tests has been estimated at 16-18 million curies (1 Ci = 3.7×10^{11} Bq) of strontium-90, 25-29 million curies of cesium-137,

Review

Synthèse

Dr. Leaning is with the Division of Emergency Medicine, Harvard Medical School, Boston, Mass.

This article has been peer reviewed.

CMAJ 2000;163(9):1157-61

Series editor: Dr. Michael McCally, Department of Community and Preventive Medicine, Mount Sinai School of Medicine, New York, NY

400 000 curies of plutonium-239 and (for the atmospheric tests only) 10 million curies of carbon-14.^{11,21}

More is known from the United States than from other countries about radiation releases from the military production of nuclear weapons. Production sites that have been investigated and found to have caused significant environmental contamination include the Hanford Nuclear Reservation in Washington state (producing weapons-grade plutonium), the Oak Ridge Reservation in Tennessee (producing components for nuclear weapons), the Rocky Flats Plant in Colorado (producing plutonium triggers for warheads) and the Savannah River Plant in Georgia (producing tritium and plutonium). Accidental releases and continued emissions as part of daily operations have been reported at these and many other production facilities.²¹ Disputes regarding the human health effects of these exposures have not been entirely resolved, despite extensive study.^{24,25} The US government has recently acknowledged that occupational exposures to nuclear and other toxic materials at these plants justifies the awarding of compensation to over 3000 current and retired workers whose health has been adversely affected.²⁶

Aerial and naval bombardment

Bombardment of the urban infrastructure, which constitutes the environment for a significant fraction of the world's human population, has always caused forced displacement of survivors. During World War II, when air power for the first time was deployed as the pivotal military technology, the practice of bombing civilian settlements became increasingly prevalent, and hundreds of thousands of people died as a result.²⁷ In the aerial bombardments of Tokyo in March 1945, about 100 000 to 200 000 people were killed. In the fire bombings of 70 German cities, including Hamburg in 1943 and Dresden in 1945, it is estimated that 500 000 to 800 000 people died.²⁸ About 200 000 people died from the acute effects of the atomic bombs in Hiroshima and Nagasaki in 1945.²⁹

The bombardment of cities and the destruction of forests, farms, transport systems and irrigation networks during World War II produced devastating environmental consequences,³⁰ and by the end of the war there were almost 50 million refugees and displaced people.^{31,32} In the last year of the war the land of coastal and northern France was torn up, Holland south of the Zuyder Sea was flooded with the destruction of dikes, and many ports were clogged with unexploded ordnance and sunken ships. Great damage had been done to most cities in Europe, with the hardest hit including Warsaw, Berlin, Hamburg, Dresden, Dusseldorf, Boulogne, Le Havre, Rouen, Brest, Pisa, Verona, Lyons, Budapest, Leningrad, Kiev and Cracow.

All visitors to central Europe reported a feeling of unreality; lunar landscapes dotted with enormous heaps of rubble and bomb craters, deserted and stinking ruins that had once been business

centres and residential areas. To find housing for the survivors was the most urgent problem, but in Germany about a quarter of all houses were uninhabitable, and almost as many in Poland, Greece, Yugoslavia, and the European part of the Soviet Union. In the American zone of Germany 81 per cent of all houses had been destroyed or damaged. In the German-occupied parts of the Soviet Union the homes of six million families had been destroyed, leaving about 25 million people without shelter.³³

Estimates of war damage in Japan noted that 66 cities had suffered major damage, with about 40% of their area destroyed; throughout Japan about 9 million people were left homeless. Comprehensive data are not available, but limited evidence from the first 2 post-war years suggests that, because of vast food shortages and the failure of the 1945 rice harvest, hunger and malnutrition afflicted the majority of the population and thousands died from causes related to starvation.³⁴

This sequence of aerial bombardment, destruction of home and urban and rural infrastructure, and progressive waves of dislocated or homeless people, can be seen in all wars subsequent to World War II. In the 15 years of the war in Southeast Asia, the US bombardment of Vietnam, Laos and Cambodia forced about 17 million people to become refugees.³⁵ In the Gulf War, the allied forces crippled the urban support systems of major cities in Iraq.³⁶⁻³⁸ In the conflicts of the post-Cold War era, marked by sieges of cities, attacks on safe havens and pulverization of towns to effect ethnic cleansing, millions of people have been forced to flee within or across national borders. In 1999 about 35 million people were counted as refugees or internally displaced people as a result of war or internal crisis.^{39,40}

Land mines

As a result of the last 50 years of wars in Europe, Africa, Asia and Latin America, an estimated 70-100 million antipersonnel land mines are still active and in place worldwide, and another 100 million exist in stockpiles.⁴¹ Almost 400 million have been strewn across continents since World War II, and with the proliferation of civil wars waged by irregular forces, the use and spread of land mines as a preferred method of securing and denying land has accelerated.⁴² Land mines are placed now without regard to requirements under international law to mark, map, monitor and remove them.^{43,44} Hence, the majority of the victims of land-mine explosions are civilians engaged in daily farming or foraging activities.⁴⁵⁻⁴⁸ Reliable regional estimates of incident rates of injury and death are difficult to come by; one frequently cited statistic is that land mines injure or kill about 500 people every week.⁴⁹

The countryside of Kosovo was rimmed and internally laced with land mines laid by all sides; after a year of international efforts to remove them, an estimated 1415 known or suspected minefields remain. Since the June 1999 ceasefire and the return of the civilian population, the monthly toll killed from land-mine or cluster-bomb explosions has

dropped from 44 deaths and 109 serious injuries in June 1999 to no deaths and 15 serious injuries in April 2000.⁵⁰

Land mines accelerate environmental damage through 1 of 4 mechanisms: fear of mines denies access to abundant natural resources and arable land; populations are forced to move preferentially into marginal and fragile environments in order to avoid minefields; this migration speeds depletion of biological diversity; and land-mine explosions disrupt essential soil and water processes.

Review of experiences in the 20th century indicates that the persistence of active mines and unexploded ordnance haunts old battle areas and that, despite intensive efforts at clearance and deactivation, millions of hectares remain under interdiction in Europe, North Africa and Asia.⁵¹ In Libya one third of its land mass is considered contaminated by land mines and unexploded munitions from World War II.⁵² When these mines do explode, in addition to causing serious injury and death to humans, domestic animals and wildlife, they shatter soil systems, destroy plant life and disrupt water flows, accelerating ecosystem disruption.⁵³ Interactions between natural disasters and buried land mines slow attempts to demine areas and protect populations. For instance, the floods in Mozambique in 1999 and 2000 are feared to have displaced the hundreds of thousands of land mines left from the civil war, and concern about their whereabouts has delayed recovery operations. Painstaking efforts to mark known minefields have been set back considerably by the flood waters, and a new mapping team has been sent out by the international community.⁵⁴

Despoliation, defoliation and toxic pollution

Attempts to damage the environment as a tactic of war against the formal enemy and as a means of instilling terror in the general populace have been described throughout history.^{55,56} During World War II instances of dike disruption,^{57,58} dam destruction⁵⁹ and scorched earth retreats⁶⁰ have been well documented. Interactions between natural disasters and buried land mines slow attempts to demine areas and protect populations.

It is generally accepted that the extensive use of environmental destruction as a strategic practice in war can be seen to date from the use of defoliants during the war in Southeast Asia. From 1965 to 1971 the United States sprayed 3640 km² of South Vietnam's cropland with herbicides, using a total estimated amount of 55 million kg. The stated rationale was to deny the enemy sources of food and means of cover.³⁵ This widespread use of chemicals to destroy farmland, forest and water sources is unprecedented, and the environmental consequences are still relatively unexplored. International teams have been granted access for field assessments only in the last few years.⁶¹

Of the many wars waged since Vietnam, the Gulf War during January and February 1991 demonstrates the ways in which the technologies of war and industry can be used to wreak widespread environmental havoc. Iraqi's release of

about 10 million barrels of Kuwaiti oil into Gulf waters⁶² caused great stress to an ecosystem already suffering from decades of abuse (oil spills, the Iraq–Iran war, freighter traffic and industrial waste). Scientific assessments of this ecological loss and the catastrophe resulting from the Iraqi firing of 732 Kuwaiti oil wells^{63,64} are underway, although constrained by incomplete data and controversy.^{65–69}

More recent wars, or what the humanitarian relief community terms “complex humanitarian emergencies,”^{70,71} have been assessed for their potential, through the creation of large refugee camps, to inflict harm on the local environment in which the camps are situated. In the cases of the refugee camps in the African Great Lakes region from 1994–1997, Mozambique, Sudan and the Afghanistan–Pakistan border areas, a number of studies are now looking at issues of deforestation, encroachment on vulnerable ecosystems and national parks, water pollution and sanitation degradation, air pollution and loss of endangered species.^{72,73}

Future work on the environmental effects of war must address 4 main issues: information, threat assessment, vulnerability assessment and the role of international law.

- *Information:* Insufficient information exists about the effects of war on natural ecosystems, both in the immediate aftermath of war and over the long term. Methods for historical and contemporaneous reporting are incompletely developed and lack robust institutional support. Without improvement in these areas, assessments of the environmental damage of war will continue to be fragmentary.
- *Threat assessment:* Escalation in numbers of weapons, advances in technology and widespread proliferation, including threats, of terrorist use^{74,75} now place the local, regional and global environment in greater jeopardy than ever before. Nuclear weapons, the most extreme technology, have been shown in careful theoretical studies to be capable, even in limited regional use, of destroying vast sections of the world's environment.⁷⁶ Despite the fact that our capacity to contain and mitigate environmental effects of current weapons systems used in war is grossly underdeveloped, the world community continues to permit, and even support, a multiplicity of regional and international arms races.⁷⁷
- *Vulnerability assessment:* Historical data on the destruction of coral reefs during the war in the Pacific⁷⁸ and enduring changes in desert terrain from the North African campaigns of World War II^{79,80} provide faint and isolated hints that fragile environments take a long time to recover from war. Burdened by rapid population growth in many parts of the world, unrestrained settlement and economic exploitation, regional ecosystems are increasingly threatened.⁸¹ As we encroach upon the margins of our environment into the 21st century, post-war ecological resilience cannot be assumed to be present in all places, particularly within a human timeframe.
- *International law:* The legal and ethical framework

within which the medical and public health profession works during wartime is defined by the Geneva Conventions and related documents. The current discussion is whether existing law to limit the environmental effects of war is sufficient, if fully enforced, or whether new law is needed. Proposals to set up environmental surveillance systems, as enforcement mechanisms to support current law, were developed during the Gulf War.⁸²⁻⁸⁴

The increasing participation of health care professionals in these 4 areas of work may lend impetus to the development of research and policy leading to more positive outcomes.

Competing interests: None declared.

References

- Gabriel RA, Metz KS. *A history of military medicine*. New York: Greenwood Press; 1992.
- Taliaferro WH, editor. *Medicine and the war*. Chicago: University of Chicago Press; 1972.
- Rhodes R. Man-made death: a neglected mortality. *JAMA* 1988;260:686-7.
- Levy BS, Sidel VW. *War and public health*. New York: Oxford University Press; 1997.
- Leaning J. War and the environment: human health consequences of the environmental damage of war. In: Chivian E, McCally M, Hu H, Haines A, editors. *Critical condition: human health and the environment*. Cambridge (MA): MIT Press; 1993. p. 123-37.
- Barnaby F. The spread of the capability to do violence: an introduction to environmental warfare. *Ambio* 1975;4:178-244.
- Finger M. The military, the nation state, and the environment. *Ecologist* 1991;21:220-5.
- Homer-Dixon TF. On the threshold: environmental change as causes of acute conflict. *Int Security* 1991;16:76-116.
- Homer-Dixon TF. Environmental scarcities and violent conflict: evidence from cases. *Int Security* 1994;19:5-40.
- Renner M. Assessing the military's war on the environment. In: Brown L, editor. *State of the world 1991*. New York: W.W. Norton; 1991. p. 132-52.
- International Physicians for the Prevention of Nuclear War and the Institute for Energy and Environmental Research. *Radioactive heaven and earth: the health and environmental effects of nuclear weapons testing in, on, and above the earth*. New York: Apex Press; 1991. p. 34-5, 162.
- Danielsson B. Poisoned Pacific: the legacy of French nuclear testing. *Bull Atomic Sci* 1990;46(2):22-34. Available: www.bullatomsci.org/issues/1990/mar90/mar90danielsson.html (accessed 2000 Sept 27).
- An end to all nuclear explosions: the long-overdue test ban. *Defense Monitor* 1991;20(3):1-8.
- Lyon JL, Klauber MR, Gardner JW, Udall KS. Childhood leukemias associated with fallout from nuclear testing. *N Engl J Med* 1979;300:397-402.
- Hamilton TE, van Belle G, LoGerfo JP. Thyroid neoplasia in Marshall Islanders exposed to nuclear fallout. *JAMA* 1987;258:629-36.
- Makhijani A, Hu H, Yih K, editors. *Nuclear wastelands: a global guide to nuclear weapons production and its health and environmental effects*. Cambridge (MA): MIT Press; 1995.
- Bensen DW, Sparrow AH. Survival of food crops and livestock in the event of nuclear war. In: *Proceedings of symposium at Brookhaven National Laboratory*. Washington: US Atomic Energy Commission; 1971.
- Cochran TB, Norris RS. A first look at the Soviet bomb complex. *Bull Atomic Sci* 1991;47(4):25-31. Available: www.bullatomsci.org/issues/1991/may91/may91cochran.html (accessed 2000 Sept 27).
- Kitfield J. The environmental cleanup quagmire. *Military Forum* 1989;Apr:36-40.
- Coyle D. *Deadly defense: military radioactive landfills*. New York: Radioactive Waste Campaign; 1988.
- Office of Technology Assessment. *Complex cleanup: the environmental legacy of nuclear weapons production*. Washington: The Office; 1991. Rep no OTA-0-484. Available: www.wws.princeton.edu/~ota/ns20/alpha_f.html (accessed 2000 Sept 27).
- National Cancer Institute. *Study estimating thyroid doses of I-131 received by Americans from Nevada atmospheric nuclear bomb tests*. Washington: The Institute; 1997.
- Sidel VW, Shahi G. The impact of military activities on development, environment and health. In: Shahi G, Levy B, Binger A, Kjellstrom T, Lawrence R, editors. *International perspectives on environment, development and health: toward a sustainable world*. New York: Springer; 1997. p. 283-312.
- Geiger HJ, Rush D. *Dead reckoning: a critical review of the Department of Energy's epidemiologic research*. Washington: Physicians for Social Responsibility; 1992.
- Committee on the Biological Effects of Ionizing Radiation, National Research Council. *Health effects of exposure to low levels of ionizing radiation*. BEIR V. Washington: National Academy Press; 1990.
- Secretary Richardson announces proposal to compensate thousands of sick workers [press release]. Washington: US Department of Energy; 2000 Apr 12. Available: www.doe.gov/news/releases/00/aprpr/pr00103.htm (accessed 2000 Sept 27).
- Westing AH. Misspent energy: munition expenditures past and future. *Bull Peace Proposals* 1986;16(1):9-10.
- Postel T. A review of the physics of large urban fires. In: Solomon F, Marston RQ, editors. *The medical implications of nuclear war*. Washington: National Academy Press; 1986. p. 73-95. Available: books.nap.edu/books/0309036925/html/73.html (accessed 2000 Sept 27).
- Committee for the Compilation of Materials Caused by the Atomic Bombs in Hiroshima and Nagasaki. *Hiroshima and Nagasaki: the physical, medical, and social effects of the atomic bombings*. New York: Basic Books; 1981. p. 367.
- United States Strategic bombing survey. New York: Garland Publishers; 1976.
- Laquer W. *Europe since Hitler*. New York: Penguin Books; 1984. p. 25.
- Proudfoot MJ. *European refugees 1939-1952: a study in forced population movement*. Evanston (IL): Northwestern University Press; 1956. p. 34.
- Laquer W. *Europe since Hitler*. New York: Penguin Books; 1984. p. 15-6.
- Dower JW. *Embracing defeat: Japan in the wake of World War II*. New York: W.W. Norton; 1999. p. 33-120.
- Westing AH. *Warfare in a fragile world: military impacts on the human environment*. London: Taylor and Francis; 1980.
- Arkin WM, Durrant D, Cherni M. *On impact: modern warfare and the environment; a case study of the Gulf War*. London (UK): Greenpeace; 1991.
- Save the Children Fund. *Iraq situation report for Save the Children*. UK. London (UK): The Fund; 1991.
- Renner MG. Military victory, ecological defeat. *World Watch* 1991;July/Aug:27-33.
- U.S. Committee for Refugees Web site. Available: www.refugees.org (accessed 2000 Oct 11).
- United States Mission to the UN. *Global humanitarian emergencies 1998-99*. New York: United Nations; 1999.
- Department of Humanitarian Affairs, Mine Clearance and Policy Unit. *Land mines facts*. New York: United Nations; 1996.
- Westing AH. *Warfare in a fragile world: military impact on the human environment*. London (UK): Taylor & Francis; 1980. p. 95-6.
- Arms Project of Human Rights Watch and Physicians for Human Rights. *Landmines: a deadly legacy*. New York: Human Rights Watch; 1993. p. 16-34.
- Prokosch E. *The technology of killing: a military and political history of antipersonnel weapons*. London (UK): Zed Books; 1995.
- Coupland R, Korver A. Injuries from anti-personnel mines: the experience of the International Committee of the Red Cross. *Br Med J* 1991;303:1509-12.
- Stover E, Keller AS, Cobey J, Sopheap S. The medical and social consequences of land mines in Cambodia. *JAMA* 1994;272:331-6.
- Strada G. The horror of land mines. *Sci Am* May 1996;274:40-5.
- Ascherio A, Biellik R, Epstein A, Snetro G, Gloyd S, Ayotte B, et al. Deaths and injuries caused by land mines in Mozambique. *Lancet* 1995;346:721-4.
- Giannou C. Antipersonnel landmines: facts, fictions, and priorities. *BMJ* 1997;315:1453-4.
- International Crisis Group. *Kosovo report card*. Pristina/Brussels: The Group; 2000 Aug 28. ICG Balkans rep no 100.
- Westing AH, editor. *Explosive remnants of war: mitigating the environmental effects*. London (UK): Taylor & Francis; 1985.
- Sgaier K. Explosive remnants of World War II in Libya: impact on agricultural development. In: Westing AH, editors. *Explosive remnants of war: mitigating the environmental effects*. London (UK): Taylor & Francis; 1985. p. 33-7.
- Eliasson J. An international approach towards humanitarian assistance and economic development of countries affected by land mines. In: Cahill K, editor. *Clearing the fields: solutions to the global land mines crisis*. New York: Basic Books; 1995. p. 308-18.
- International Campaign to Ban Landmines. *Landmine monitor report 1999: toward a mine-free world*. New York: Human Rights Watch; 1999.
- Jones A. *The art of war in the western world*. New York: Oxford University Press; 1987.
- Royster C. *The destructive war: William Tecumseh Sherman, Stonewall Jackson, and the Americans*. New York: Knopf; 1991.
- Westing AH, editor. *Environmental hazards of war: releasing dangerous forces in an industrialized world*. Thousand Oaks (CA): Sage Publications; 1990. p. 6.
- Westing AH. *Weapons of mass destruction and the environment*. London (UK): Taylor & Francis; 1977. p. 54.
- The attack on the irrigation dams in North Korea. *Air Univ Q Rev* 1953/54;6 (winter):40-61.
- Lund DH. The revival of northern Norway. *Geographical J* 1947;109:185-97.
- Orians GH, Pfeiffer EW. Ecological effects of the war in Vietnam. *Science* 1970;168:544-54.

62. United Nations Environment Programme. *Introductory report of the Executive Director. Environmental consequences of the armed conflict between Iraq and Kuwait*. New York: UNEP; 1991 May 10. Report no UNEP/GC.16/4/Add.1.
63. Carothers A. *After Desert Storm: the deluge*. Greenpeace; Oct/Nov/Dec 1991. p. 14-7.
64. Sheppard C, Price A. Will marine life survive the Gulf War? *New Scientist* 1991;Mar 9:36-40.
65. Horgan J. Up in flames. *Sci Am* 1991;264(5):17-24.
66. Horgan J. Burning questions. *Sci Am* 1991;265(1):17-24.
67. Wald ML. Experts worried by Kuwait fires. *New York Times* 1991 Aug 14.
68. Stone R. Kuwait quits smoking. *Science* 1992;255:1357.
69. Canby TY. After the storm. *National Geographic* 1991;Aug:2-32.
70. *Agenda for development*. New York: United Nations; 1997.
71. Kaldor M, Vashee B, editors. *The new wars*. Vol 1 of *Restructuring the global military sector*. London (UK): UNU World Institute for Development Economics Research; 1997.
72. United Nations High Commissioner for Refugees, International Organization for Migration and Refugee Policy Group. Environmentally-induced population displacements and environmental impacts resulting from mass migration. In: *International symposium report, April 21-24, 1996*; Geneva: International Organization for Migration; 1996.
73. Kibreab G. Environmental causes and impact of refugee movements: a critique of the current debate. *Disasters* 1997;21:20-38.
74. US Public Health Service, Office of Emergency Preparedness. *Proceedings of the seminar on responding to the consequences of chemical and biological terrorism*; 1995 Jul 11-14; Washington. Washington: The Office; 1996. Rep no 1996-416-003.
75. Tucker JB. National health and medical services response to incidents of chemical and biological terrorism. *JAMA* 1997;278:362-8.
76. Arkin W, von Hippel F, Levi BG. The consequences of a "limited" nuclear war in East and West Germany. In: Peterson J, editor. *The aftermath: the human and ecological consequences of nuclear war*. New York: Pantheon Books; 1983. p. 165-87.
77. Renner M. *Budgeting for disarmament: the costs of war and peace* [World Watch paper 122]. Washington: World Watch Institute; 1994.
78. Ruff T. Ciguatera in the Pacific: a link with military activities. *Lancet* 1989;1:201-5.
79. Oliver FW. Dust-storms in Egypt and their relation to the war period, as noted in Maryut, 1939-1945. *Geographical J* 1945;106:26-49.
80. Oliver FW. Dust-storms in Egypt as noted in Maryut: a supplement. *Geographical J* 1947;108:221-6.
81. World Commission on Environment and Development. *Our common future*. Oxford: Oxford University Press; 1987.
82. Barnaby F. The environmental impact of the Gulf war. *Ecologist* 1991;21:166-72.
83. Toukan A. Humanity at war: the environmental price. *Physician Soc Respons Q* 1991;1:214-20.
84. Nimetz M, Caine GM. Crimes against nature. *Amicus J* 1991;13:8-10.

Reprint requests to: Dr. Jennifer Leaning, François-Xavier Bagnoud Center for Health and Human Rights, Harvard School of Public Health, 651 Huntington Ave., Boston MA 02115; jleaning@hsph.harvard.edu

Articles to date in this series

- McCally M. Environment and health: an overview. *CMAJ* 2000;163(5):533-5.
- Speidel JJ. Environment and health: 1. Population, consumption and human health. *CMAJ* 2000;163(5):551-6.
- Haines A, McMichael AJ, Epstein PR. Environment and health: 2. Global climate change and health. *CMAJ* 2000;163(6):729-34.
- De Gruijl FR, van der Leun JC. Environment and health: 3. Ozone depletion and ultraviolet radiation. *CMAJ* 2000;163(7):851-5.
- Clapp R. Environment and health: 4. Cancer. *CMAJ* 2000; 163(8):1009-12.

2000 Physician Manager Institute

For the leadership and management skills necessary to function effectively

Approved for RCPSC, CFPC and
AAFP study credits

PMI-3 / PMI-4

Nov. 5-7 / Nov. 8-10, 2000 Sutton Place Hotel,
Vancouver

In-house PMI

A practical, cost-effective
and focused training opportunity held
on site for leaders and managers

For information:
tel 800 663-7336 or 613 731-8610
x2319 (PMI) or x2261 (In-house PMI)
michah@cma.ca
www.cma.ca/prodev/pmi

ASSOCIATION
MÉDICALE
CANADIENNE



CANADIAN
MEDICAL
ASSOCIATION



Canadian College of Health Service Executives
Collège canadien des directeurs de services de santé