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ENVIRONMENT 2006

ABSTRACT: The members of the 2006 Industrial College of the Armed Forces (ICAF) Environment Industry Study (EIS) evaluated a wide range of environmental issues that have implications for US national security in the context of a complex, interdependent global economy; an intensifying international debate regarding the cause and consequences of climate change; and a shifting, sometimes confusing, landscape of international allies and threats. The EIS determined that it is essential for the US to take a conscious, proactive lead in literally “creating our environment.” Leaders and citizens must openly address issues affecting not only our natural resources, but those we share with the world. This paper evaluates the current environmental conditions and impacts, highlighting the critical issue of climate change; examines what is already being done to address these issues; discusses implications regarding national security; and provides recommendations for ways we can contribute positively to the ecosystem, thereby constructively influencing the environment to produce the greatest benefit for all its members. In the final analysis, this paper describes choices. How we, as individuals and nations, chose to participate in the environment in the past now determines present realities. Some of those realities are stark—changing weather patterns, massive deforestation, collapsed fisheries, diminishing freshwater supplies. But we will continue to have choices, just as we will continue to participate in and thereby create the environment. The 2006 EIS members saw first-hand the impacts of people who chose short-term gain and now are dealing with long-term consequences, both inside and outside the US. Conversely, we also studied and spoke to government leaders moving from awareness to action, successful corporations discovering shareholder value in sustainable strategies, and individual citizens who are “thinking globally and acting locally.” Finally, we have greater insight into the strategic value of environmental security, and, perhaps most importantly, that the environment really is everyone’s business.

LtCol Ted Banta, US Marine Corps
 CDR Jim Buckley, US Navy
 Ms. Kathleen Curd, Dept of Army
 Dr. Karsten Deiseroth, EADS, Germany
 Lt Col David DeMartino, US Air Force
 LtCol Norman Eliassen, US Marine Corps
 Mr. Michael Etzinger, Dept of Army
 COL Jude Fernan, US Army
 Lt Col Keith Kosan, US Air Force
 Lt Col William Leister, US Air Force
 LTC Oleh Levchenko, Ukrainian Army
 Mr. David Mudrick, Dept of Homeland Security
 Ms. Maureen Quinlan, Dept of Air Force
 COL Andrew Riley, US Army
 CDR Daniel Seep, US Navy
 COL Yakov Shahrabani, Israeli Air Force

Dr. Steven Meyer, Faculty Lead
 AMB Clifford Bond, Faculty
 AMB Michael Klosson, Faculty

PLACES VISITED

Domestic

Fairfax County Water Treatment Facility, VA
 World Resources Institute, Washington DC
 US House of Representatives Committee on Resources, Washington DC
 Senate Committee on Environment and Public Works, Washington DC
 World Bank, Washington DC
 Chesapeake Bay Foundation, MD
 BP Solar, MD
 Wheelabrator, MD
 Governor's Office; Juneau, AK
 US Coast Guard; Juneau, AK
 NOAA; Juneau, AK
 EPA; Juneau, AK
 US Fish & Wildlife Services; Juneau, AK
 Sealaska; Juneau, AK
 SE Alaska Conservation Council; Juneau, AK
 Earthjustice; Juneau, AK
 Bear Creek Outfitters; Juneau, AK
 US Forest Service; Juneau, AK
 Denali Commission; Anchorage, AK
 Conoco Phillips; Anchorage, AK
 Alaska Conservation Foundation; Anchorage, AK
 Audubon Alaska; Anchorage, AK
 BP; Anchorage, AK
 DuPont Corporate HQ, DE
 Woodrow Wilson Center, Washington DC

International

Mai Po Wetland Park, Hong Kong
 Environmental Protection Agency, Hong Kong
 Consulate General, Hong Kong
 Friends of the Earth, Hong Kong
 China Exploration & Research Society, Hong Kong
 The Conservancy Association, Hong Kong
 Civic Exchange, Hong Kong
 Yunnan University; Kunming, China
 Dianchi Lake; Kunming, China
 International Institute for Rural Reconstruction; Kunming, China
 Conservation International; Kunming, China
 Yunnan Eco-Network; Kunming, China
 Nature Conservancy; Lijiang, China
 Biodiversity Conservation and Development Association; Lijiang, China
 Tiger Leaping Gorge; China
 Rural NW Yunnan Province Village; China (Vicinity Lijiang)

Green Watershed; Lijiang, China

China Environmental & Sustainable Development Reference and Research Center; Beijing, China

China-Japan Friendship Environmental Protection Center; Beijing, China

Pacific Environment and Global Greengrants Fund; Beijing, China

Green Earth Volunteers; Beijing, China

Community Action; Beijing, China

Beijing Brooks Environmental Center; Beijing, China

US Embassy; Beijing, China

Sustainable Development Center of Municipal Science & Technology Commission; Beijing, China

Environmental Defense for the Energy & Environment; Beijing, China

Friends of Nature; Beijing, China



INTRODUCTION

The environment is invented by our presence in it. We do not parachute into a sea of turbulence, to sink or swim. We and our environments become one system, each influencing the other, each co-determining the other. ... Organisms do not experience environments. They create them.

Margaret Wheatley and Myron Kellner-Rogers, *A Simpler Way*

As Wheatley and Kellner-Rogers suggest, our presence in the environment does not have inherently positive or negative value. But the choices we make do have a profound impact. They will in fact determine the quality of the environment. All too often our choices have produced devastating results, ranging from lethal contamination of air, land, and water resources to extinction of species and total collapse of societies. Therefore, as full-fledged members of a constantly changing ecosystem, humans must adapt their behaviors not only to elicit its full value—whether for subsistence or enhanced quality of life—but to promote the health of the environment.

The members of the 2006 Industrial College of the Armed Forces (ICAF) Environment Industry Study (EIS) evaluated a wide range of environmental issues that have implications for US business and national security in the context of a complex, interdependent global economy; an intensifying international debate regarding the cause and consequences of climate change; and a shifting, sometimes confusing, landscape of international allies and threats. We have determined that it is essential for the US to take a conscious, proactive lead in literally “creating our environment.” Leaders and citizens must openly address issues affecting not only our natural resources, but those we share with the world. This paper accomplishes the following:

- Evaluates the current environmental conditions and impacts, highlighting the critical issue of climate change;
- Examines what is already being done to address these issues;
- Discusses implications regarding national security;
- Provides recommendations for ways we can contribute positively to the ecosystem, thereby constructively influencing the environment to produce the greatest benefit for all its members.

CURRENT ENVIRONMENTAL CONDITIONS & IMPACTS

A systematic assessment of current conditions and impacts of the three sectors that define the physical environment—air, land, and water—informs our conclusions and recommendations. Since we are operating on the assumption that human choices influence the quality of the environment, the space between conditions and impacts—fraught with risks and opportunities—is the place where we can most make a difference. Perhaps our most controversial deduction is that current air, land, and water conditions have been directly impacted by humans, and one key result has been climate change. We also conclude that resultant environmental impacts—air quality, land capacity, and water quality and quantity—have a direct bearing on the stability and prosperity of people and nations, and therefore on national security, both domestically and globally.

Air

The two primary air quality challenges are air pollution and the amount of CO₂ in the air. Air pollution leads to various health issues including lung cancer, emphysema, and provides a small contribution to asthma. Use of biomass fuels such as wood for cooking and heating and the associated smoke has been identified as the major indoor pollutant while particulate matter has been identified as the major health related outdoor pollutant.¹ Figure 1 in the Appendix shows the worldwide increase in atmospheric concentration of CO₂, as well as the human contribution. Increases in CO₂ concentration are linked to a trend of rising temperatures, or what can generally be characterized as climate change. Also, direct impacts of poor air quality are dramatic. According to the World Health Organization (WHO), indoor air pollution is responsible for the death of 1.6 million people every year. It is estimated that outdoor air pollution claims another 800,000 lives. Countless others have their everyday lives adversely affected with debilitating, yet non-lethal maladies.

Agriculture, which also plays a significant role in air quality, is responsible for an estimated one third of climate change as related to global warming. There is general agreement in the scientific community that about 25% of Greenhouse Gas (GHG) is produced by agricultural activity, mainly deforestation and burning of biomass. Most of the methane in the atmosphere comes from livestock ruminants, forest fires, wetland rice cultivation and waste products, while soil tillage and nitrogen fertilizers account for 70% of nitrous oxides.²

Significant Regional Indicators

Despite improvements in air quality, in the US an estimated 42.5 million people breathe unhealthy levels of both ozone and particulate pollution. In 1998 the U.S., Canada and Mexico contributed 22.5%, 1.9% and 1.5% respectively to the global production of CO₂.³ In the US, Mexico and Canada, approximately 80% of CO₂ emissions come from energy related sources, highlighting the significance of fossil fuel combustion in the increasing levels of GHG emissions.

Air pollution in Latin America remains a significant challenge. Inefficient energy generation, solid fuel combustion, and hydrocarbon-based transportation continue to degrade the region's atmosphere. This trend is accentuated by expansion of industrial production to meet globalization-driven demands, urban population increase, and increased motor vehicle use. WHO reports the resultant public health issues include respiratory, pulmonary, and carcinogenic effects that frequently make headlines in western press.⁴ Additionally, indoor air pollution from solid fuels is estimated to inflict even greater burden of disease than outdoor air pollution.⁵

In Europe, acid rain is caused by fallout from gaseous emission of SO₂ and NO_x, coming from power plants and industrial boilers, transportation, and evaporation of slurry from animal stockyards and manure application on farms. The main threat to health is fine particulates. The imbalance of ozone distribution, triggered by pollution from burning fossil fuels leads to ozone accumulation at the ground level which damage human's lungs--causing 20,000 deaths annually in the EU.⁶

As Asian countries continue to develop, additional air pollution in the form of smoke is causing new health challenges. Haze is formed from forest fires, burning of agricultural waste, emissions from vehicles and biofuels, and is made up of ash, acids, aerosols and other particles, reducing sunlight reaching the Earth's surface by up to 15% and potentially affecting weather patterns.⁷ The 2006 EIS members experienced China's notorious air pollution problem first-hand, lending credence to reports that air pollution in some Chinese cities is the worst in the world. Pollutants in China are rising due to reliance on coal-dominated energy generation, rapid and significant industrial expansion, and sharply increasing numbers of motor vehicles. Acid rain has spread over

much of the country and is now prevalent in 25% of Chinese cities for more than half of the rainy days each year.⁸

Land

There is a direct correlation between land use and air quality. Since trees absorb twice the CO₂ as does the planet's atmosphere, loss of plant life through deforestation decreases the earth's ability to convert rising levels of CO₂ to oxygen. Trees store CO₂, using the carbon as nutrients and releasing the oxygen back into the air--a process that can take up to 40 years. When a tree is cut, not only is its photosynthetic capacity no longer available, the stored carbon is released back into the air. For these reasons, deforestation accounts for 25% of all man-made CO₂ emission--2 billion tons of carbon each year. By reducing deforestation, replanting old forests and planting new forests, CO₂ emissions from fossil fuels could be offset by about 15% per year over the next 50 years.⁹ Deforestation destroys more than 32 million acres of forest each year, and China accounts for half of the market for this wood. Primary forests, which account for up to 26% of all global forests, are destroyed at a rate of almost 15 million acres per year. Loss of trees causes soil erosion which precipitates flooding and mudslides. Desertification, drought, and the spread of disease are also linked to deforestation, and improper erosion control allows increased nutrients into the water supplies, often killing fish that many people depend upon for food.

Significant Regional Indicators

In North America about 24% of the US land area is forested, down from an estimated 54% 8,000 years ago, although forested lands increased in size by 1% from 1990-2000. Canadian forests account for 25% of the nation's total land area, down from 66% of original forest lands, but showing no change in overall size from 1990-2000. These figures indicate that both countries have stabilized the overall percentages of forested lands, suggesting some degree of success with sustainable forest policies implemented at the national level. While the numbers are reassuring, rising temperatures associated with climate change still threaten the future of Canadian and US forests. In contrast, Mexico's 55.2 million hectares of forested land accounts for 28% of their total land area, down from 56% of original forested land and representing a 10% decrease from 1990-2000. This decline in forested areas reflects a deforestation trend that continues on the order of between 314,000 and 1.1 million hectares annually, much of which is attributed to illegal logging conducted by poverty-stricken landowners and organized crime groups with devastating effects to the size and biodiversity of Mexico's forests.¹⁰

The conditions in the rest of Latin America are equally worrisome. Latin America, which contained 25% of the world's forests in 2003, is losing its forests at alarming rates.¹¹ These forests span the scale of ecosystem types from high altitude cloud forests to equatorial rain forests to arid scrub zones. They are home to unique species, representing extensive biodiversity. They are also key CO₂ sinks, critical to controlling atmospheric GHG accumulation. The UN Food and Agriculture Organization (FAO) research contends that "overgrazing, poor irrigation techniques, deforestation, and removal of vegetal cover for domestic uses are among the factors that endanger 70 percent of the highly vulnerable dry soils."¹² Land-use conversion to support societal development and economic growth is driving lasting effects on the terrestrial ecosystems in the region as well as the atmosphere.

In Europe, there are a number of pressures on the land, most prominently erosion, sealing, and salinization. The main contributors to erosion are acid rains and leaching of farm chemicals. There are two million land sites that are contaminated from almost 100,000 pollution sources, major

contaminants including heavy metals, oil spills, mine tailings, and mineral processing. Sealing also exposes additional risks to soil degradation; salinization is caused by poor irrigation practices.

In Asia, China leads the world's countries as most severely damaged by erosion, now affecting 19% of its land area and resulting in soil loss of 5 billion tons per year. It is one of the world's most forest-poor countries, with only 0.3 acres per person, compared to world average of 1.6, contributing to erosion and floods. Climate change and deforestation both contribute to droughts that affect 30% of the country's croplands each year. Indeed, China is noted for the frequency, number, extent and damage of natural disasters, including dust storms, landslides, droughts, and floods, that have all been associated with human environmental impact.¹³

Water

More than a billion people worldwide do not have access to clean water. Populations are being displaced due to diminishing water resources, and estimates show that by 2035, as many as three billion people may live in areas with severe water shortages. According to WHO, more than 20% of the world population does not have a regular supply of drinking water. Not only is scarcity an issue, water quality is equally troublesome. Water pollution is responsible for countless maladies. WHO estimates that nearly 1.8 million people die each year from diarrheal effects brought on by drinking polluted water.¹⁴ Nine of every 10 deaths from infectious disease worldwide are of the waterborne type, again as a result of using unclean water.¹⁵ Water treatment facilities are scarce in developing countries, resulting in millions of people drinking, bathing, and cooking with untreated water. Sources of water pollution are numerous; and significantly, many are interlinked with other environmental conditions. For example, some portion of the air pollution previously described that settles to the Earth inevitably ends up in water sources. Runoff from aforementioned deforested areas adds to pollution levels as well. These conditions are stark on their own; however, issues related to water quality and scarcity also potentially have the greatest geo-strategic impact of the three environmental sectors evaluated in this study.

Significant Regional Indicators

The US has unquestionably benefited from environmental regulations that reversed decades of pollution and destruction of water ecosystems; nonetheless, we face additional challenges such as salinization and pollution of surface and groundwater supplies from agricultural and industrial activities. Even more so than the U.S., Canada has an abundance of freshwater with over 2.9 billion km³ of natural renewable water resources that equated to over 92,000 cubic meters of fresh water per person in 2002. Compared to its northern neighbors, Mexico has a smaller freshwater resource base with only 457 km³ of natural renewable water resources, equating to 4,490 cubic meters per person in 2002. Mexico faces significant challenges with fresh water supplies from the effects of domestic and industrial pollution.

In the remainder of Latin America, the regional water challenge is making the resource available for population demands. Irregular distribution of water resources coupled with a reduction in available reserves due to deforestation, urban expansion, and excessive use stresses populations across the region.¹⁶ Moreover, infrastructure falls short of demands in many of the urban and rural areas. This year 60% of the population did not have a regular water supply, while 116 million people did not have access to sanitation services.¹⁷

In Europe there is sufficient quantity of fresh water; however, water quality is an acute issue. A large number of pollutants, such as sewage effluent, farm and food-processing wastes, pesticides, and veterinary medicines from farmlands have contributed both to surface and groundwater

contamination in almost half of European countries, especially those in the east that are moving towards free market economies, as well as those located in the post-Chernobyl radioactive contamination zone. Excessive pumping of water from aquifers for agricultural needs has also resulted in sinking water tables, empty wells, and saline intrusion. The intensification and combination of these conditions are expected to lead to serious water stresses in Europe in the future. Europe's marine and coastal resources are also being challenged. In the Baltic Sea, the main stressors are eutrophication, anoxic conditions, toxic blooms of algae, and overexploitation of fisheries. In the Barents Sea, pollution is increasing due to shipping, military activities, oil production, declining biodiversity, and melting ice cover. The Mediterranean Sea is being compromised by coastal erosion, toxic algal blooms, low nutrient levels, and alien species.¹⁸

Conditions in Africa are even more troubling. Over 300 million people are still without safe water. Unequal access to adequate water is a critical issue. The richest are twice as likely to use drinking water from an improved source and four times more likely to use improved sanitation than the poorest. Frustration levels rise when water or sanitation prices in one African city are drastically higher than in a neighboring city. For example, in Nairobi slums the cost of water can be 20 times the price of water in the richer suburbs.¹⁹

In the Middle East, a vast majority of people in the region also suffer from water stress, primarily resulting from generally dry climate conditions, periodic droughts due to weather changes, soil degradation due to deforestation and overgrazing, and the region's increasing population.²⁰ It is now the poorest in the world in per capita water availability, representing only 1/3 of Asian and 15% of African levels.²¹ Seventy-five percent of the region's main water resources are the Jordan River basin, the coastal aquifer, and the mountain aquifer, mainly located in the West Bank, and is an inevitable reason for conflict.²² Importantly, if there is no significant change in the water supply-demand equation, such as desalination or imported water with new pipelines from northern countries, water quality and quantity will decrease dramatically within a decade.²³ Until 1990 all countries in the Middle East (with the exception of Israel and Libya) had water policy strategies that were based on past expectations of water availability rather than on current realities, further emphasizing the lack of management of this vital resource.²⁴

In contrast, although there is no water shortage in Central Asia, poor management of shared resources has resulted in tensions and disputes in the region.²⁵ The perpetuation of the region's water resource issues is tied to the region's geography, climate and its Soviet Union legacy. Current rivalries among the new independent states in the region have intensified the issues. More specifically, lack of a coherent water resource management and uncertainty over future water infrastructure plans among Central Asian states are the main reasons water resources will continue to be the primary cause of tensions and disputes in the region.²⁶

Finally, in China, water challenges are dramatic. According to a presentation to the 2006 EIS from scientists at Yunnan University, China is already a water-shortage country. They predict that by 2030, when the population reaches 1.6 billion, per capita water possession will drop to levels that will severely stress the population. About 75% of China's lakes and almost all coastal seas are polluted, due to industrial and municipal waste water discharges, and runoffs of fertilizers, pesticides, and manure.²⁷ We visited China's sixth largest freshwater lake, Dianchi Lake in Kunming, and observed first-hand the sheer magnitude of China's water pollution challenges. Over the years, industrial waste water was emptied into the upper section of the Dianchi, degrading the lake's natural purification capacity. The sediment at the bottom of the lake contains a toxic mix of cadmium, arsenic, and lead. Even after \$2 billion was spent attempting to clean up the lake, the water fails to achieve even minimal standards. According to deputy director of the Yunnan Provincial Institute of Environmental Science, it would take 20-30 years to clean up the lake.²⁸ Ironically, despite these alarming statistics, we observed the lake being perceived as a valued

community scenic spot. Despite the lake's unhealthy color and noxious odors, people were fishing and boating (some paddling by hand), upscale lakefront homes were under construction, and families strolled on the adjacent boardwalk, including a number of bridal parties posing for portraits. This scene typifies the overwhelming and complex nature of China's water pollution issues resulting from rapid socio-economic growth.

Air, Land, Water Convergence: The Climate Change Debate

The 2006 EIS operated in a context of intensifying public debate regarding climate change—or “global warming.” In pop culture, the issue is bracketed by the apocalyptic image of an Arctic New York City in the film *Day After Tomorrow* and Michael Crichton's novel *State of Fear*, which advances the case that global warming is a conspiracy by environmentalists seeking to make money from fear that can be created in the public's mind. The violence of the 2004 Asian tsunami and the 2005 Hurricane Katrina further punctuated the public debate, and myriad cover stories in print and TV news magazines quoted an array of scientific data and theory. Closer to home, presentations to the EIS members by NASA, the World Bank, the World Resource Institute, and many others, contended that the scientific debate regarding climate change was essentially “over,” and now we're only left with framing our responses. Speakers in Alaska characterized their state as “Ground Zero” for climate change, and even oil company representatives there acknowledged the necessity to develop new operational methods to contend with prematurely thawing permafrost. In contrast, staff from the US Senate and House Majority Committees responsible for environmental issues would not acknowledge that climate change was more than a normal cyclic phenomenon, and one staffer even suggested reading Crichton's aforementioned novel as an expert source on the topic.

A preponderance of our independent research indicates that the earth's climate through history has revealed that small forces, maintained long enough, can cause climate change. Indeed, the convergence of the air, land, and water conditions previously described appears to be affecting global climate patterns. Most credible scientific sources agree that dramatic, demonstrable, potentially irreversible changes already are taking place. 2005 was the hottest year ever recorded by NASA's Goddard Institute. Eight of the ten hottest years on record have occurred since 1996.²⁹ The problem is to accurately project the extent of those changes. A substantial body of evidence suggests that the Greenland and Arctic ice caps are rapidly melting due to increased atmospheric temperatures from GHG concentrations, with many Arctic ecosystems and communities already experiencing the changes brought by this phenomenon. The immediate effects range from changes to polar bear and seal habitats³⁰ to destruction of ice road networks in Canada,³¹ but the most far-reaching effects with global impact could result from rising sea levels associated with ice melt runoff. With rates of sea level rise estimated at up to one meter over 20 years, low-lying coastal areas of North America could be subject to flooding and wave damage that would quite literally redraw national maps. In addition to the economic and demographic effects of flooding on coastal urban areas, there could be substantial losses of agricultural areas from flooding and loss of river delta watershed areas.

Climate change will have both direct and indirect effects. For example, the decline in the amount of arable land as a direct result of climate change certainly will impact many countries' ability to produce sufficient food for its peoples. The worst affected countries could very likely be those sub-Saharan African nations that are already ill-equipped to provide for their citizens. From an indirect perspective, the spread of tropical diseases such as malaria may increase as the warmer temperatures move north. The WHO estimates that climate change accounts for about 150,000 additional deaths per year, as well as about 5 million heat induced illnesses.

Although there continues to be dissent in some quarters, the impact of climate change on agriculture ecosystems suggests that human induced GHG emissions are contributing to changes to weather patterns, and that the inertial character of climate change cannot be reversed quickly. Therefore, major modifications to crop cycles, coastal/deltaic agriculture loss, human population movements, crop geopolitical balance, increased global security, and an increase in crop/animal vs. pest /disease occurrences are all very likely occurrences.³² Soil is the heart of the agriculture industry, and concern for soil comes in quantity of available arable land, soil fertility, erosion and soil temperature. Temperature in addition to affecting soil will also have a serious impact on growing season length, earlier harvesting, multiple cropping cycles in the same season, and crop producing areas potentially expanding towards the poles. Finally, all agriculture is obviously strongly influenced by water; and climate change will modify rainfall, evaporation, runoff, and soil moisture storage.³³

Another trend associated with climate change is the proliferation of insect pests. Longer growing seasons and warmer temperatures provide ideal conditions for insect pests to complete additional reproductive cycles like we are seeing with the spruce bark beetle in Alaska and flea beetle populations in the Northeast.³⁴ The population of the mountain pine beetle in Canada's British Columbia has exploded with the warming climate and is killing more trees than logging and wildfires. The tiny beetle has infested an area three times the size of Maryland, killing large swaths of lodgepole pine and reshaping the future of the forest and the communities in it.³⁵ Warmer temperatures during the winter months allow for insect larvae to winter-over in areas previously limited by cold, leading to greater infestation during the following crop season.³⁶

Finally, energy use is the biggest contributor of CO₂, with electrical power production and transportation accounting for the majority of the CO₂ produced. Specifically, the use of coal/natural gas for the production of electrical power and the use of oil (diesel, jet fuel and gasoline) for transportation are pouring CO₂ into the atmosphere. Dramatic changes are required in electric power and transportation to extensively reduce the amount of CO₂ released, which will be discussed in detail in the following section.

THE SOLUTIONS: ACTORS AND SECTORS

In a remark to the 2006 EIS members, an Environmental NGO leader in Hong Kong aptly posed the question, "Our future is not to be predicted, but made. So who is to be involved in the making?" Predicting the environmental future is most constructive when it provides a context for action. The next section of this paper discusses who is currently involved in the making—specifically, how governments, non-governmental organizations, and private enterprise are engaged, and how the world population perceives environmental issues.

Governments

In the U.S., the government is addressing environmental issues through policy actions and smaller initiatives, although there does not appear to be a coherently linked strategy. The current administration published a National Energy Plan providing incentives for renewable energy and energy-efficient vehicles.³⁷ While there is public debate regarding whether the plan will help or not, it nevertheless provides a focal point for discussion and federal action. Meanwhile, the Export Import Bank, a financial agent of the US Government, provides financial assistance to help sell American goods and services in the international market.³⁸ According to EBI, the US has a three billion dollar export surplus in environmental technology.³⁹ Our comparative advantage in environmental technology combined with assistance from the Export Import Bank creates great

business opportunities for America, helps our economy grow and improves the environment. Examples of smaller, more localized initiatives include the federal grant to the University of Missouri to open an environmental technology office in Beijing to assist companies focused on wastewater, drinking water, and solid waste management⁴⁰ and the Denali Commission, which was formed by Congressional mandate in 1998 to work with federal, state, local, tribal and other agencies to develop diversified and sustainable economies in Alaska. The Commission attempts to fill the gaps between the multiple agencies trying to improve the quality of life in Alaska while maintaining its biodiversity. One demonstration project that the Denali commission has participated in is the establishment of a wind farm in western Alaska.⁴¹

Major environmental programs in Europe include the Sixth Community Environment Action Programme and the United Nation Development Programme-GEF Dnipro Basin Environment Program. The EU GHG emission trading provides selected industries with emission permits for GHG. Each year the EU reduces the number of permits forcing companies to become more efficient as well as providing them the opportunity to sell their excess emissions for profit.⁴²

Latin American governments acknowledge the need for a sustainable development agenda, tailored to the realities of each nation.⁴³ Many programs are underway, driven by governments, NGOs, industry and a conscientious populace. Brazil recently strengthened laws in a concerted effort to combat illegal logging, reducing the rate of deforestation by 30% in only one year.⁴⁴ The Global Environment Facility (GEF) is enabling projects in Brazil and the Guyana Shield to conserve the largest remaining tracts of tropical rainforests.⁴⁵ In Bogotá, the government energized several clean-air projects ranging from a bus-based transit system and strict limits on automobile usage to over 1,200 new parks and 300 kilometers of bicycle paths.⁴⁶ In Costa Rica and Panama, programs are in place to capitalize on a surge in ecotourism. The GEF is sponsoring programs in Latin America to restore pasture land and boost farm productivity in poor areas.⁴⁷ And this spring, the 4th World Water Forum was held in Mexico City, an ideal backdrop to heighten public awareness of sustainable development and to facilitate regional change.

Facing overwhelming signs of their country's environmental degradation, the Chinese government is beginning the arduous journey from awareness to action. While many environmental protection laws and policies have been enacted, most are not effectively implemented or enforced.⁴⁸ The 2006 EIS members witnessed Beijing's public commitment to improve the environment in such high-profile initiatives as the 11th Five Year Plan (2006-2010), which includes goals to reduce energy consumption per unit GDP by 20%, and the Beijing 2008 "Green" Olympics vision. Nonetheless, a severely understaffed State Environmental Protection Administration; competing interests among central, provincial, and municipal governments; and the focus on rapid economic growth surely will hamper progress on their environmental agendas. As Jared Diamond aptly observes, "As for the outcome of China's current environmental problems, all one can say for sure is that things will get worse before they get better, because of time lags and the momentum of damage already under way."⁴⁹

In the Middle East, the outlook during the first years of the 1990's was promising: On October 26, 1994 Israel and Jordan signed their peace treaty, in which they both "recognize that their water resources are not sufficient to meet their needs... [and therefore, they jointly will promote] ways to alleviate water shortage."⁵⁰ In 1992, following the Oslo agreement between Israel and the Palestinian Authority, five multilateral working groups were set up, examining a wide range of strategic issues. One of the groups, the Middle East Multilateral Working Group on Water Resources devotedly explored the key issue of water.⁵¹ Joint organizations, such as the Executive Action Team, the Middle East Desalination Research Center, and the Water Care organization (an educational program for public water awareness), have also been established.⁵² Even though the

successes of a decade ago have not been continued as the region continues to experience political turbulence, the strategic opportunities offered by regional water solutions remain viable.

In Central Asia, USAID has engaged in the region to improve democratization, economic development, health care and natural resource management. Water resource management initiatives have been key to USAID's strategy in the region. Their early efforts while perhaps too ambitious for the newly independent states due to the political and economic realities of the region,⁵³ nonetheless addressed water resource management through larger geographical sectors that required organizations to work with the "entrenched water *nomenklatura*."⁵⁴

Finally, another critical government actor in the environment is the UN. The United Nations Environmental Program (UNEP) is charged to provide leadership to solve some of the world's major environmental problems. In fact, environmental sustainability is one of the tenets of the Millennium Development Goals.⁵⁵ UNEP ensures that a wide range of developed and developing countries are included in the assessment and discussion of environment issues, and they can reinforce the importance and relationship between environmental sustainability and security. With a heavy focus on Africa and its multiple environmental challenges, UNEP provides assistance with technological solutions for green cities, reduction of leaded gasoline, and capacity building.⁵⁶ In response to the previously discussed climate phenomena, the UN has also established an Intergovernmental Panel on Climate Change (IPCC) with responsibility to analyze global warming. The IPCC has defined climate-forcing scenarios, used these scenarios in simulation of 21st-century climate, and estimated the impact of temperatures and precipitation changes on agriculture, natural ecosystems, wildlife and other matters.

Non-Governmental Organizations (NGOs)

NGOs play a vital role not only in supporting the environment but also as a balancing factor for governments. Their approaches range from cooperation to contention. For example, during our Alaskan field studies, the 2006 EIS members met with the Southeast Alaska Conservation Council (SEACC), which views itself as a grassroots organization focused on mobilizing public opinion in favor of the environment.⁵⁷ In contrast, our interview with the Natural Resources Defense Council suggested that they view themselves in a more traditional watchdog role, employing litigation as a primary tool to spur action—and reaction. Somewhere in the middle, the Chesapeake Bay Foundation provides a good example of the challenges faced by NGOs. Focused on restoring the Chesapeake Bay, the Foundation has spent forty years trying to improve the bay and watershed while trying to coordinate action amongst the states of Maryland, Virginia and Pennsylvania.⁵⁸ This undertaking has proved to be especially difficult given the wide range of opinions and competing demands.

In addition to interacting with governments on environmental agendas, NGO's play a key role in environmental education. Greenpeace, the World Wild Life Fund (WWF) , Earthwatch, Earthscan, the Foundation for Environmental Education (FEE), Rainforest Action Network, the World Resources Institute (WRI), and many other NGOs offer literature, courses, environmental education support and even manage local environmental education programs. The Earthwatch education center offers environmental education ideas & lesson plans,⁵⁹ and the FEE targets energy and environmental literacy and runs an Eco School program.⁶⁰ The WWF also offers fully developed environmental education packages covering all levels from middle school to high school.⁶¹ Finally, the World Bank is a major player in the strengthening of the education institutions in developing countries. It is the world's largest external financier of education. With its Fast Track Initiative Trust Fund and Education Program Development Fund it supports education projects in 25 developing countries.

NGOs also support technology development. For example, one important capability that technology affords nations is the ability to “see” their environmental ecosystems and assess their status. WRI partnered with Global Forest Watch (GFW) to provide countries around the world with the capability to identify and manage their natural forests.⁶² Their slogan, “what gets mapped gets managed” effectively describes how GFW has worked to use global information systems and other analytical tools to provide countries with the tools to manage their forests.⁶³ In Russia, GFW provided the Ministry of Natural Resources with maps and data sets covering Russia’s 100 nature reserves, 35 national parks and 69 federal wildlife preserves. This level of detail assisted the ministry in identifying and deconflicting oil exploration claims within protected areas.⁶⁴ With this increased knowledge and capacity, the Ministry could manage their natural resources in a more efficient and effective manner. GFW also works with developing countries in Africa like Cameroon where GFW provided an interactive forestry atlas allowing the government to monitor illegal forest activities by logging companies.⁶⁵ The US can also benefit from the use of technology to map ecosystems. Work completed by SEACC in the Tongass National Forest used existing government data on habitats to create an effective display of critical habitats designed to assist the Department of Interior in logging lease allocations.⁶⁶

Finally, NGOs support, inspire, and educate those in the greatest need. Exemplifying the slogan, “Think globally, act locally,” these grassroots organizations focus on small works that make big impacts. Our China field studies provided many notable examples. For example, the Nature Conservancy’s Green Village Credit provides loans of up to \$1250 geared toward both installing sustainable energy systems and creating income generation activities. Green Village Credit makes loans available only to households that install sustainable energy technologies where household credit and loans to generate income can be repaid from increasing income. Other examples are Green Watershed, which promotes community participation to build their capacity to manage their watersheds sustainably; and Green Earth, which is devoted to setting up school libraries in communities along the Nu River in order to preserve and research that valuable resource. Against daunting odds, NGOs in China persist in their objectives. As Elizabeth Economy observes about fledgling NGOs in Yunnan Province, “Even with limited human and financial capital, these NGOs have proved remarkably adept at sustaining their work; in fact, there are some striking examples of environmental activism that reach beyond what has been attempted by Beijing activist, which may well serve as models for future environmental activism in China.”⁶⁷

Business & Technology

Environmental Business Market

The environmental business market is difficult to define because it does not fall easily into a single industry. For example, the US Census Bureau has no Industry Series Reports titled “Environmental Business”; rather, environmental issues and programs are found in many sectors including Utilities; Construction; Professional, Scientific, and Technical Services; and Administrative and Support and Waste Management and Remediation.⁶⁸ The Department of Commerce defines the industry as all goods and services associated with environmental protection, assessment, compliance with environmental regulations, pollution control, waste management, remediation, design and operation of environmental infrastructure and delivery of key environmental resources.⁶⁹ Environmental Business International (EBI) takes this a step further by identifying 14 activities under the three broad categories of services, equipment, and resources (Table 1, Appendix).

EBI also offers strategic business information in newsletters and comprehensive research reports to members of the industry. While they expect to see overall market growth, they anticipate a decline in domestic hazardous waste, remediation, and air pollution control equipment that will offset the large market growth in wastewater treatment, water equipment and environmental energy. The projected growth in these sectors is attributed to demographics or domestic development while energy source growth is related to economic issues like the rising cost of oil and growing concerns about air quality and climate change.

Globally, EBI assesses that environmental spending will be dominated by the industrialized, high per-capita income countries. The US is almost 40% of the global market, with Western Europe comprising 30%, and Japan at 17% (Table 2, Appendix).⁷⁰ However, EBI sees incredible growth potential, and therefore US export potential, in the larger developing countries. Those of particular interest include China, India and Brazil, which are being driven by growing populations and increased energy needs. As expected, China presents the greatest potential as they plan to spend approximately \$157 billion dollars on environmental protection in the next five years. In fact, US environmental technology exports to China increased 125% from 2002 to 2004 (Table 3, Appendix).⁷¹ As China continues to develop, the Department of Commerce expects increased market demand for US products, particularly the cleaner production technologies. But as good as the outlook is for environmental businesses, they will still face challenges in the form of competition from Europe, Japan, and Australia, as well as relatively high tariffs and difficult distribution regulations and contracting procedures. The business sector's focus on water and wastewater, energy, air quality, and climate change, as well as EBI's assessment of China's potential, mirror the essential themes which emerged from our EIS research and field studies.

Corporate Responsibility

The basic rule in business is to survive and take care of the shareholders. To that end, businesses develop environmentally friendly strategies because they think it will pay off in the long run. General Electric's (GE) recent push toward becoming a greener company is just one example of this trend. One of GE's goals is to reduce main greenhouse gases within each of its business units. GE will be challenged to push riskier technology like fuel cells, solar energy, hydrogen storage and nanotechnology while continuing to work their more mainstream technology.⁷² Increasing numbers of companies from every industry are recognizing the profit potential in the environmental movement. Renewed scientific and public concern about climate change is bringing out the "green" in everyone. US companies have a competitive advantage due to our mature market and years of product differentiation. When the environmental movement began, it was not a competitive market because demand and supply did not determine the price. Federal intervention was necessary to create the market. Today, the environmental market has expanded with little additional government intervention, growing beyond the traditional environmental business definition given earlier as all industries realize the value of natural resources and the importance of being seen as socially responsible.

ISO 14000 certification is a good example. The International Organization for Standardization (ISO) is a network of national standards institutes from 147 countries. They developed ISO 14000 as a series of voluntary standards on environmental management systems. Although voluntary, global certifications increased significantly over the past 5 years and there are currently about 100,000 worldwide. Japan is the world leader with over 19,000, China is second with 8,900, and the US is lagging behind at about 6,000.⁷³ Although we are lagging, US numbers have increased in the last few years as US companies from every industry realized that certification

is often a prerequisite for international business. Certification is seen as a value in the market that's driving compliance.

ISO 14000 tracks management systems while ISO 14064, released in 2005, is the new standard for the quantification, monitoring, and reporting of GHG. Since climate change is regarded as one of the biggest environmental issues and one of the greatest challenges facing nations, governments, businesses and citizens, multi-stakeholder initiatives are being developed to limit GHG emissions through various regulatory schemes and incentive programs such as trading, taxes, voluntary incentive programs, international treaties and carbon sequestration projects.⁷⁴ Like ISO 14000, this is a voluntary program, but a large number of US and international companies are getting involved. In fact, a number of US companies were years ahead of ISO on this climate change issue. In 2000, they started the Chicago Climate Exchange (CCX), the world's first greenhouse gas emission registry, reduction and trading system for all six greenhouse gases. CCX is a self-regulatory, rules based exchange designed and governed by CCX members. Members make a voluntary but legally binding commitment to reduce GHG emissions and by December 2006 all members will have reduced direct emissions 4% below a baseline period of 1998-2001. The goals established by the organization are "to facilitate the transaction of greenhouse gas emissions allowance trading with price transparency, design excellence and environmental integrity; to build the skills and institutions needed to cost-effectively manage greenhouse gas emissions; to facilitate capacity-building in both public and private sector to facilitate greenhouse gas mitigation; to strengthen the intellectual framework required for cost effective and valid greenhouse gas reduction; to help inform the public debate on managing the risk of global climate change."⁷⁵

Finally, there are other organizations like the Green Power Market Development Group, a coalition of US corporations and the WRI. The group includes companies like Delphi, Dow Chemical, DuPont, FedEx, GM, IBM that have teamed together to develop new green power projects from wind, biomass, and solar.⁷⁶ And in the process they're working together to address climate change using both business and environmental models. Conservation International created a similar organization when they partnered with Ford Motor Company in 2000 as the Center for Environmental Leadership in Business. Ford brought 25 million dollars to the partnership with the goal of engaging industry leaders in order to achieve conservation-oriented outcomes. Current business partners include Intel, SC Johnson, Mitsubishi, and Weyerhaeuser along with a host of environmental NGOs. Their cooperation has allowed the Center to be recognized as a world leader in harnessing business ingenuity for environmental solutions regarding biodiversity and climate change.⁷⁷

Technology

Private enterprise is a key leader in technology innovation, which clearly plays a decisive role in mitigating the negative environmental effects. Waste water treatment plants treat sewer water prior to its return to the river and represent a growing sector within the environmental market.⁷⁸ These plants are large, complicated, and operate with surprisingly low manpower. Another proven technology is waste to energy plants. Wheelabrator Technologies Inc. operates clean energy plants throughout the nation. The Wheelabrator waste to energy plant in Baltimore disposes of municipal wastes and generates approximately 60,000 kilowatts of clean electricity.⁷⁹ Technology also provides two relatively new alternatives to overcome water shortages—desalination and imported water from water-rich countries. These innovative solutions underline the fact that the problem is no longer water shortage but water value—i.e., it is no longer an existential problem but an economic one, and moreover, technology research and innovations provide these solutions as cost-effective ones.

Technological innovation in energy is arguably the most strategically critical factor in positively influencing the environment, particularly given the nexus between GHG emissions and climate change. The demand for electricity and fuel for transportation is already huge and growing worldwide, particularly in rapidly developing countries such as China and India. Therefore, innovation in these sectors clearly has the greatest impact potential.

Technology solutions for increasing global capacity for clean electrical generation is currently focused on coal, natural gas, hydroelectric, nuclear, wind, solar, and geothermal sources. The cleanest way to directly burn coal is by gasifying and then burning it in a turbine to produce electricity. Further improvements can be obtained if gasified coal is chemically separated into CO₂ and H₂; the H₂ is then burned to produce electricity. This technology is still maturing and is the subject of the US FutureGen project. In either method, the CO₂ must be sequestered. With the number of coal power plants in the US and the number being built worldwide (particularly in China) sequestering will become a requirement for CO₂ reduction. Natural gas use is increasing in power production because it doesn't require as much emission reduction equipment as coal to meet regulations. However, like coal it produces CO₂, although less than coal due to its higher hydrogen content. The natural gas to H₂ process can also be used for clean power production by sequestering the resulting CO₂ and burning the H₂.

Two energy sources that do not release any CO₂ into the atmosphere are hydroelectric and nuclear power. Hydroelectric power currently accounts for about 20% of world power. However, there is a limit to how much power it can produce worldwide, and although it is a great renewable energy source, the construction of dams requires careful social and ecological analysis. Nuclear power currently produces ~17% of the world's, and 20% of US electrical power. Three Mile Island and Chernobyl greatly slowed development of nuclear power; however that trend is changing; the world is starting to recognize that nuclear power is a solution for eliminating CO₂. A number of initiatives are underway to address concerns of cost, safety, waste, and proliferation. Most notably, the US is engaged in the development of the Generation IV reactor design and a number of related nuclear programs.

Solar, wind, and geothermal sources are increasing in popularity as renewable energy sources, albeit with less capacity potential than the sources already mentioned. Electricity from photovoltaic panels is a great option especially in homes, schools and businesses. Every building has a roof and thus a place to put solar cells so potential sites for its use are innumerable. Additionally, peak power production from solar energy normally matches up with peak demand. Currently, the cost of the solar cells has restricted their use; however, as electricity prices go up, and solar cell technology improves, solar cells will become much more prevalent. Electricity production from wind is already greatly increasing. Wind is a good additional source to the electric power grid, but its use is limited to certain regions and depending on wind conditions power output is highly variable. Finally, large scale geothermal plants are a great renewable energy source that should be exploited where possible, but the sites are limited to certain regions; thus it will play a smaller role in the CO₂ solution. Significantly, the US is the world leader in geothermal electrical power production.

Increasing requirements for transportation is resulting in a proliferation of cars and trucks in the world; the number of vehicles could double to over 1.4 billion by 2030.⁸⁰ Oil is the finite resource fueling the majority of transportation around the globe. In the US transportation accounts for about $\frac{2}{3}$ of the nation's oil use. Increased concern for CO₂ emissions will cause dramatic change to transportation, and a burst of technological innovation is underway. Flex fuel vehicles, for example, are already in the US and more are being produced each year. Flex fuel vehicles run on a combination of different fuels, however, the premise is the same in all of them: reduce the amount of fossil fuel required to propel vehicles with the addition of a renewable source fuel and in the process make vehicles run cleaner. Hybrid cars and light trucks use combined energy sources for

propulsion to gain efficiencies. They are just now starting to gain momentum; from major car manufacturers to truck builders to the military, all are allocating more resources for hybrid development. Heavy hybrids have yet to make it to the mainstream, but they offer a huge potential in a sector where fuel economy is typically dismal. Projected oil savings will be from tens (in 2010) to hundreds of millions of barrels per year.⁸¹

Hydrogen is the next step in transportation. California has started several initiatives to make hydrogen-based transportation a reality. In the future, hydrogen likely will be used for all energy production. Fusion will produce electricity which in turn will produce hydrogen for fuel cells. In the move to hydrogen based power, the electrical power companies and the oil and gas industry will collide as the power companies move into fuel (hydrogen) production for transportation and the oil and gas companies move into “clean” (zero CO₂) electrical power production. Power companies, like the Hydrogen Utility Group (HUG), are very interested in hydrogen.⁸² They see “synergies from co-generating electricity and hydrogen” as a way to gain energy market share and level electric demand by producing H₂ during off-peak hours. They are marketing “clean” co-production of electricity/hydrogen from renewables, clean coal, and advanced nuclear and want to play a big role (profit) in the move to hydrogen. The first oil and gas company to recognize hydrogen’s future is BP. BP Hydrogen Power has North Atlantic and California projects for converting natural gas and petroleum coke (respectively), into H₂ and CO₂. They will then use the H₂ for electric power production and put the CO₂ in the ground (sequester it) to increase production from an oil field. BP is also putting \$8 billion toward renewable energy production, moving to gain market share in power generation.

Environmental Awareness (EA) and Education

A key element to completing the environmental outlook picture is to assess the level of EA in the populace. There is a direct correlation between levels of EA and a community, government, or individual’s willingness to seek solutions to environmental challenges. Significantly, EA has declined in developed countries,⁸³ while it has increased in developing countries.⁸⁴ This trend can be attributed partially to the solving of critical environmental issues in the developed countries while the solution of environmental issue in the developing countries becomes more and more a question of survival. However, in general, environment does not reach the top list of perceived threats. In a world wide survey asking people which of 5 dangers poses the greatest threat to the world, environment ranks mostly on the 4th or 5th place.⁸⁵ Only in countries where environmental issues are most acute, like in China, it reaches place 1. Therefore the raising of EA in order to uplift the priority of sustainable development in societies is a major challenge.

Even if the awareness level is sound, people have a lack of basic understanding of environmental issues. A survey of the National Environmental and Training Foundation (NETF) in the US in 2006 found that two out of three survey respondents failed to correctly answer 9 or more of 12 simple questions on the environment.⁸⁶ Only 23% of Americans were able to identify run-off as the leading cause of water pollution. Only 33% of Americans knew that burning fossil fuels is America’s primary method for generating electricity, or what impact this has on air quality. Misinformation was as much of a problem as lack of knowledge. In the EU, the picture is not much different. In Germany, for instance, BP conducted a survey polling the public about the term and meaning of “sustained development” and “Kyoto Protocol.” Sixty-seven percent of Germans had never heard of “sustainable development” and 52% did not know that the Kyoto Protocol for the world-wide reduction CO₂ emissions exists.⁸⁷ Environmental literacy is even lower in Africa. In a survey of basic environmental knowledge of pupils in South Africa, 70% answered less than 50% correctly.⁸⁸

EA must be increased before individuals can change their behavior on an informed basis. Misperceptions often influenced by media also may lessen public support for certain types of environmental regulation and consequently impede leaders to address some of the most complex environmental problems. That a sound level of environmental knowledge is important is supported by a study which found that higher environmental education correlates significantly with a higher degree of pro-environmental behavior.⁸⁹ For instance, environmentally educated people are 50% more likely to recycle.

Finally, leaders in industry and government can by the nature of their positions influence the environmental behavior of a society most. Therefore, an informed environmental background in leaders is essential to make sustainable development a success. Unfortunately, a US survey found little difference in environmental knowledge in average Americans and their governing bodies.⁹⁰ Accordingly, the members of the public are unprepared for their increasingly complex environmental responsibilities. The above issue was addressed by Martin and Jucker in their opening speech on the 2003 conference in Prague on education for a sustainable future. They claimed that our society is failing to produce leaders to address our most pressing problems. If the universities are the nursery of tomorrow's political and industrial leaders, graduates in every discipline need a sound knowledge in sustainability.⁹¹ On the positive side, a 2005 survey found that an increasing number of business schools are offering courses in ethics, corporate social responsibility, or environmental sustainability,⁹² again indicating the private enterprise is ahead of governments in many cases on environmental awareness.

NATIONAL SECURITY IMPLICATIONS

Once the realm only of the scientist and those of the same ilk, who read and review refereed technical and scientific journals, environmental security has grown in importance to the point that lofty generals and admirals responsible for regional security now speak of it often.

Vice Admiral Paul G. Gaffney II, US Navy, President, National Defense University

So, how is all this a security issue? In short, climate change associated with other environmental factors—land and forest degradation through salinization, deforestation, erosion, and over farming; competition for dwindling fossil energy resources; fresh water scarcity and pollution; habitat and biodiversity loss; massive urbanization and industrialization—directly impacts international stability and prosperity, placing increasing pressure on already stressed populations and governments. Globalization has increased the interconnectivity and interdependency of the world so much that economic and societal breakdown may spiral across the planet. Schwartz and Randall aptly illustrated the linkages between environmental conditions and national security in their landmark study on abrupt global climate change. For example, they postulate that increasing concentrations of atmospheric GHG could result in an average temperature increase of 5 degrees Fahrenheit over North America, resulting in changes to precipitation patterns and watersheds that could stress the carrying capacity of North American ecosystems. As agricultural productivity drops and water becomes increasingly scarce, the US may adopt an internal focus to provide for domestic needs. Increasing stress on Mexican ecosystems may generate more human migration, exacerbating the chronically volatile subject of illegal immigration as natural resources dwindle. In addition to immigration, cross-border water issues may strain the good relations between the U.S., Mexico and Canada.⁹³

Gregory Foster, in *Environmental Security: The Search for Strategic Legitimacy*, contends that “there is a growing acceptance today of the proposition that the environment and security are indissolubly linked. The term *environmental security* is, in fact, now an established, if persistently nebulous, part of the argot of national security affairs.”⁹⁴ Dr. Foster’s and Vice Admiral Gaffney’s observations notwithstanding, in the final analysis there is still a reluctance in the US to completely legitimize the environment, much less climate change, as a top strategic priority.

The 2006 National Security Strategy

Awareness of environmental security is only implied in the recently published *National Security Strategy of the United States of America*. The President concludes his introductory letter with this: “The second pillar of our strategy is confronting the challenges of our time by leading a growing community of democracies. Many of the problems we face—from the threat of pandemic disease, to proliferation of weapons of mass destruction, to terrorism, to human trafficking, to natural disasters—reach across borders. Effective multinational efforts are essential to solve these problems. Yet history has shown that only when we do our part will others do theirs. America must continue to lead.” The first of the two pillars of the strategy is “promoting freedom, justice, and human dignity.” Still, the mention of pandemic disease, natural disasters, and America leading by doing its part hopefully implies that the environment could be a major concern for national security.

However, further reading doesn’t confirm that optimism. The environment and related issues are not referenced again until the last three sections of the report, where they are mentioned only briefly. Section VIII, Develop Agendas for Cooperative Action with the Other Main Centers of Global Power, comments, “We have also faced challenges in forging consensus with other major nations on the most effective measures to protect the environment,” and regarding Sino-US relations, “We will work to increase our cooperation to combat disease pandemics and reverse environmental degradation.” Section IX, Transform America’s National Security Institutions to Meet the Challenges and Opportunities of the 21st Century, describes as a new challenge for the Department of Defense, “Catastrophic challenges involving the acquisition, possession, and use of WMD by state and non-state actors; and deadly pandemics and other natural disasters that produce WMD-like effects.” In Section X, Engage the Opportunities and Confront the Challenges of Globalization, the environment is more directly addressed: “Environmental destruction, whether caused by human behavior or cataclysmic mega-disasters such as floods, hurricanes, earthquakes, or tsunamis. Problems of this scope may overwhelm the capacity of local authorities to respond, and may even overtax national militaries, requiring a larger international response.” In the end, the *National Security Strategy* does little to promote environmental concerns as a priority.

Department of Defense (DoD) Position & Actions

Like the White House, DoD has demonstrated reluctance to confront environmental issues as a basic threat to security, although they are constantly dealing with them at a lower level. The military faces numerous local environmental concerns regarding encroachment, noise abatement, toxic wastes and contamination, unexploded munitions, and the like, on 5,014 active, BRAC, or formerly used defense sites, including 128 Superfund locations. The DoD briefly appeared to be taking a strategic environmental stance when it ordered a study by two consultants, published in October 2003: *An Abrupt Climate Change Scenario and Its Implications for United States National Security*. In the study, the authors stated, “We have created a climate change scenario that although not the most likely, is plausible, and would challenge United States national security in ways that

should be considered immediately." They postulated a scenario, based on Arctic melting and changes in the Gulf Stream, whereby North America and Europe cooled significantly while other parts of the world warmed, creating among other problems a significant shortfall in the world's food supply. The authors issued seven preliminary recommendations:

1. Improve predictive climate models.
2. Assemble comprehensive predictive models of climate change impacts.
3. Create vulnerability metrics.
4. Identify no-regrets strategies.
5. Rehearse adaptive responses.
6. Explore local implications.
7. Explore geo-engineering options that control the climate.

The report allegedly was never passed on to the Secretary of Defense, although its content was allowed to go public through a commercial magazine article. More comprehensive suggestions for major military transformation are suggested by others.

Despite its seeming reluctance to integrate environment issues into strategic planning, the Pentagon has gone a long way toward preparing for the eventuality of major environment-related instabilities by declaring stabilization and reconstruction operations to be core military capabilities. This further justifies the use of the military in disaster recovery and operations other than warfare, including peacekeeping and nation building, and indirectly prepares it for the very type of duties that would accompany rapid climate change. Ostensibly, it means training and planning for such operations will become mandatory.

Defining a "New Security Paradigm"

In his essay *A New Security Paradigm*, Gregory Foster states "Peace on Earth depends on our ability to secure our living environment."⁹⁵ The 2006 EIS members have concluded that for America and many countries around the world, we need to expand the debate and focus more on the relationship between the environment and security. The UN has recognized this relationship and has identified the environment as one of the seven threats to human security.⁹⁶ Perhaps due to US prosperity and status as a superpower, America has been slow to acknowledge this concern. For emerging nations, the negative influences to their economy caused by the destruction and exploitation of their natural resources are a real threat to economic growth and survival. As the world's leading superpower, we need to take a strong leadership role in bringing the actors together and leveraging existing and future technology to reduce the risk to security caused by threats to the environment.

Pertinent examples of the criticality and power of environmental security are demonstrable in the Middle East and Central Asia. According to Yitzhak Rabin, "If we solve every other problem in the Middle East but do not satisfactorily resolve the water problem, our region will explode. Peace will not be possible." Although water has not been the most prominent aspect of the Israeli-Arab confrontation, it can become a main contributor to cooperation and progress.⁹⁷ Water resources and cooperative management in the Middle East can be a pivotal point in the positive development of bilateral and multilateral regional relations. In Central Asia, water availability and quality issues have become the primary cause of disputes and tensions, potentially leading to local, state, regional and possibly world conflicts that would negatively affect US security and economic growth.⁹⁸ An analysis of the region through the lens of water resource management will show that, though not a top priority in the National Security Strategy, water issues in the region do affect US security and prosperity.

RECOMMENDATIONS

All scientific work is incomplete—whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone action that appears to demand at a given time. Who knows, asked Robert Browning, but the world may end tonight?

Sir Austin Bradford Hill, 1897-1991

While scientific research and public debate will (and should) continue both domestically and globally about environmental issues, particularly as related to climate change implications, sufficient evidence exists to suggest that we no longer have the freedom to postpone action. The United States Government has a responsibility to harness its political, economic, and social power by providing global leadership in ways that will positively influence our future environmental security. Given the broad, strategic implications of this framework, the policy space where our nation can influence the environment is crucial. After extensive research, interviews, and field studies, the 2006 EIS members recommend the following actions be taken in this endeavor:

1. Develop and Strengthen Awareness and Public Policies Regarding Climate Change Implications by ...

Acknowledging that current evidence demonstrates a strong link between GHG emissions and climate change. Integrate this awareness into strategic documents such as the *National Security Strategy*, as well as into legislative strategies guided by the US House of Representatives Committee on Resources and the Senate Committee on Environment and Public Works.

Revitalizing Department of Defense strategic focus on climate change implications for national security by developing action plans based on the October 2003 report, *An Abrupt Climate Change Scenario and Its Implications for United States National Security*. Continue contingency planning for similar scenarios.

2. Reduce Greenhouse Gas (GHG) Emissions by ...

Expanding nuclear power generation in a prudent manner through next-generation reactor technology.

Increase funding to accelerate the development of fossil fuel alternatives, methods for sequestering CO₂ and photovoltaic research.

Leading an international coalition to develop and deploy hybrid vehicles with a follow-on road map to hydrogen vehicles designed to end CO₂ emissions from ground transportation.

Developing incentives for farmers and large landowners to create and maintain “carbon sinks” and conservation tillage techniques that absorb atmospheric CO₂.

Developing incentives for farmers to reduce methane or nitrous oxide emissions from agricultural sources.

Lifting agricultural subsidies that encourage inefficient use of water and direct irrigation subsidies of \$4.4B per year.

Preparing for climate change effects by incentivizing development of heat- and drought-resistant crops by using biogenetically altered seeds and crops and introducing crop varieties that require longer or shorter growing seasons, as appropriate.

3. Inspire a National Ethos of Environmental Awareness and Conservation by ...

Raising the level of Environmental Literacy. Public schools and universities must integrate environmental education holistically into their curriculums. Federal grants and scholarships to universities should be reviewed and realigned as necessary to support national environmental objectives.

Encouraging voluntary water rationing across the country and developing incentives for water conservation to ensure the US continues to enjoy ready access to this vital resource.

Increasing emphasis on conserving forest and watershed resources. Governments, NGOs, business, and individuals must continue to develop and adhere to sustainable development philosophies that preserve the inherent value of our natural resources.

4. Leverage Environmental Issues in all Facets of Global Engagement by

Increasing awareness of the necessity for population control. The US government should encourage and participate in forums such as the 1994 United Nations International Conference on Population and Development, which focused on developing a plan of action for establishing programs to ensure a sustainable population for the planet.

Promoting environmental sustainability through good governance and free trade initiatives, leveraging bilateral and multilateral economic agreements like NAFTA and CAFTA-DR and supporting efforts through the World Bank, the UN and the Global Environment Facility (GEF) to bring about acceptable business standards, progressive development and positive regional stability. Compel American industry to act responsibly in all markets through statute, trade accords and public pressure, which, in turn, heightens local awareness and promotes change in foreign behavior.

Employing environmental strategies to help resolve even the toughest political challenges: Support a plan to address the Israel-Jordan-Palestinian water shortage through a network of canals and desalination plants; encourage a strategy of gradualism in multilateral water resource management arrangements between Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan while providing political, economic and environmental assistance in an effort to secure peace and stability in the region; and support a plan to address fragile water issues in Africa as an integral part of our national security strategy.

Strengthening international policies to preserve fisheries. More selective fishing techniques need to be employed to assure only the desired species are being harvested, and international agreements must be enforced.

Support China's Commitment to Greener Energy Sources, by sharing and partnering on technology innovations.

Vigorously supporting United Nations Environmental Initiatives, such as those sponsored by UNEP and the Intergovernmental Panel on Climate Change.

CONCLUSION

We stand now where two roads diverge. But unlike the roads of Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road -- the one "less traveled by" -- offers our last, our only chance to reach a destination that assures the preservation of our earth. The choice, after all, is ours to make.

Rachel Carson, *Silent Spring*

In the final analysis, this paper describes choices. How we, as individuals and nations, chose to participate in the environment in the past now determines present realities. Some of those realities are stark—changing weather patterns, massive deforestation, collapsed fisheries, diminishing freshwater supplies. But we will continue to have choices, just as we will continue to participate in and thereby create the environment. The US, as well as the global community, stand together at the fork in the road that Rachel Carson described over forty years ago in her ground-breaking work, *Silent Spring*.

The 2006 EIS members have seen first-hand the impacts of people who chose short-term gain and now are dealing with long-term consequences, both inside and outside the US. We have also studied and spoken to those who are taking the other fork in the road—government leaders moving from awareness to action, successful corporations discovering shareholder value in sustainable strategies, and individual citizens who are “thinking globally and acting locally.” Finally, we have greater insight into the strategic value of environmental security, and, perhaps most importantly, that the environment really is everyone’s business.

Taking the path “less traveled by” to assure the preservation of our earth will require tough choices. Leaders must choose to be accountable for the environment, acknowledge the challenges that exist, and take action. Nations, businesses, and individuals must choose to invest in developing technological solutions that won’t always have near-term rewards. Nations, even those with competing interests, must choose to work together to conserve and preserve finite resources. If the right choices are made, the potential reward is substantial: security derived from health, stability, and prosperity.

APPENDIX

Table 1 – Environmental Activities (source: EBI)

Environmental Industry Segment	1970	70-80		80-90		90-00		00-10	
		1980	Growth	1990	Growth	2000	Growth	2010	Growth
Services									
Analytical Services	0.1	0.4	300%	1.5	314%	1.3	-26%	1.5	15%
Wastewater Treatment Works	4.3	9.2	116%	19.8	116%	27.3	34%	37.0	36%
Solid Waste Management	3.2	8.5	164%	26.1	208%	37.9	45%	45.6	20%
Hazardous Waste Management	0.1	0.6	550%	6.3	921%	5.4	-15%	3.0	-44%
Remediation/Industrial Services	0.1	0.4	550%	8.5	1813%	11.7	5%	8.5	-27%
Consulting & Engineering	0.3	1.5	367%	12.5	761%	15.2	21%	17.0	12%
Equipment									
Water Equipment and Chemicals	3.2	6.9	117%	13.5	95%	21.2	57%	27.8	31%
Instruments & Information Systems	0.1	0.2	100%	2.0	820%	3.7	84%	4.5	22%
Air Pollution Control Equipment	1.0	3.0	196%	10.7	258%	17.1	30%	10.0	-42%
Waste Management Equipment	2.0	4.0	105%	10.4	159%	10.5	20%	13.0	24%
Process & Prevention Technology	0.0	0.1	259%	0.4	418%	1.2	192%	2.6	117%
Resources									
Water Utilities	5.7	11.9	109%	19.8	67%	30.3	53%	38.0	25%
Resource Recovery (recycling)	1.2	4.4	283%	13.1	197%	16.9	29%	23.0	36%
Environmental Energy Sources	0.3	1.5	420%	1.8	15%	3.3	87%	8.5	158%
U.S. Totals:	\$21.4	\$52.6	145%	\$146.4	178%	\$203	35%	\$240	18%

Table 2 – Global Markets by Region

By Region	% of Total		2001	
	2001	2000	2001	growth
USA	38%	\$203.1	\$210.4	3.6%
Western Europe	30%	162.8	169.0	3.8%
Japan	17%	94.6	96.9	2.5%
Rest of Asia	5%	23.5	26.4	12.0%
Mexico	0%	2.3	2.5	7.0%
Rest of Latin America	2%	9.6	10.3	8.0%
Canada	3%	14.3	14.7	3.0%
Australia/NZ	2%	9.0	9.3	4.0%
Central & East Europe	2%	9.5	10.3	9.0%
Middle East	1%	6.4	6.9	7.0%
Africa	1%	3.4	3.6	8.0%
Total (\$billions)	100%	\$538	\$560	3%

Table 3 – US Environmental Technology Exports
(from Mr. Joseph Ayoub presentation, DoC, Slide 6)

RANK	COUNTRY	2002	2003	2004	% Chg, '02-'04
1	Canada	5,469,286,752	6,006,039,003	6,268,984,121	15%
2	Mexico	3,596,170,762	3,871,197,409	4,213,132,647	17%
3	Japan	1,827,069,829	1,960,213,864	2,252,036,789	23%
4	Germany	1,258,194,230	1,427,827,186	1,739,958,172	38%
5	China	754,348,417	1,151,859,958	1,694,064,569	125%
17	Brazil	324,171,480	292,180,378	342,419,523	6%
18	Thailand	162,641,536	200,056,370	267,349,723	64%
19	Philippines	131,778,759	228,598,181	258,117,247	96%
20	India	155,163,019	178,868,574	256,903,706	66%

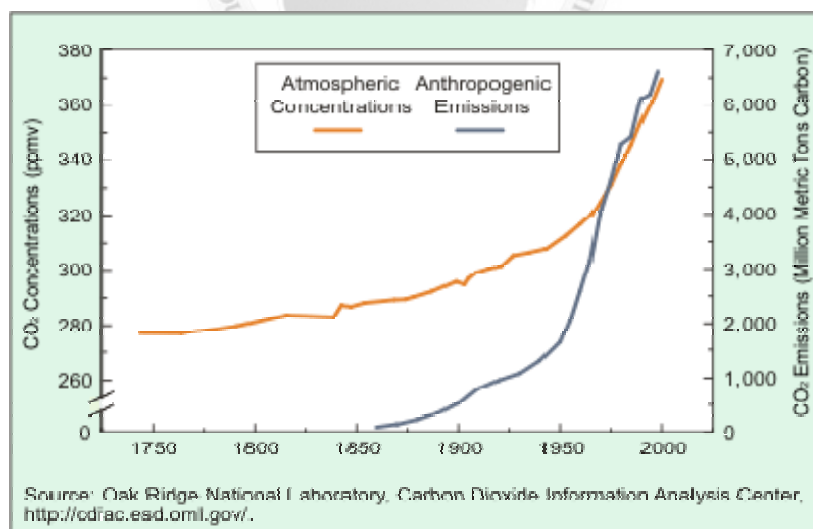


Figure 1. Atmospheric Carbon Dioxide Concentrations

-
- ¹ World Health Organization, Indoor Air Pollution and Health. Retrieved April 26, 2006 from <http://www.who.int/mediacentre/factsheets/fs292/en/index.html>
- ² FAO. 2001. Agriculture 21. Agriculture's role in climate change. Retrieved 4/12/2006 <http://www.fao.org/ag/magazine/0103sp2.html>
- ³ World Resources International (2003). EarthTrends Country Profiles. Retrieved March 27, 2006 from http://earthtrends.wri.org/country_profiles/index.php?theme=9&rcode=5
- ⁴ United Nations Environment Programme (2003). *Global Environment Outlook – 3: Latin America and the Caribbean*. Extracted on April 12, 2006, from http://mirror.unep.org/geo/pdfs/GEO__lac2003English.pdf
- ⁵ The World Bank (2005). *Environment Matters: Annual Review*. The World Bank Group: Washington DC.
- ⁶ European Environment Agency. (2005). *Market based instruments for environmental policy in Europe*. Retrieved March 30, 2006 from http://reports.eea.eu.int/technical_report_2005_8/en
- ⁷ United Nations Environment Programme. (2005). *UNEP 2005 Annual Report* [Brochure]. Nairobi, Kenya.
- ⁸ Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*. New York: Penguin Group, 363.
- ⁹ Kourous, G. (2005, December 9). Incentives to curb deforestation needed to counter climate change. *Food and Agriculture Organization of the United Nations*. Retrieved April 28, 2006 from <http://www.fao.org/newsroom/en/news/2005/1000176/index.html>
- ¹⁰ Cevallos, Diego (2005, October 18). Environment: Mexico Reverses Forest Destruction – or Does It? *Global Information Network, p.1*. Retrieved March 8, 2006 from ProQuest.
- ¹¹ United Nations Environment Programme (2003).
- ¹² United Nations Environment Programme (2003).
- ¹³ Diamond, 368.
- ¹⁴ World Health Organization (2002) World Health Report. Retrieved April 26, 2006 from http://www.who.int/whr/2002/en/whr02_en.pfd
- ¹⁵ Medscape Medical News. (2000, February 23) Pollution and Malnutrition to Increase Disease Worldwide. Retrieved April 26, 2006 from <http://www.medscape.com/viewarticle/411665>
- ¹⁶ United Nations Environment Programme (2003).

-
- ¹⁷ United Nations Environment Programme (2006). *Global Environment Outlook: GEO Year Book 2006*. Extracted on April 12, 2006, from <http://www.unep.org/geo/yearbook/yb2006/>.
- ¹⁸ European Environment Agency. (2005).
- ¹⁹ Tobin, Vanessa. UNICEF. Retrieved 30 March, 2006 from Powerpoint presentation retrieved from www.getf.org.
- ²⁰ Falkenmark, M., Widstrand, C. (1992). *Population and water resources: A delicate balance*, Population Bulletin, Population Reference Bureau.
- ²¹ Berman, I., Wihbey, P.M. (1999). *The New Water Politics of the Middle East*, Retrieved April 7, 2006 from <http://www.israeleconomy.org/strategic/water.htm>.
- ²² Sherman, M., *The politics of water in the Middle East*, St. Martin Press, Inc.
- ²³ Allan, Tony (2002). *The middle East water question*. New York: I.B Tauris Publishers.
- ²⁴ Allan (2002).
- ²⁵ Karaev, Zainiddin. *Water Diplomacy in Central Asia*. Retrieved March 15, 2006, from, <http://www.weltpolitik.net/Sachgebiete/Globale%20Zukunftsfragen/Energie%20und%20Ressourcen/Analysen/Water%20Diplomacy%20in%20Central%20Asia.html>
- ²⁶ Weinthal, Erika. (2002). *State Making and Environmental Cooperation; Linking Domestic and International Politics in Central Asia*. Cambridge, Mass; MIT Press.
- ²⁷ Diamond, 364.
- ²⁸ Economy, E. (2004). *The river runs black: The environmental challenge to China's future*. New York: Cornell University, 125.
- ²⁹ Williams, E. (2006). Climate change on the farm. More grapes, fewer apples, wilder rains, hotter cows. This and more may be ahead for New England. Retrieved 3/27/2006. <http://valleyadvocate.com/gbase/news/content?oid:148699>
- ³⁰ Struck, Doug (2006, March 22). Inuit See Signs In Arctic Thaw. *The Washington Post*, pg. A1.
- ³¹ Cherney, Elena (2006, April 4). Road to St. Theresa is Paved With Ice – It, Alas, is Melting. *The Wall Street Journal*, pg. A1.
- ³² FAO. 2004. Climate change: The Issue. Retrieved 3/27/2006. <http://www.fao.org/clim/>
- ³³ Rosenzweig, C. / Hillel, D. 1995. Potential impacts of climate change on agriculture and Food supply. *Consequences* Vol1, No. 2, summer 1995. Retrieved 3/27/2006. [http://gcrio.org/consequences/summer 1995/agriculture.html](http://gcrio.org/consequences/summer%201995/agriculture.html)
- ³⁴ Williams (2006)

-
- ³⁵ Struck (2006)
- ³⁶ Rosenzweig/Hillel (1995)
- ³⁷ Press Release, 'President Bush Signs Into Law a National Energy Plan. Retrieved 25 April 2006 at <http://www.whitehouse.gov/news/releases/2005/08/20050808-4.html>. Government publication.
- ³⁸ O'Connor, Craig. Financing International Exports', Export Import Bank Briefing to the Environmental Industry Study', March 30, 2006.
- ³⁹ Paterson, Andrew. *Environmental Market Outlook to 2010*. Briefing to Environmental Industry Study. 10 March 2006.
- ⁴⁰ *University Chases Chinese deals for environmental cleanup*. The Associated Press State & Local Wire. January 28 2006.
- ⁴¹ Canelos, George J. 'Denali Commission Overview Briefing to the Environmental Industry Study', April 20, 2006.
- ⁴² *NDP-GEF Dnipro Basin Environment Program*. (2002). Retrieved April 1, 2006 from <http://www.dnipro-gef.net/about/implications.php>
- ⁴³ Machinea, Jose (2004). *New Priorities for Latin America and the Caribbean*. United Nations Chronicle, Number 1, 2004.
- ⁴⁴ UNEP (2006)
- ⁴⁵ Global Environmental Facility (2005). *Achieving the Millennium Development Goals*. Brochure.
- ⁴⁶ The World Bank (2005). *Environment Matters: Annual Review*. The World Bank Group: Washington DC.
- ⁴⁷ GEF (2005)
- ⁴⁸ Diamond, 373.
- ⁴⁹ Diamond, 374.
- ⁵⁰ Taken from Article 6 of the Israel-Jordan peace agreement, October 26, 1994.
- ⁵¹ Assaf, K., *Joint Projects and Programs Promoting Middle East Cooperation and Knowledge in the Water Sector*. Retrieved on April 5, 2006 from <http://www.ipcri.org/watconf/papers/karen.pdf>
- ⁵² Retrieved on April 7, 2006 from <http://www.exact-me.org/>

-
- ⁵³ United States Agency for Information and Development (USAID). *Controlling Conflict in Central Asia*. Retrieved March 15, 2006, from http://www.usaid.gov/locations/europe_eurasia/car/caip_pci.html
- ⁵⁴ Weinthal, 189.
- ⁵⁵ UNEP (2005)
- ⁵⁶ Hansen, J. (2004, March). Defusing The Global Warming TIME BOMB [Electronic version]. *Scientific American*, Vol. 290, Issue 3, 68-77.
- ⁵⁷ Heath, Russell. 'Southeast Alaska Conservation Council Briefing to the Environmental Industry Study', April 19, 2006.
- ⁵⁸ *State of the Bay 2005*. Chesapeake Bay Foundation, Annapolis
- ⁵⁹ Earthwatch (2006). *Who we are*. Retrieved March 23, 2006, from Earthwatch Web site: <http://www.earthwatch.org>.
- ⁶⁰ Foundation for Environmental Education (FEE) (2006). *About FEE*. Retrieved March 23, 2006, from FEE Web site: <http://www.fee-international.org/AboutFEE>.
- ⁶¹ WWF (2006). *WWF - who we are and how we came about*. Retrieved March 23, 2006, from WWF Web site: http://www.panda.org/about_wwf/who_we_are/index.cfm.
- ⁶² World Resources Institute, 'Briefing to the Environmental Industry Study', March 10, 2006
- ⁶³ Global Forest Watch. (2005) *Top Ten Outcomes*. [Brochure]. Washington, DC.
- ⁶⁴ GFW Russia. Retrieved 25 April 2006 at <http://www.globalforestwatch.org/english/russia/news.htm#sustainableforestry>
- ⁶⁵ GFW Central Africa. Retrieved 25 April 2006 at <http://www.globalforestwatch.org/english/centralafrica/index.htm>
- ⁶⁶ Heath (2006)
- ⁶⁷ Economy, 156.

Notes

- ⁶⁸ United States Census Bureau, Economic Census Industry Series Schedule, <http://www.census.gov/econ/census02/guide/INDSUMM.HTM>
- ⁶⁹ Ayoub, Joseph, "Global Environmental Market: Overview of Trends and Competition," A briefing on behalf of the Dept of Commerce to the ICAF Environmental Industry Study,

March 2006, p. 6.

⁷⁰ Avoub, p. 3

⁷¹ Avoub, p. 12.

⁷² *A lean, clean electric machine – The greening of General Electric*. The Economist. December 10, 2005.

⁷³ Cascio, Joe, “Selected Initiatives and Developments in International Standardization and Regulation,” A briefing presented to the ICAF Environmental Industry Study, 16 March 2006.

⁷⁴ Environmental Protection Agency, “About EPA,” downloaded at <http://www.epa.gov/epahome/aboutepa.htm>

⁷⁵ Chicago Climate Exchange, downloaded at <http://www.chicagoclimatex.com/>

⁷⁶ Cutter Information Corp., “Green Power Purchases Continue,” *Business and the Environment*, March 2005, Downloaded from the NDU Library at http://infotrac.galegroup.com/itw/infomark/855/812/85056834w4/pur=c11_ITOF_0_A130/

⁷⁷ Conservation International, “The Center for Environmental Leadership,” downloaded at <http://www.celb.org/xp/CELB/>

⁷⁸ Paterson, Andrew. *Environmental Market Outlook to 2010*. Briefing to Environmental Industry Study. 10 March 2006.

⁷⁹ Wheelabrator Baltimore. Retrieved 26 April 2006 at <http://www.wheelabratortechnologies.com/WTI/CEP/Baltimore.asp>

⁸⁰ GM - http://www.nrel.gov/hydrogen/pdfs/gm_hug_briefing.pdf

⁸¹ DOE-ah² psp - http://www.nrel.gov/vehiclesandfuels/ahhps/pdfs/ahhps_prog_brief.pdf

⁸² HUG – utility - http://www.nrel.gov/hydrogen/pdfs/utility_hug_briefing.pdf

⁸³ Coyle, Kevin (2005, September). *Environmental Literacy in America*. Washington, DC: National Environmental Education & Training Foundation.

⁸⁴ Evan, Warren (2006, March 24). Visit to the World Bank of students from ICAF at the NDU. [Meeting Presentation]. DC: Washington.

⁸⁵ Pew Institute (2002). *Global attitudes final top-line*. Retrieved March 26, 2006, from: <http://people-press.org/reports/pdf/165topline.pdf>.

-
- ⁸⁶ The National Environmental and Training Foundation (NETF) (1997) *Two out of Three Americans Get a Failing Grade on the National Environmental Report Card*. Retrieved March 29, 2006, from: <http://www.neetf.org/roper/1997%20Summary.htm#Summary%20and%20Overview>.
- ⁸⁷ BP (2004). *Was wissen die Deutschen ueber Kyoto, Oekosteuer und Emissionshandel?*. Retrieved April 6, 2006, from http://www.verivox.de/i/bp_kyoto_umfrage.pdf.
- ⁸⁸ Block, L. & Schoeman, D.C. (N/A) *A Survey Of Environmental Knowledge, Attitudes And Beh* Afrikaans University, Republic of South Africa. Retrieved March 29, 2006, from:

<http://72.14.203.104/search?q=cache:MIYZHvA6J4J:geog.tamu.edu/sarah/blockschoeman3.pdf+a+survey+of+environmental+knowledge+south+africa&hl=en&gl=us&ct=clnk&cd=1>.
- ⁸⁹ Coyle, Kevin (2005, September). *Environmental Literacy in America*. Washington, DC: National Environmental Education & Training Foundation.
- ⁹⁰ Coyle (2005)
- ⁹¹ Brown, M Leann (2000). Scientific uncertainty and learning in European Union environmental policymaking. *Policy Studies Journal*. Urbana: 2000. Vol.28, Iss. 3; pg. 576, 21 pgs.
- ⁹² World Resource Institute (WRI) (2005, October 19) *Business Schools Respond to New Global Realities, Survey Shows*. Retrieved March 28, 2006, from:
http://newsroom.wri.org/newsrelease_text.cfm?NewsReleaseID=346
- ⁹³ Schwartz, Peter & Randall, Doug (2003, October). *An Abrupt Climate Change Scenario and Its Implications for United States National Security*. Retrieved March 3, 2006 from ProQuest.
- ⁹⁴ Foster, G. (2001). Environmental security: The search for strategic legitimacy. *Armed Forces and Society*, 27(3), 373-395.
- ⁹⁵ Foster, G. (2005, January/February). A New Security Paradigm. *World-Watch*, Vol. 18, Iss. 1, pp. 36-46.
- ⁹⁶ UNEP (2005)
- ⁹⁷ Sherman, M. *The politics of water in the Middle East*, St. Martin Press, Inc
- ⁹⁸ Zараev (2006)