by Robert Jawitz

The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP) in 1988. Since then it has made periodic assessments of the situation. In its latest assessment report (2007), it predicts global warming, primarily caused by the combustion of fossil fuels, will create a multitude of disastrous consequences. (See Appendix A).

In 2006, Livestock's Long Shadow was published by LEAD, The Livestock, Environment & Development Initiative, sponsored by The Food & Agricultural Organization of the UN, The World Bank, and representative agencies of the EU, France, Germany, UK, US Denmark and Switzerland and the International Fund for Agricultural Development. In its executive summary, it states "The livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global." (See Appendix B)

In 1991, the ISRIC, the International Soil Reference and Information Centre (ISRIC) in the Netherlands, in the first-and still the most comprehensive-study of global soil misuse, estimated in 1991 that humankind has degraded more than 7.5 million square miles of land. Our species, in other words, is rapidly trashing an area the size of the United States and Canada combined. In September, 2008, in an article in National Geographic Magazine called "Our Good Earth", it was reported, "This year food shortages, caused in part by the diminishing quantity and quality of the world's soil (see have led to riots in Asia, Africa, and Latin America." (See Appendix C).

On September 30, 2008, the World Ocean Council (WOC) was formed at the UN. The inaugural meeting included participants from the aquaculture, fisheries, oil and gas, maritime salvage and marine mining, as well other ocean, industries. UN Global Compact executive director Georg Kell and UN Division of Ocean Affairs and Law of the Sea director Vaclav Mikulka opened the session. The WOC reported; "The global marine environment and its resources are being degraded, destroyed and overexploited at an ever increasing rate and global scale. In the area of fisheries, human consumption of fish grew from 20 - 85 million ton during 1960 - 2002 and 70% of fish stocks are now considered to be fully exploited or overexploited." (See Appendix D)

The IPCC clearly put the source of global warming in the years of the industrial revolution. The

graphs shown in Appendix E, prepared as part of the IPPC AR4 report, June 29, 2007, shows that CO2 equivalents were fairly constant from 10,000 years before 1750 but exploded between 1750 and 2005, the years of the industrial revolution.

According to a description by Joseph Montagna of the Industrial Revolution for a curriculum at Yale, "The era known as the Industrial Revolution was a period in which fundamental changes occurred in agriculture, textile and metal manufacture, transportation, economic policies and the social structure in England (and later the World). The year 1760 is generally accepted as the "eve" of the Industrial Revolution."

The Industrial Revolution was marked initially by the burning of coal to power the steam engines, the locomotives, the textile industry, the ships and to heat the buildings of the 18th and 19th Centuries. In 1859, however, the first oil well was drilled in Western Pennsylvania by Edwin Drake. It was first used as kerosene for lighting, then furnaces for heat, but primarily, at the dawn of the 20th century, it became the fuel of the automobile. Today, all forms of transportation are fueled by oil; cars, trucks, buses, trains, ships, and airplanes. It supplanted coal for all industrial uses except for the power generation sector. It was these abundant, relatively cheap, easy to exploit, highly concentrated energy forms of coal and oil that transformed our civilization into what we now consider modern society.

Our modern society is characterized by the conspicuous consumption of this energy. Our two cars per family, our centrally heated houses made of industrialized products and appliances, our diets rich in meat from Texas or Brasil, grains from Kansas or Canada, bananas from Costa Rica, oranges from Israel and lettuce from California, our leisure marked by airplane flights or cruise ships to Cancun, Barcelona or Miami, and our global businesses that transport our products and ourselves all over the world is illustrative of our conspicuous consumption of energy. The US, for instance, is consuming about 400 gallons of oil a year per citizen- about 17% of its nation's energy use- for agriculture, a close second to our vehicular use. Tractor's, combines, harvesters, irrigation, sprayers, tillers, balers, and other equipment all use petroleum. Even bigger gas guzzlers on the farm are not the machines, but the so-called inputs. Synthetic fertilizers, pesticides, and herbicides use oil and natural gas as their starting materials, and in their manufacturing. More than a quarter of all farming energy goes into synthetic fertilizers. But getting the crop from seed to harvest takes only one-fifth of the total oil used for US food. The lion's share is consumed during the trip from the farm to your plate. Each food item in a typical US meal has traveled an average of 1,500 miles. In addition to direct transport, other fuel-thirsty steps include processing (drying, milling, cutting, sorting, baking), packaging, warehousing, and refrigeration. Energy calories consumed by production, packaging, and shipping far outweigh

the energy calories we receive from the food.

But now we are finding there are severe costs associated with the use of these cheap highly concentrated forms of energy. The first cost is our atmosphere. The IPCC in the AR4 report stated, "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level." This climate warming is primarily due to the greenhouse effect of CO2 from combustion of these fossil fuels, but also from the global atmospheric concentration of methane which has 23 times the greenhouse effect of CO2 and which is primarily due to agricultural/livestock activities and the global concentration of nitrous oxide which has 296 times the greenhouse effect of CO2 and which is more than a third caused by agricultural/livestock activities. The costs of global warming are so numerous, we won't even try to mention them all, but, as an example, "Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change.....In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020."

Which brings us to the second cost; land degradation. Cheap access and use of oil during the industrial revolution changed the agricultural system of our civilization. Because of the increased yields out of ranch and farmland due to the use of machines, urbanization became possible. It took fewer and fewer ranchers and farmers to support more and more non-farm families. These corporate ranches and farms were able to exploit larger and larger farms and pastures to support diets more and more dependent on meat and dairy. In Appendix B, it states, "The livestock sector is by far the single largest anthropogenic user of land. The total area occupied by grazing is equivalent to 26 percent of the ice-free terrestrial surface of the planet. In addition, the total area dedicated to feedcrop production amounts to 33 percent of total arable land. In all, livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet. Expansion of livestock production is a key factor in deforestation, especially in Latin America where the greatest amount of deforestation is occurring - 70 percent of previous forested land in the Amazon is occupied by pastures, and feedcrops cover a large part of the remainder. About 20 percent of the world's pastures and rangelands, with 73 percent of rangelands in dry areas, have been degraded to some extent, mostly through overgrazing, compaction and erosion created by livestock action." In Appendix C, it states, In Europe, soil compaction (from large machines) is thought to affect almost 130,000 square miles of farmland, and one expert suggests that the reduced harvests from compaction cost midwestern farmers in the U.S. $100 million in lost revenue every year. Connoisseurs of human fecklessness will appreciate that even as humankind is ratchetting up its demands on soil, we are destroying it faster than ever before. "Taking the long view, we are running out of dirt," says David R. Montgomery, a geologist at the University of Washington in Seattle."

The third cost of the industrial revolution and its related agricultural revolution is the depletion of our global freshwater resources. According to Appendix B, "The world is moving towards increasing problems of freshwater shortage, scarcity and depletion, with 64 percent of the world's population expected to live in water-stressed basins by 2025." The *Earth Policy Institute* , a Washington based independent research organization, argues that: "There are substitutes for oil but there are no substitutes for water. Excessive pumping for irrigation to satisfy food needs today almost guarantees a decline in food production tomorrow.... The food we consume requires 500 times as much water as we need to drink every day and agriculture is the most water-intensive sector of the economy. Seventy per cent of all water pumped from underground or diverted from rivers is used for irrigation, 20% is used by industry and 10% goes to domestic residences."

A fourth cost is the health of our oceans. Our mechanized ships and related equipment using coal and oil for fuels have greatly expanded our exploitation of our oceans. In Appendix D, it states, "The global marine environment and its resources are being degraded, destroyed and overexploited at an ever increasing rate and global scale. This is affecting the coastal inhabitants and communities worldwide that depend on marine areas for food and livelihood, as about 37% of the world's population lives within 100 km of the sea. The ocean's essential role in regulating climate is being compromised as ocean ecosystem health declines. Ocean industries such as shipping, oil, fisheries, aquaculture, and tourism are big and are expanding rapidly, bringing ever increasing impacts to the marine environment and its biodiversity. Seaborne shipping accounts for about 90% of global trade. US container shipments quintupled from 1980 to 2006, and worldwide cargo will double or triple by 2020. Cruise ship passenger capacity doubled in the past 20 years and continues to expand. Shipping impacts to marine biodiversity include oil spills from tankers and fuel tanks, invasive species, and waste discharge at sea. Ship borne air pollution is projected to increase 150% over the next 30 years. Oil and gas industry operations in the marine environment result in a range of impacts from seismic testing, platform spills, drilling waste, etc. Fisheries impacts include over harvesting, excessive by-catch, trawling of ocean bottom habitat and direct and indirect impacts to marine mammals, seabird and other endangered wildlife."

Which brings us to our fifth cost; we are losing biodiversity. The excessive exploitation of our land and oceans, because of mechanization, has led to unprecedented loss in animal and plant species. A report from *Environment New Service* (August 2, 1999) says that "The current extinction rate is now approaching 1,000 times the background rate and may climb to 10,000 times the background rate during the next century, if present trends continue. At this rate, one-third to two-thirds of all species of plants, animals, and other organisms would be lost during the second half of the next century, a loss that would easily equal those of past extinctions." A huge report known as the Millennium Ecosystem Assessment, started in 2000, was released in March 2005. Amongst many warnings for humankind, it noted that there has been (as summarized from the *BBC*) a substantial and largely

irreversible loss in the diversity of life on Earth
, with some 10-30% of the mammal, bird and amphibian species currently threatened with extinction, all due to human actions.

The Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC) was adopted for use December 11, 1997 in Kyoto. The purpose of this protocol was to have an international commitment to reduce greenhouse gas emissions to respond to global warming. There were 182 parties that ratified the proposal. The Kyoto Protocol is a laudatory effort by the 182 ratifiers to reduce atmospheric CO2e emissions and most of them are reaching the targets set by the Protocol.

Between November 30 and December 11, 2009, the Climate Conference in Copenhagen in scheduled ostensibly to prepare for the expiration of the Kyoto Protocol in 2012.

Between now and 2012, the international community has an opportunity to not only address global warming but to address, comprehensively, all of the severe problems caused by the Industrial Revolution.

And so, **WHERE DO WE GO FROM HERE?**

Climate change may be the greatest problem facing the world, but the other problems caused by the Industrial Revolution; land degradation, depletion of global freshwater resources, the destruction and overexploitation of our marine environment and the irreversibility of the extinctions of the biodiversity of life are nearly as important. All those problems have the same root of cause and the solution to them must be based on the same root. The fact is, even if we can replace fossil fuels with alternative non-CO2 emitting energy sources and with CO2 emitting but closed carbon cycle sources (which we can't and never will), unless we change the exploitive practices engendered from the Industrial Revolution to our natural environment, we face consequences that are more horrific than ever experienced by mankind. Because of the loss of rain and the destruction from storms from climate change, the mismanagement of our arable lands, the despoiling of our soils, the pollution of our drinking water, and the trashing of our oceans we face mass starvation on a scale that make death from war and genocide a minor footnote to history.

THE POST INDUSTRIAL SOCIETY

Most people in industrialized societies don't understand how dependent we are on oil. We are so used to easy access to fuel and relatively cheap industrialized goods ,we can't envision a time or place where this isn't the case. But people in Africa, Latin America and most of Asia know what scarcity is about. People around New Orleans after Katrina or Houston after Ike know what it was like without gasoline and electricity; when their cars wouldn't go and they couldn't get to the grocery store or get home at all. In 2003, people of Italy experienced what a blackout is like. In 2006, most of the East Coast of the US experienced what a blackout is like. The commerce just stopped. They struggled to just to get food and water.

Recently, we had a world-wide financial meltdown. It took huge resources of governments to avert a depression. Now people throughout the industrialized world know how fragile our economic system is. Now all the industrialized countries are saddled with huge debt. How can these countries respond to environmental disasters? Now imagine all industrialized societies without oil.

Of course the oil producing countries say we shouldn't worry; there's plenty of oil for another hundred years. That may or may not be. In either case, our environment can't survive another hundred years burning oil. One way or another, we have to wean ourselves off oil (and coal and natural gas). As those "developing countries" want the benefits of the industrialized culture and as populations grow, those easy and cheap resources won't be so easy, cheap, or available and change will happen whether or not we plan for it. But we should plan for it. We can avert the worst of the pain if we adjust to this world without oil, this post industrial society, before the catastrophes happen.

The post industrial society must be based on conservation of resources. Our wake-up call with the atmosphere shows us how small a planet it is that we live in and how interdependent we all are with it. The atmosphere is but a paper-thin layer on the surface of the globe and we have found how careless emissions from our vehicles, factories, generating stations and heating fuels can have disastrous consequences for us all. We have found that deforestation affects the carbon flux of the atmosphere and is a significant cause of climate change. We have found that our soils too are but a thin and fragile layer on our planet and are being squandered at an alarming rate. We have found the livestock industry has overwhelmed this thin layer of soils on our planet and will soon be unsustainable. We have found that our oceans are not a limitless resource and that in a little more than 40 years we have exhausted 70% of the fish resources. We have found that our drinking water resources, so critical for survival to all animal forms of life, has been so degraded that 64% of the world's population will live in water-stressed areas

by 2025.

The post industrial society, the civilization of the 21st century, will require we live a different lifestyle. It starts with the conservation and efficient use of energy. We can no longer afford to transport our products from all over the world to feed us, clothe us and to build our buildings with. We can no longer afford to transport ourselves long distances to shop or conduct our business. We need to reconsider the use of energy intensive products and practices. We need to decentralize our agriculture, our manufacturing and our commerce.

Primarily, however, we need to reconsider our diet. We repeat, LEAD, in its report "Livestock's Long Shadow", stated that, "The livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global." These problems include land degradation, serious contribution to global warming (damage to our atmosphere & climate), water degradation and depletion and damage to biodiversity. All of these problems are related. Land degradation relates to the changes of land use to create pasture for livestock at the expense of arable land and forest. Damage to our atmosphere and climate relates to the fossil fuel emissions required for feed production as well as the methane and nitrous oxide emissions from fertilizers and the animals themselves. Water degradation relates to increased water use for livestock in the midst of freshwater shortages and scarcity and to the pollution of water reserves ("livestock are responsible for an estimated 55 percent of erosion and sediment, 37 percent of pesticide use, 50 percent of antibiotic use, and a third of the loads of nitrogen and phosphorus into freshwater resources"). Damage to biodiversity relates to the fact that "it is the major driver of deforestation, as well as one of the leading drivers of land degradation, pollution, climate change, overfishing, sedimentation of coastal areas and facilitation of invasions by alien species."

Other reports show that while we get only 1/3 of our protein from Livestock, we devote 70% of our agricultural land and 30% of our planet for it. We get 940 calories from 12 oz steak while it took 32,900 calories of fossil fuel to raise it. 1 # of meat takes 8 times more energy and many times more arable land to provide as 1# of vegetable-sourced protein (like Tofu).

These environmental costs are mainly because of Western tastes. Most of India, population 950 million, doesn't eat meat and most of China, population 1,250 million, doesn't eat dairy. But, as Asia adopts Western culture, so will its food tastes change.

The LEAD report states;

"Growing populations and incomes, along with changing food preferences, are rapidly increasing demand for livestock products, while globalization is boosting trade in livestock inputs and products. Global production of meat is projected to more than double from 229 million tonnes in 1999/01 to 465 million tonnes in 2050, and that of milk to grow from 580 to 1,043 million tonnes. The environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level."

In "Quantification of the Environmental Impact of Different Dietary Protein Choices" (Reijnders & Sore, American Journal Of Clinical Nutrition) the authors state: "Many scientists and even policymakers have begun to question the sustainability of agriculture as practiced today. Particular skepticism has been directed at supporting the increased demand for animal products in the diet of the economically advantaged persons of the world. Throughout the world, there appears to be a direct link between dietary preference, agricultural production, and environmental degradation.

Between the Copenhagen Conference late in 2009 and the expiration of Kyoto in 2012, the nations of the world have an opportunity to address all of the severe environmental problems we inherited from the Industrial Revolution. It is appropriate because all these problems are interrelated. The reduction of emissions is more than moderating and monitoring smokestacks. The reduction of emissions has more to do with changing the habits that cause emissions. It is these habits which drives the ranchers to grow beef, which drives trawlers to overfish, which drives Detroit to make SUV's, and which drives us to fly to London for a meeting.

APPENDIX A

THE IPPC REPORT

In its Fourth Assessment Report (2007), Group 1 "The Physical Science Basis" the IPCC reports:

- "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."
- "Eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature"
- "The ocean has been absorbing more than 80% of the heat added to the climate system. Such warming causes salt water to expand, contributing to sea level rise."
- "Mountain glaciers and snow cover have declined on average in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rise."
- "Losses from the ice sheets of Greenland and Antarctica have very likely contributed to sea level rise over 1993 to 2003. Flow speed has increased for some Greenland and Antarctic outlet glaciers, which drain ice from the interior of the ice sheets. The corresponding increased ice sheet mass loss has often followed thinning, reduction or loss of ice shelves or loss of floating glacier tongues. Such dynamic ice loss is sufficient to explain most of the Antarctic net mass loss and approximately half of the Greenland net mass loss. The remainder of the ice loss from Greenland has occurred because losses due to melting have exceeded accumulation due to snowfall."
- "Global average sea level rose at an average rate of 1.8mm per year over 1961 to 2003. The rate was faster over 1993 to 2003: about 3.1 mm per year."
- Model based projections of global average sea level rise at the end of the 21st century (according to the A1F1 2007 scenario) would be 260 to 590 mm per year.

- The A1F1 scenario, according to table SPM.3, shows a projected global average surface warming between 2090 and 2099 to be between 2.4 and 6.4 degrees C.
- "Global average sea level in the last interglacial period was likely 4-6 m higher than the 20th century due to the retreat of polar ice. Ice core data indicate that the average polar temperatures at that time were 3 degrees C to 5 degrees higher than present, because of differences in the Earth's orbit. The Greenland Ice Sheet and other artic ice fields likely contributed no more than 4 m of the observed sea level rise (the remainder probably contributed from Antarctica)."

6 meters is the equivalent of 19.841 feet of sea level rise. If the global average temperature at the end of the century is 6.4 degrees C greater than 2000 levels, proportionally to 5 degrees C, the average sea level rise would be 25.4 feet. This does not represent all the ice from the

Greenland Ice Sheet and the Western Antarctic Ice Sheets. All the ice from those would represent a sea level rise of 12 m or almost 40'.

The Fourth Assessment Report, Group 2 "Impacts, Adaptation and Vulnerability" reports:

Africa

- "By 2020, between 75 and 250 million people are projected to be exposed to an increase of water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems."
- "Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change.....In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020."
- "Local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes due to rising temperatures, which may be exacerbated by continued over-fishing."
- "Mangroves and coral reefs are projected to be further degraded, with additional consequences for fisheries and tourism."

Asia

- "Glacier melt in the Himalayas is projected to increase flooding, and rock avalanches from destabilized slopes, and to affect water resources within the next two or three decades. This will be followed by decreased river flows as the glaciers recede."
- "Freshwater availability in Central, South, East and Southeast Asia, particularly in large river basins, is projected to decrease due to climate change which, along with population growth and increasing demand arising from higher standards of living, could adversely affect more than a billion people by the 2050's."
- "Coastal areas, especially heavily populated mega-delta regions in the South, East and Southeast Asia, will be at greatest risk due to increased flooding from the sea and, in some mega-deltas, flooding from the rivers."
- "Climate change is projected to impinge on sustainable development of most developing countries of Asia, as it compounds the pressures on natural resources and the environment associated with rapid urbanization, industrialization and economic development."

- "Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and Southeast Asia due to projected changes in the hydrological cycle associated with global warming. Increases in coastal water temperature would exacerbate the abundance and/or toxicity of cholera in South Asia."

Australia and New Zealand

- "As a result of reduced precipitation and increased evaporation, water security problems are projected to intensify by 2030 in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions."
- "Significant loss of biodiversity is projected to occur by 2020 in some ecologically-rich sites including the Great Barrier Reef and Queensland Wet Tropics. Other sites at risk include Kakadu wetlands, southwest Australia, sub-Antarctic islands and the alpine areas of both countries."
- "Ongoing coastal development and population growth in areas such as Cairns and Southeast Queensland (Australia) and Northland to Bay of Plenty (New Zealand) are expected to exacerbate risks from sea-level rise and increases in the severity and frequency of storms and coastal flooding by 2050."

Europe

- "Nearly all European regions are anticipated to be negatively affected by some future impacts of climate change and these will pose challenges to many economic sectors. Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods, and more frequent coastal flooding and increased erosion (due to storminess and sea-level rise). The great majority of organisms and ecosystems will have difficulty adapting to climate change. Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emission scenarios by 2080)."
- "In Southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity. It is projected to increase health risks due to heat waves and frequency of wildfires."
- "In Central and Eastern Europe, summer precipitation is projected to decrease, causing higher water stress. Health risks due to heat waves are projected to increase. Forest productivity is expected to decline and frequency of peatland fires to increase."

Latin America

- "By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation. There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America."

- "In drier areas, climate change is expected to lead to salinisation and desertification of agricultural land. Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase."
- "Sea-level rise is projected to cause increased risk of flooding in low-lying areas. Increases in sea surface temperature due to climate change are projected to have adverse effects on Mesoamerican coral reefs, and cause shifts in the location of south-east Pacific fish stocks."
- "Changes in precipitation patterns and a disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation."

North America

- "Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources."
- "Disturbances from pests, diseases, and fire are projected to have increasing impacts on forests, with an extended period of high fire risk and large increases in area burned."
- "Cities that currently experience heat waves are expected to be further challenged by an increased number and intensity and duration of heat waves during the course of the century, with potential for adverse health impacts. Elderly populations are most at risk."
- "Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Population growth and rising value of infrastructure in coastal areas increase vulnerability to climate variability and future climate change, with losses projected to increase if the intensity of tropical storms increases. Current adaptation is uneven and readiness for increased exposure is low."

APPENDIX B

LIVESTOCK'S LONG SHADOW

In 2006, Livestock's Long Shadow was published by LEAD, The Livestock, Environment & Development Initiative, sponsored by The Food & Agricultural Organization of the UN, The World Bank, and representative agencies of the EU, France, Germany, UK, US Denmark and Switzerland and the International Fund for Agricultural Development.

In its executive summary, it states "The livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global." These problems include:

LAND DEGRADATION

"The livestock sector is by far the single largest anthropogenic user of land. The total area occupied by grazing is equivalent to 26 percent of the ice-free terrestrial surface of the planet. In addition, the total area dedicated to feedcrop production amounts to 33 percent of total arable land. In all, livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet.
Expansion of livestock production is a key factor in deforestation, especially in Latin America where the greatest amount of deforestation is occurring - 70 percent of previous forested land in the Amazon is occupied by pastures, and feedcrops cover a large part of the remainder. About 20 percent of the world's pastures and rangelands, with 73 percent of rangelands in dry areas, have been degraded to some extent, mostly through overgrazing, compaction and erosion created by livestock action. The dry lands in particular are affected by these trends, as livestock are often the only source of livelihoods for the people living in these areas."

ATMOSPHERE AND CLIMATE

"With rising temperatures, rising sea levels, melting icecaps and glaciers, shifting ocean currents and weather patterns, climate change is the most serious challenge facing the human race.

The livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions measured in CO2 equivalent. This is a higher share than transport.

The livestock sector accounts for 9 percent of anthropogenic CO2 emissions. The largest share of this derives from land-use changes - especially deforestation - caused by expansion of pastures and arable land for feedcrops. Livestock are responsible for much larger shares of some gases with far higher potential to warm the atmosphere. The sector emits 37 percent of anthropogenic methane (with 23 times the global warming potential (GWP) of CO2) most of that from enteric fermentation by ruminants. It emits 65 percent of anthropogenic nitrous oxide (with 296 times the GWP of CO2), the great majority from manure. Livestock are also responsible for almost two-thirds (64 percent) of anthropogenic ammonia emissions, which contribute significantly to acid rain and acidification of ecosystems."

WATER

"The world is moving towards increasing problems of freshwater shortage, scarcity and depletion, with 64 percent of the world's population expected to live in water-stressed basins by 2025.

The livestock sector is a key player in increasing water use, accounting for over 8 percent of global human water use, mostly for the irrigation of feedcrops. It is probably the largest sectoral source of water pollution, contributing to eutrophication, "dead" zones in coastal areas, degradation of coral reefs, human health problems, emergence of antibiotic resistance and many others. The major sources of pollution are from animal wastes, antibiotics and hormones, chemicals from tanneries, fertilizers and pesticides used for feedcrops, and sediments from eroded pastures. Global figures are not available but in the United States, with the world's fourth largest land area, livestock are responsible for an estimated 55 percent of erosion and sediment, 37 percent of pesticide use, 50 percent of antibiotic use, and a third of the loads of nitrogen and phosphorus into freshwater resources.

Livestock also affect the replenishment of freshwater by compacting soil, reducing infiltration, degrading the banks of watercourses, drying up floodplains and lowering water tables. Livestock's contribution to deforestation also increases runoff and reduces dry season flows."

BIODIVERSITY

"We are in an era of unprecedented threats to biodiversity. The loss of species is estimated to be running 50 to 500 times higher than background rates found in the fossil record. Fifteen out of 24 important ecosystem services are assessed to be in decline.
Livestock now account for about 20 percent of the total terrestrial animal biomass, and the 30 percent of the earth's land surface that they now pre-empt was once habitat for wildlife. Indeed, the livestock sector may well be the leading player in the reduction of biodiversity, since it is the major driver of deforestation, as well as one of the leading drivers of land degradation, pollution, climate change, overfishing, sedimentation of coastal areas and facilitation of invasions by alien species. In addition, resource conflicts with pastoralists threaten species of wild predators and also protected areas close to pastures. Meanwhile in developed regions, especially Europe, pastures had become a location of diverse long-established types of ecosystem, many of which are now threatened by pasture abandonment.
Some 306 of the 825 terrestrial ecoregions identified by the Worldwide Fund for Nature (WWF) - ranged across all biomes and all biogeographical realms, reported livestock as one of the current threats. Conservation International has identified 35 global hotspots for biodiversity, characterized by exceptional levels of plant endemism and serious levels of habitat loss. Of these, 23 are reported to be affected by livestock production. An analysis of the authoritative World Conservation Union (IUCN) Red List of Threatened Species shows that most of the world's threatened species are suffering habitat loss where livestock are a factor."

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just to avoid increasing the level of damage beyond its present level."

APPENDIX C

OUR GOOD EARTH

The future rests on the soil beneath our feet.

By Charles C. Mann - National Geographic, September, 2008

On a warm September day, farmers from all over the state gather around the enormous machines. Combines, balers, rippers, cultivators, diskers, tractors of every variety-all can be found at the annual Wisconsin Farm Technology Days show. But the stars of the show are the great harvesters, looming over the crowd. They have names like hot rods-the Claas Jaguar 970, the Krone BiG X 1000-and are painted with colors bright as fireworks. The machines weigh 15 tons apiece and have tires tall as a tall man. When I visited Wisconsin Farm Technology Days last year, John Deere was letting visitors test its 8530 tractor, an electromechanical marvel so sophisticated that I had no idea how to operate it. Not to worry: The tractor drove itself,

navigating by satellite. I sat high and happy in the air-conditioned bridge, while beneath my feet vast wheels rolled over the earth.

The farmers grin as they watch the machines thunder through the cornfields. In the long run, though, they may be destroying their livelihoods. Midwestern topsoil, some of the finest cropland in the world, is made up of loose, heterogeneous clumps with plenty of air pockets between them. Big, heavy machines like the harvesters mash wet soil into an undifferentiated, nigh impenetrable slab-a process called compaction. Roots can't penetrate compacted ground; water can't drain into the earth and instead runs off, causing erosion. And because compaction can occur deep in the ground, it can take decades to reverse. Farm-equipment companies, aware of the problem, put huge tires on their machines to spread out the impact. And farmers are using satellite navigation to confine vehicles to specific paths, leaving the rest of the soil untouched. Nonetheless, this kind of compaction remains a serious issue-at least in nations where farmers can afford $400,000 harvesters.

Unfortunately, compaction is just one, relatively small piece in a mosaic of interrelated problems afflicting soils all over the planet. In the developing world, far more arable land is being lost to human-induced erosion and desertification, directly affecting the lives of 250 million people. In the first-and still the most comprehensive-study of global soil misuse, scientists at the International Soil Reference and Information Centre (ISRIC) in the Netherlands estimated in 1991 that humankind has degraded more than 7.5 million square miles of land. Our species, in other words, is rapidly trashing an area the size of the United States and Canada combined.

This year food shortages, caused in part by the diminishing quantity and quality of the world's soil (see " Dirt Poor "), have led to riots in Asia, Africa, and Latin America. By 2030, when today's toddlers have toddlers of their own, 8.3 billion people will walk the Earth; to feed them, the UN Food and Agriculture Organization estimates, farmers will have to grow almost 30 percent more grain than they do now. Connoisseurs of human fecklessness will appreciate that even as humankind is ratchetting up its demands on soil, we are destroying it faster than ever before. "Taking the long view, we are running out of dirt," says David R. Montgomery, a geologist at the University of Washington in Seattle.

Journalists sometimes describe unsexy subjects as MEGO: My eyes glaze over. Alas, soil degradation is the essence of MEGO. Nonetheless, the stakes-and the opportunities-could hardly be higher, says Rattan Lal, a prominent soil scientist at Ohio State University. Researchers and ordinary farmers around the world are finding that even devastated soils can be restored. The payoff, Lal says, is the chance not only to fight hunger but also to attack problems like water scarcity and even global warming. Indeed, some researchers believe that

global warming can be slowed significantly by using vast stores of carbon to reengineer the world's bad soils. "Political stability, environmental quality, hunger, and poverty all have the same root," Lal says. "In the long run, the solution to each is restoring the most basic of all resources, the soil."

Walking the roads on the farm hosting Wisconsin Farm Technology Days, it was easy for me to figure out what had worried Jethro Tull. Not Jethro Tull the 1970s rock band-Jethro Tull the agricultural reformer of the 18th century. Under my feet the prairie soil had been squashed by tractors and harvesters into a peculiar surface that felt like the poured-rubber flooring used around swimming pools. It was a modern version of a phenomenon noted by Tull: When farmers always plow in the same path, the ground becomes "trodden as hard as the Highway by the Cattle that draw the Harrows."

Tull knew the solution: Don't keep plowing in the same path. In fact, farmers are increasingly not using plows at all-a system called no-till farming. But their other machines continue to grow in size and weight. In Europe, soil compaction is thought to affect almost 130,000 square miles of farmland, and one expert suggests that the reduced harvests from compaction cost midwestern farmers in the U.S. $100 million in lost revenue every year.

The ultimate reason that compaction continues to afflict rich nations is the same reason that other forms of soil degradation afflict poor ones: Political and economic institutions are not set up to pay attention to soils. The Chinese officials who are rewarded for getting trees planted without concern about their survival are little different from the farmers in the Midwest who continue to use huge harvesters because they can't afford the labor to run several smaller machines.

Next to the compacted road on the Wisconsin farm was a demonstration of horse-drawn plowing. The earth curling up from the moldboard was dark, moist, refulgent-perfect midwestern topsoil. Photographer Jim Richardson got on his belly to capture it. He asked me to hunker down and hold a light. Soon we drew a small, puzzled crowd. Someone explained that we were looking at the soil. "What are they doing that for?" one woman asked loudly. In her voice I could hear the thought: MEGO.

When I told this story over the phone to David Montgomery, the University of Washington geologist, I could almost hear him shaking his head. "With eight billion people, we're going to *ha ve*

to start getting interested in soil," he said. "We're simply not going to be able to keep treating it like dirt."

APPENDIX D

WORLD OCEAN COUNCIL

(from its website www.trustforconservationinnovation.org/worldocean.php)

Oceans provide 59% of the world's ecosystem benefits; nearshore marine areas alone (5% of the Earth's surface) provide 38% of these global benefits. The global marine environment and its resources are being degraded, destroyed and overexploited at an ever increasing rate and global scale. This is affecting the coastal inhabitants and communities worldwide that depend on marine areas for food and livelihood, as about 37% of the world's population lives within 100 km of the sea. The ocean's essential role in regulating climate is being compromised as ocean ecosystem health declines.

The private sector is a primary user of ocean areas and resources. Many businesses are

entirely dependent upon ocean resources, services and space, e.g. marine transport, offshore oil and gas, ports, fisheries, aquaculture, marine tourism, and seabed mining. The worldwide economic value of ocean goods and services is estimated at USD 6-21 trillion. Ocean industries such as shipping, oil, fisheries, aquaculture, and tourism are big and are expanding rapidly, bringing ever increasing impacts to the marine environment and its biodiversity. Seaborne shipping accounts for about 90% of global trade. US container shipments quintupled from 1980 to 2006, and worldwide cargo will double or triple by 2020. Cruise ship passenger capacity doubled in the past 20 years and continues to expand. Shipping impacts to marine biodiversity include oil spills from tankers and fuel tanks, invasive species, and waste discharge at sea. Ship borne air pollution is projected to increase 150% over the next 30 years.

Ocean oil industry activity increased 9% in recent years. About 4,000 ocean wells exist around the world and exploration is expanding to ever deeper areas, particularly in many developing countries. Oil and gas industry operations in the marine environment result in a range of impacts from seismic testing, platform spills, drilling waste, etc. In the area of fisheries, human consumption of fish grew from 20 - 85 million ton during 1960 - 2002 and 70% of fish stocks are now considered to be fully exploited or overexploited. Fisheries impacts include over harvesting, excessive by-catch, trawling of ocean bottom habitat and direct and indirect impacts to marine mammals, seabird and other endangered wildlife. Other growing ocean industries include aquaculture, seabed mining, bioprospecting and offshore wind energy - all creating additional impacts and user conflicts. Conflicts are on the rise. For example, territorial skirmishes have erupted between fishers and oil exploration firms off the coast of Norway as fishing vessels and seismic exploration vessels work the same areas.

The private sector is best placed to develop and implement the solutions needed to ensure marine ecosystem use is sustainable and impacts are reduced. The problem is that the oceans are a dynamic, interconnected "commons" for which everyone, and no one, is completely responsible, with few incentives to take on shared environmental problems. Currently, ocean problems are primarily addressed by government regulation, intergovernmental agencies or by advocacy groups raising awareness and confronting industry on a sector- or incident-specific basis (e.g. trawling and oil spills). At the same time, climate change is impacting ocean industries in a variety of ways.

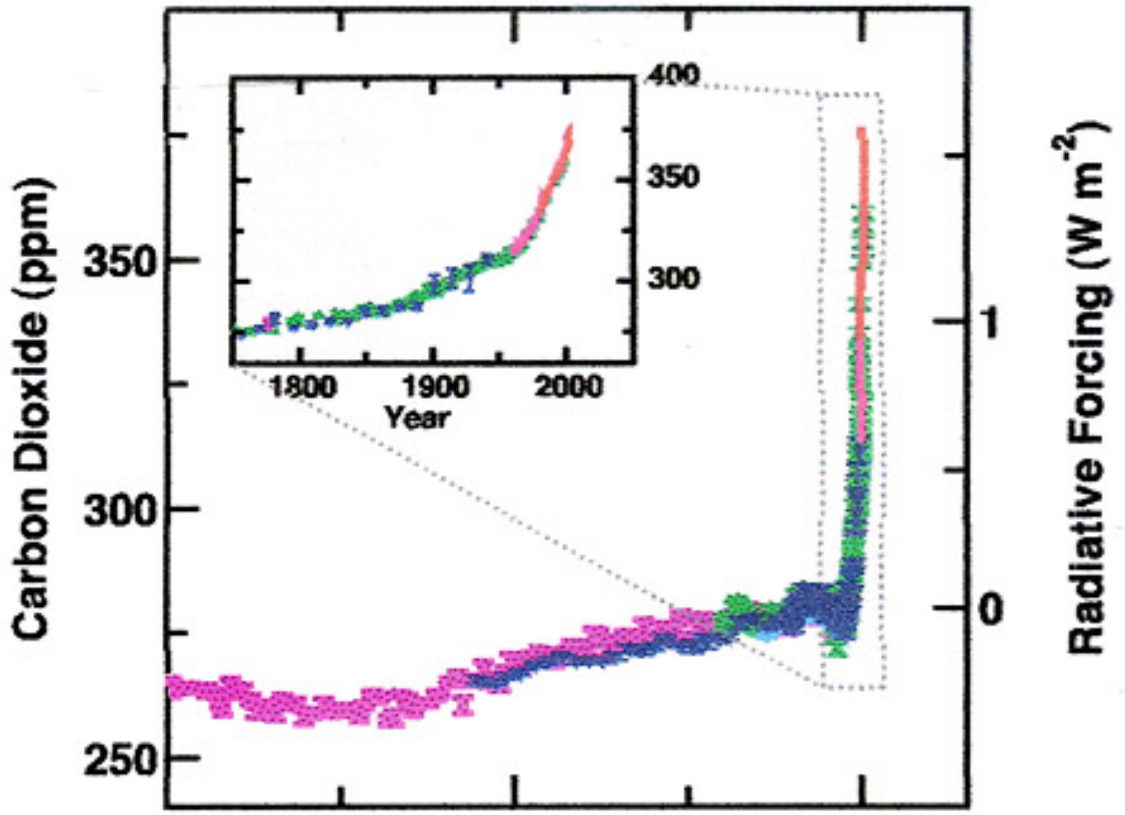
Achieving sustainability in the world's transboundary, interconnected oceans requires action at the global scale of marine environmental issues by those responsible for the major uses and impacts; i.e. the private sector. Ocean industries are thus best placed to develop shared approaches to climate change, but up till now they have not been doing so in a way that addresses the global scale of the problems. Some companies try to do business in a more environmentally sustainable way, but industry efforts are usually piecemeal and often reactive - undertaken by one company in a limited area. The efforts of a single company or even a whole

industry sector will not be enough to address global, cumulative impacts on the marine environment at the scope and scale needed.

APPENDIX E

HISTORIC CHANGES IN GREENHOUSE GASES

(from the IPCC AR4 Report; Summary for Policymakers)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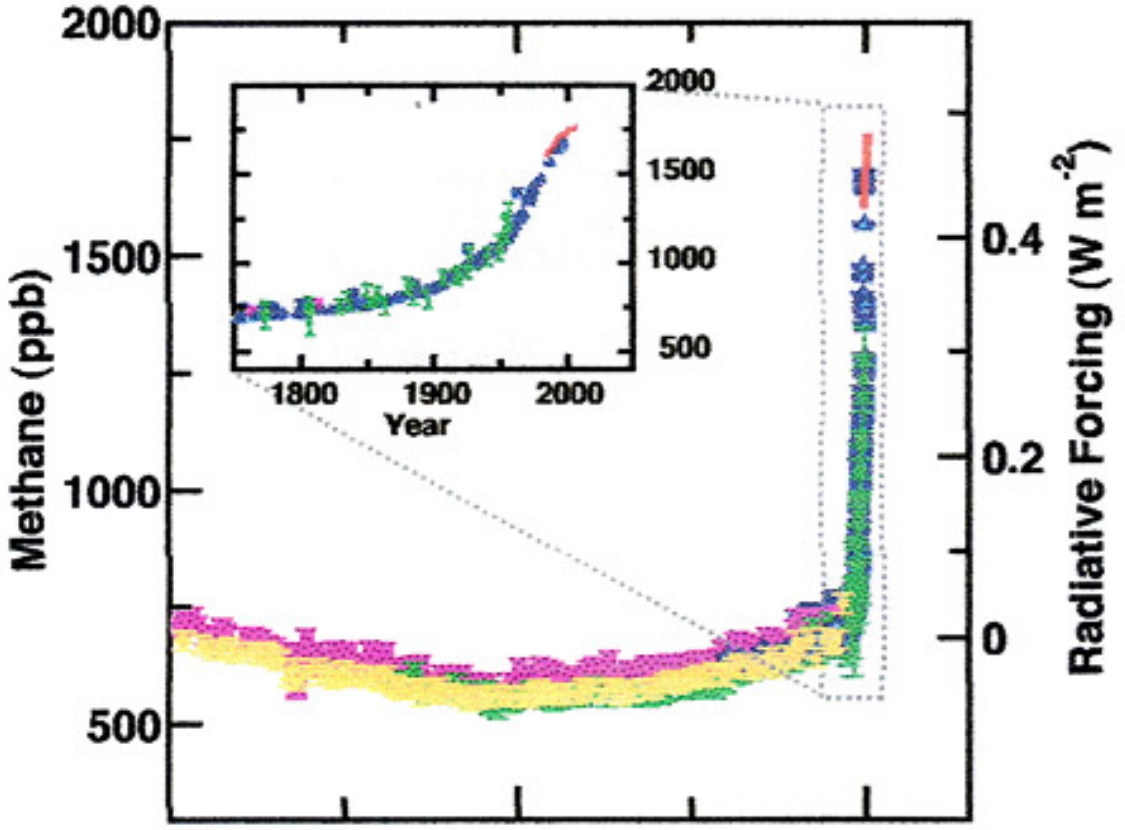
350
300
1800
1900
2000
Year
1
0
Radiative Forcing (W m-2)


Methane (ppb)
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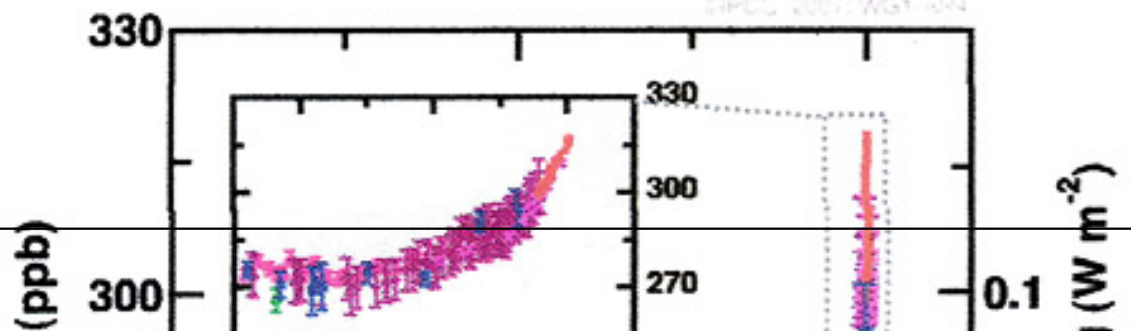
500
2000
1500
1000
500
1800
1900
2000
Year
0.4
0.2
0
Radiative Forcing (W m-2)


(ppb)
330
300
330
300
270
1800
1900
2000
Year
0.1
(W m-2)

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