IoWATCH

THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

FALL 1997

This is the second of two issues of *IoWatch* that examines how anthropogenic changes in climate could affect the health of humans.

Global Warming and Human Health, Part 2

As our understanding of potential global warming trends continues to rise, questions about their effects become more pronounced. Since the late 1980s, the influence of climate change on human health has become a major concern. Warnings have been heard increasingly from researchers as well as from international organizations such as the World Health Organization. Their message has been clear: while the magnitude of impact of global warming on human health remains vague, with the number of people affected varying from site to site, global warming is expected to affect human health in multiple ways.

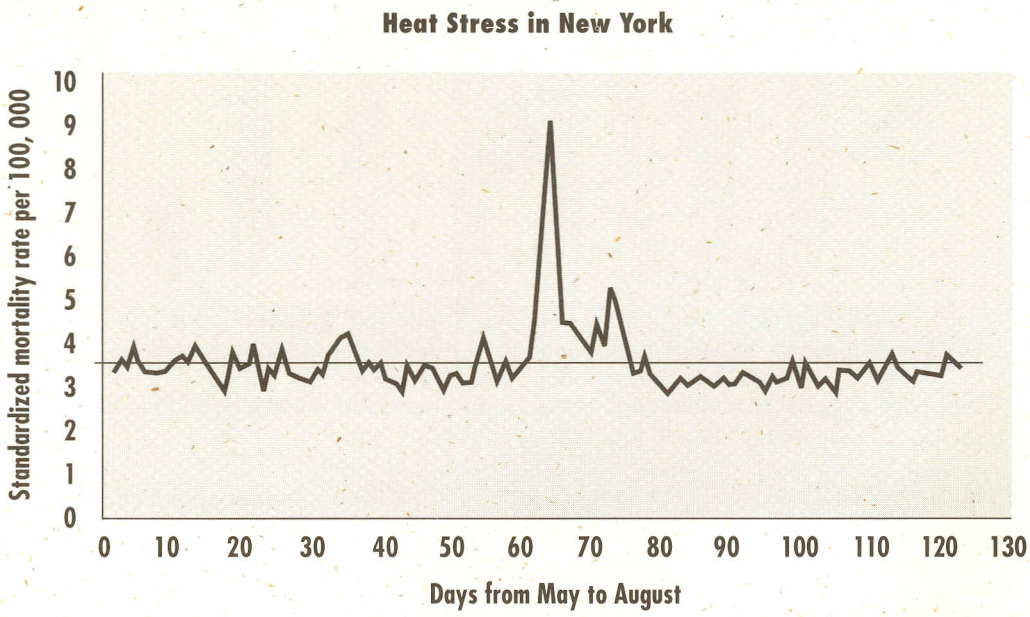
Two such ways were described in the spring issue of *IoWatch*. Global warming is expected to alter the distribution and ecology of infectious agents (thus leading to a resurgence and spread of certain infectious diseases) and to alter crop production, agricultural pests, and other factors that reflect on the human food supply. Iowa is not immune to such problems. This past July, for example, Iowa recorded its first known case of the hantavirus infection that was described in our last *IoWatch*, becoming the 26th state to report this emerging and often deadly disease. In August, an article in *The Atlantic Monthly* described the return and resurgence of locally transmitted malaria in many areas of the U.S.

The following paragraphs describe two other health-related concerns: the rising heat stress and increasing numbers of extreme climatic events that are predicted to accompany global warming.

Human Health and Rising Temperatures

We've grown up with stories of the Dust Bowl days here in Iowa, of those times when the spirits of Midwesterners shriveled along with their crops and the sky was darkened by parched earth lifted skyward. The average July temperature in Iowa that landmark decade was a mere 4°F warmer than the mean 50 years later, about in the middle of the range of increase predicted for a century from now with global warming. But that was the average, not the extreme. The first of the great heat waves swept into Iowa in July, 1930, killing thousands of field horses. By Sunday, August 3, the average high for the state was 106.4°F, hotter than any previous day on record. That was but a harbinger of things to come. Intense heat continued to attack the state, with Keokuk reaching 118° in the summer of 1934, and the state's average maximum climbing to 108.7° on July 14, 1936. While the July-August average

for 1930 was 76.1°, the average for 1934 crept up to 76.5°, and in 1936—the most torrid summer of the decade—the state's average temperature spiked at 81.3°. In a typical year, about 175 people in the U.S. die from excessive summer heat and sunshine, their bodies losing the ability to maintain homeostasis and prevent core temperatures from rising to meet those of the outer world. Between 1930 and 1936, the heat killed nearly 15,000 people—4768 in 1936 alone.



Mortality rates increase dramatically during heat waves, a fact demonstrated in this depiction of daily mortality during a 1966 heat wave in New York. (Source: Kalkstein LS, WJ Maunder, G Jendritzky. 1996. *Climate and Human Health*, 2nd edition. World Meteorological Organization, No. 843.)

Humans are in many ways frail creatures, dependent on protection both from the cold and from heat in order to survive. This need for shelter from the elements would be modulated by the changing climate. Researchers believe that warming of our global climate could significantly increase the number of heat-related deaths and illnesses, an increase that would be only partially matched by the decrease in cold-related deaths.

Because of their vulnerability, people have developed social, behavioral, and technological mechanisms for isolating themselves from the weather—for example certain ways of dressing and of heating and air conditioning their homes. In addition, given time, people acclimatize to temperature extremes to some degree. But extended hot temperatures can overtax the body's natural cooling mechanisms, especially when humidity is high and winds are low. Marked short-term fluctuations—such as the very hot days that most global climate models predict will increase—are especially difficult to withstand because they allow little time for physical or physiological adjustment. As temperatures rise, the body struggles to maintain a constant internal temperature. At some point, however, its natural cooling mechanisms no longer suffice. The cardiovascular system no longer responds properly, resulting in heat exhaustion with faintness, rapid heartbeat, low blood pressure, cold clammy skin, and nausea. Or the body's core temperature may begin to rise, producing heat stroke and in extreme cases leading to confusion or delirium, seizures, coma, and death. Both heat stroke and heat exhaustion are more probable among the very young, the elderly, persons with existing conditions, and those with impaired mobility. The urban poor also have fewer recourses to escape from the extremes. High temperatures also raise the incidence of hospital admissions and mortality from cardiovascular and respiratory disorders and certain types of accidents.

Global warming may stimulate illness and death in less direct manners also. Higher temperatures accelerate the chemical reactions that produce secondary air pollutants, such as tropospheric ozone, from primary air pollutants. Thus more frequent and intense periods of very hot weather could be coupled with increasing air pollutant concentrations. While ozone is beneficial in the upper atmosphere, where it filters out the sun's UV rays, when inhaled it damages cells of the respiratory tract and impairs lung functioning. It can increase the effects of other pollutants (such as SO_2) in the lungs, and decrease defenses against infections. It appears that higher temperatures also act synergistically with air pollution: the effects of the two together induce more health problems than the sum of the two would imply. And lastly, warmer weather could affect water supply, food production, and other biological systems (such as plant production of spores and pollen) that in turn could alter human health.

Human Health and Extreme Climatic Events

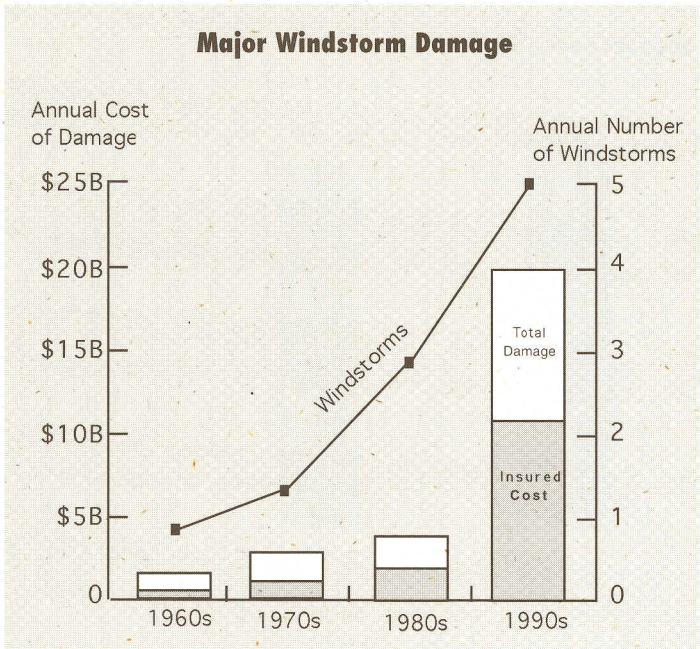
Bangladesh is washed from the north by runoff from the Himalayans and from the south by the storms sweeping in from the Bay of Bengal. If people were scarce and abundant land offered multiple sanctuaries, an occasional drenching of this tiny nation would bring little hardship. But Bangladesh's flatlands offer few safehouses for the country's densely packed millions, especially those who inhabit the gigantic delta of the Ganges and Brahmaputra Rivers. Monsoons can bring catastrophic floods cascading down from the highlands. And storm surges from the frequent cyclones sometimes sweep over 100 miles inland. These cyclones killed 300,000 people in 1970, and another 140,000 in 1991. Continued population growth will push more people onto the vulnerable coastal lands, where the masses will be exposed to increasingly frequent and severe storm surges. Or they may be forced to fight a more sinister fate: losing their landbase permanently to a slowly rising sea.

Changing climate is likely to increase weather variability. Heavy precipitation events are predicted to become more frequent regionally, while models show other regions already prone to drought experiencing longer and more severe dry periods. These events may be exacerbated by human activities, overgrazing and forest clearing for example, multiplying the likelihood of both drought and of flooding. The effects of the resulting regional droughts and floods will depend on the vulnerability of each natural environment and human society.

Apart from the obvious dangers of drowning and acute injury, flooded areas experience health problems as sanitation systems break down, food supplies are destroyed, croplands are eroded or contaminated, and dangerous chemicals or wastes are washed into floodwaters. Drought affects health primarily through impacting the production of food and its distribution. Malnutrition increases. Severe diarrhea and diseases associated with poor hygiene (such as scabies and conjunctivitis) increase as water quantity and quality decline. Death strikes not only through starvation, but also through diseases that take hold because of decreased immunity caused by starvation.

Both floods and droughts stimulate infectious disease as sanitation and public health infrastructures degenerate and as populations become more crowded. These disasters further affect health by increasing stress-related psychological disorders and provoking migration of displaced persons (producing "environmental refugees").

The human impacts of climate-related disasters have clearly and considerably risen during the past 25 years. However this growth is due in part to the soaring size of the human population and to its expanding vulnerability, with marginal populations increasingly being forced into "disaster risk zones." Persons with the fewest technical and social resources are affected most strongly. Projections indicate that Earth's poorest populations will increasingly



Extreme weather events are rising in frequency and in the annual cost of damage — a fact demonstrated here by the worldwide impact of major windstorms (those with over $500 million in total damage) between 1960 and 1992. Other data show that nearly half of all insured losses from natural catastrophes during the past 40 years have occurred since 1990, and that extreme weather events have become increasingly frequent in the past six years. Anthropogenic climate change is expected to increase the variability of weather, with extreme weather events becoming more frequent and affecting human health in multiple ways. (Source: "Energy Efficiency Strategies for Insurance Companies," reprint from *Center for Building Science News*, by Evan Mills.)

DID YOU KNOW

Around 250,000 deaths occur worldwide each year as a result of natural disasters, 95% of these in poor countries. Global warming would intensify extreme weather conditions. The poor would remain the most vulnerable.

The midwestern floods of 1993 are examples of the types of events that might increase with global warning.

The rice paddies of densely-populated Southeast Asia would be over 1/3 destroyed if sea levels rose the predicted 1/2 meter.

At present, an average of 46 million people experience annual flooding due to storm surges. That number will double by the year 2100 if ocean levels rise the predicted 1/2 meter, even with no anticipated human population increase.

Climate models indicate that with global warming, heat-related deaths in very large cities would rise by several thousand annually.

Taken from: AJ McMichael, A Haines, R Slooff, and S Kovats Eds. 1996. *Climate Change and Human Health.* Geneva: The World Health Organization.

congregate on land most vulnerable to disasters, and will have the fewest resources to recover from such disasters. Asia experiences the highest number of natural disasters and the greatest number of affected people. Developing countries in general experience the most deaths from natural disasters and the largest relative economic impact. However the total price tag of such disasters is far heavier in rich countries.

The predicted rise of the Earth's seas is another distinct but extreme process that would threaten human health. Models indicate that the oceans' rise—stimulated by thermal expansion of sea water and the melting of glaciers—would equal on the average a half meter by the year 2100, with the actual rise varying regionally. Since more than half of the world's population now lives within 60 km of the sea, and this population is growing faster than the world's average, rising seas could affect the health of most future humans. Small islands and heavily populated deltas would be among the most intensely impacted. Bangladesh, for example, could lose 17% of its land surface if the sea level rises a meter.

The health effects of rising seas would include the obvious displacement of large populations and the physical and mental stresses associated with forced migration. Food production and thus nutrition could decline as agricultural lands are flooded; large populations in Southeast Asia, for example, would lose some

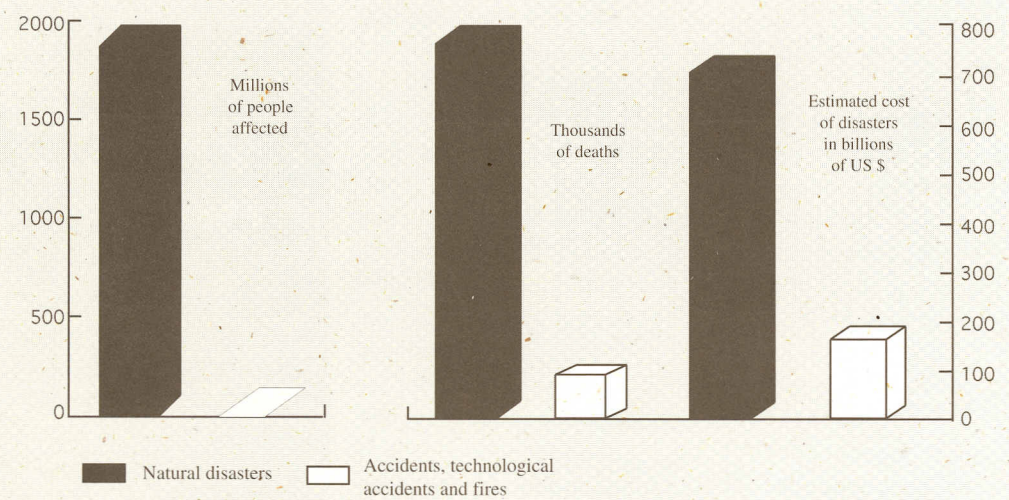
of the world's major rice-growing paddies. Increasing coastal erosion and injuries to coastal wetlands would impact the 70% of commercial fish species that complete their life cycles in these habitats. Saltwater flooding and intrusion of aquifers would reduce the amount of fresh water available both for humans and for agriculture, and could alter the distribution of disease vectors such as malaria-transmitting mosquitoes. And populations remaining in coastal areas would be increasingly susceptible to the impacts of floods and ocean-generated storm surges.

Although Iowans need not personally fear threats from rising oceans, the prospect of increasing heat stress is quite real. Recognizing this, CGRER is commencing a project to compute risk assessments for increasing heat stress in Iowa. Greg Carmichael and his students will be evaluating deaths correlated with periods of high heat and humidity in the past. Then, with the help of climate models, they will compute changes in the number of heat stress-related deaths that could be expected from warming climates.

Other CGRER members are working on ways to reduce damages and deaths from extreme climatic events. Witold Krajewski, Allen Bradley, and Kosta Georgakakos, for example, are involved in projects that will improve flood forecasting and thus increase time to prepare or flee from dangerous exposures.

Three additional new CGRER grants that relate the burning of fossil fuels to agricultural production and to human health are described in the column, "What's Up at CGRER?" Implementation of Phase III of the Iowa Greenhouse Gas Action Plan also is discussed there. Iowa can take pride in being one of the first three states to reach the third phase of this planning process, which involves putting into

Human Costs of Disasters



The various human costs of disasters—both to life and to the pocketbook—are shown here for the decade 1986 to 1995. As can be seen, natural disasters are many times more costly than accidents and fires. Other data reveal that nearly half of all insured loses from natural catastrophes during the past 40 years have occurred since 1990. This fact has increased the concern of the world's 1.4-trillion-dollar insurance industry about potential climate change, and has drawn the reinsurance leaders in Europe into advocating limits for greenhouse gas emissions at the United Nations. (Source: "The Geosciences and the UN System, in the Service of Humankind," A discussion paper produced by the World Meteorological Organization, Sept. 1996.)

action specific proposals to decrease Iowa's greenhouse gas emissions.

While such efforts are critically important, global prevention remains the best medicine. That means taking steps to decrease the emission of CO_2 and other greenhouse gases into the atmosphere. Neither scientists nor policy makers dispute the human-induced increases in atmospheric carbon dioxide or the rise in temperature over the last hundred years. The majority of scientists now link the two, tracing the temperature rise directly to increasing greenhouse gas concentrations.

Even those skeptics who deny human-induced climate warming cannot argue about today's actions producing changes tomorrow. As CGRER co-director Jerry Schnoor says, "We simply cannot spend a few hundred years burning fossil fuels that took many millions of years to accumulate without climatic consequences. The concentration of trace gases in the atmosphere is rising rapidly. We absolutely must stabilize atmospheric concentrations of these gases."

Governmental leaders from around the world will meet in Kyoto, Japan, in December, once again to negotiate a global treaty for reducing greenhouse gas emissions. The discussion will focus on enforceable guidelines for emissions between the years 2000 and 2010. Proposals such as a carbon tax or binding limitations to emissions would be major steps forward that could lead to significant declines in the production of greenhouse gases.

Although the U.S. produces about 22% of the world's greenhouse gases, the Clinton administration to date has refrained from committing itself to any specific proposals or decreases in emissions. However, hopes remain high that our government will invoke meaningful actions. Certain businesses have formed strong coalitions to lobby against any mandated decrease in emissions, arguing that this would precipitate massive economic declines and rising unemployment. But economic analyses have shown that many potential emission-reducing steps could be taken for which total benefits outweigh total costs. Additionally, the costs of failing to act on the economy, as well as human health, could be tremendous.

The Kyoto conference could signal a turning point for our atmosphere, marking the time when we choose to significantly limit the emission of greenhouse gases and safeguard the health of future life. Whether or not that will happen now remains in the hands of our policy makers.

Note: The majority of information in this article was taken from the book *Climate Change and Human Health* (AJ McMichael, A Haines, R Slooff, and S Kovats editors; published in 1996 by the World Health Organization, Geneva), a detailed assessment prepared by an international task group on behalf of the World Health Organization, the World Meteorological Organization, and the United Nations Environment Programme. Details of Iowa's Dust Bowl days came from *The Greenhouse Effect* by Harold Bernard, published in 1980 by Ballinger Publishing, Cambridge MA.

Commentary
...by Greg Carmichael

I have just returned from my sabbatical, which I spent with the World Meteorological Organization (WMO) in Geneva, Switzerland. Through this wonderful experience, I was able to increase my appreciation of the international policy and organizational aspects of environmental issues. WMO is actively involved in environmental issues such as climate change and stratospheric ozone depletion. It serves as the principal scientific arm of the United Nations on these issues. The following paragraphs are a reflection on the activities and role of such organizations.

While climate change has been the primary international environmental focus in the 1990s, it is not clear for how long or in what form this will continue to be the case. The climate debate has moved away from asking the question, "How big might the future rise in temperature due to anthropogenic activities be?" to asking, "What regional impacts might be anticipated under a human-influenced climate change?" and "What policies can we put in place to stabilize greenhouse gas emissions?" This change in emphasis reflects both a growing scientific consensus that an increase in global temperature is the most likely outcome of the rapid and recent increases in greenhouse gas emissions, and the fact that public opinion and awareness have reached a level where actions are deemed necessary.

The shift in focus impacts resources and research priorities. The increased attention to human health considerations of climate change is a good example. This interest is a logical outcome of a holistic evaluation of potential impacts of climate change, and also embodies a concerted effort to articulate the human dimensions of such impacts. The human health angle is growing in recognition and will play a larger role in future climate assessment studies.

I find it interesting that as policies directed at climate change move forward, governments and international institutions continue to struggle with the division of efforts and funds between climate change issues and other environmental issues. Many studies are indicating that environmental actions and investments focused on climate change issues are receiving a much lower priority than local environmental problems such as air pollution or safe drinking water issues. The question must be asked, do we have our sights on the right target? This is a troubling question because the financial and human resources that can be marshaled for environmental issues are limited. Issues of priority and balance are always present at an institution like WMO, which deals simultaneously with the international climate change research agenda and with requests to help modernize national meteorological services so countries can better forecast and manage next year's monsoonal rains, or the approaching severe storm, or growing air pollution problems.

I believe that climate change and local environmental concerns should not be viewed separately, but rather should be seen as coupled problems sharing common origins and solutions. The difficulty is finding the framework to effectively address the commonalties. During my time in Geneva, I helped WMO draft a strategy for addressing smaller-scale and global issues simultaneously. Urban environments, where an increasing share of the world's people live, where most energy and potable water are consumed, and where the impacts of disasters including flash floods and pollution are hardest felt, emerged as a focus.

Urban populations are growing very rapidly. By the turn of the century, almost 50% of the world's population will reside in urban areas. (In contrast, in 1930 only 30% lived in urban areas.) By the year 2000, it is anticipated that there will be 24 cities with a population greater than 10 million (the Mega Cities) and between 150 and 200 cities with a population greater than 1 million. Asia alone presently has about 1 billion urban dwellers, a number that is expected to rise to nearly 3 billion by

Faculty Focus

John Miller, Liisa Jalkanen, and Greg Carmichael, of the World Meteorological Organization's Global Atmospheric Watch (GAW) Program, celebrating recent accomplishments. WMO holds the major responsibility for monitoring global changes in the atmospheric environment. Its GAW Program provides long-term monitoring of greenhouse gases, aerosols, ozone, ultraviolet radiation, and acid deposition.

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2025. While cities are typically the focus of economic growth and productivity (e.g., the 10 Mega Cities in Asia account for about 40% of their respective GNPs), they are also the centers of consumption of electricity, water, and fossil fuels, and as a result the major producers of wastes and pollution. Each 1 million urban inhabitants emits an average of 25,000 metric tons of carbon dioxide and generates 300,000 metric tons of wastewater every day.

The impacts of urban activity on the environment are many. For example, about one person in five around the world is exposed to levels of SO_2, particulates, photochemical oxidants, and other air pollutants that exceed WHO's minimum standards. The incidence of asthma is on the rise worldwide and is widely believed to be linked to poor air quality. One child in three living in heavily polluted areas is reported to have chronic bronchitis.

The poor air quality in many cities is the result of both high emissions and certain meteorological conditions. Sources of pollutants include vehicles, industry, energy production, home heating in some countries (coal in China) or cooking (wood fuel in India), ambient dust levels, and domestic and agricultural waste disposal practices. Inversion layers — layers of warmer air above a city — trap pollution below and allow pollutant levels associated with these sources to build up during stagnation periods.

In fact the urban activities themselves modify the local climate. Urban environments are human-made and have climates that differ appreciably from the surrounding natural or rural environment. Indeed, the documented effects of urban development upon climate are the most clear-cut examples of anthropogenic climate change available. The local climates of today's large cities may well represent microcosms of the larger-scale climates of the future.

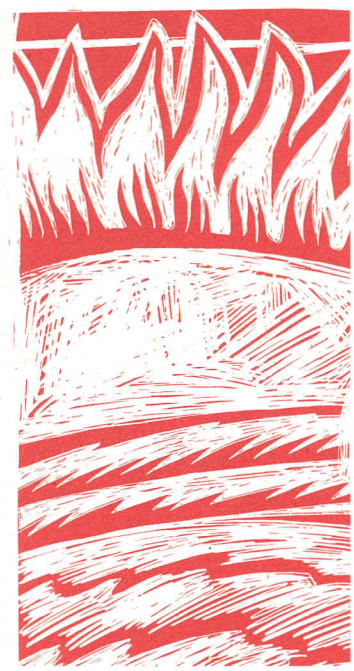
Perhaps the most notable effect of the urban landscape is the increase in urban temperatures above those of surrounding rural areas, forming urban "heat islands." Large tropical inland cities may have a mean monthly temperature 10°C higher than surrounding rural lands. Urban heat island intensities are related to population and building density, size of the city, and season. Inadvertent modification of urban climates causes discomfort due to excess heat/temperature stress, which increases energy demands for air conditioning and refrigeration. This requires more energy production and again increases the levels of gaseous and particulate pollutants in urban atmospheres. Increased heat stress and particulates of respirable size affect the old and infirm, as well as children suffering from respiratory ailments, and raises morbidity and mortality.

The explosive growth in world population during the twentieth century has put increasing demands and socio-environmental pressures on water resources. Nowhere is this more evident than in our cities, where water supplies are often threatened by excessive demand and contamination. Also cities are particularly prone to floods, especially in the developing world. Flash flooding of urban rivers is a major cause of loss of life and is becoming ever-more destructive. A notable example was the loss of 140,000 lives in Bangladesh in April, 1991, associated with a cyclone and storm surge.

While the impacts of pollution, natural disaster, and the health implications of climate change often are concentrated in urban areas, the impacts of urban activities are not confined to urban boundaries. Cities are major contributors to the threat of global climate change through their intensive use of energy and subsequent large emissions of greenhouse gases. Furthermore, pollutants generated in the urban areas can be carried long distances downwind, cross national boundaries, and cause damage to lakes, forests, and agriculture. Notable examples are acid rain and regional elevated ozone levels.

It is clear that urban activities, when taken collectively, have a profound impact on the environment at all scales. It is also clear that regional and global environmental problems are closely linked. An illustrative example is the role of aerosols as both a leading cause of urban mortality and an important radiative constituent that causes local cooling and may offset (temporarily) some of the expected warming due to greenhouse gases. Because of such links, the urban environment is becoming a critical focus in policy discussions of sustainable development and climate change.

I hope that as a result of such emerging focus areas, we can better articulate the linkages between environmental problems of various scales and can help decision makers prioritize and balance environmental policies and investments.



What's Up at CGRER?

A number of new grants have been awarded to CGRER's Greg Carmichael to address problems of climatic change and encourage the revitalization of natural balances. Some of these, for example a grant to assess changing heat stress frequency in Iowa, are directly targeted at human health concerns associated with potential global warming trends.

This grant is described in this newsletter at the conclusion of "Global Warming and Human Health, Part 2." Two other new grants fall into this same category. The first, a one-year grant from the U.S. Department of Energy and World Bank, awarded jointly to CGRER and Argonne National Laboratory, will assess the human health effects of the growing use of fossil fuels, predominantly coal, in Shanghai and Beijing, China. This grant also will assess the positive impacts that would result if modern air pollution control technologies were installed on industries and power plants.

The second, a multidisciplinary project funded by NASA's Mission to Planet Earth program involving numerous co-investigators in China and the United States, will look at the effects of regional environmental change on agriculture in rapidly-developing China. China-MAP, as the project is called, focuses on attempts to integrate a number of climatic, air quality, and agricultural computer models into a single linked system. This system then could examine changing climatic variables, industrialization scenarios, land use patterns, and cropping practices in an integrated manner. The desired result will be an ability to evaluate and identify the most promising pathways for sustained economic development in China. CGRER, in collaboration with the Geophysical Fluid Dynamics Laboratory and Argonne National Laboratory, is responsible for emissions estimates and for evaluating the impact of these emissions on the regional and global scale.

Another grant, awarded by the U.S. Department of Energy Integrated Assessment Program jointly to CGRER and Argonne National Laboratory, will explore the potential for providing Southeast Asia with computer tools to assess air pollution and greenhouse gas emissions. Asia, with its growing energy demands, is threatened by a variety of human health and ecosystem impacts as a result of its heavy reliance on fossil fuels. This grant will design a model capable of examining the joint effects of air pollution and climate change, and also capable of developing coordinated response measures.

A new grant from the U.S. Army Corps of Engineers (COE) invokes CGRER's services to improve the health of water flowing from the Iowa Army Ammunition Plant in Middletown, Iowa, which is near Burlington. An attempt is being made to use aquatic plants in a newly-created wetland to clean the munitions materials RDX and TNT from water contaminated by the plant's production activities. The COE has documented that four locally common plants [reed canary grass (*Phalaris arundinacea*), common arrowhead (*Sagittaria latifolia*), American pondweed (*Potamogeton nodosus*), and coontail (*Ceratophyllum demersum*)] are effective in removing TNT and, to a lesser extent, RDX from water. The apparent ability of some plants to "phytoremediate" contaminated water and soil through such removals suggests that they might be useful in dealing with environmental contaminants. The COE is now grading and inundating a four-acre site for the new wetland. CGRER researcher Diana Horton will monitor the development of wetland vegetation, in particular the four above-listed species. Jerry Schnoor's lab will analyze samples of plants, soil, and groundwater for metabolites of the contaminants. The lab also will be examining other native wetland species for their phytoremediation capabilities. In the spring, hybrid poplar trees will be planted around the wetland to help remove any remaining contaminants.

The Iowa Greenhouse Gas Action Plan (see "Faculty Focus" in the Fall, 1996 *IoWatch*) seeks to decrease Iowa's contributions to potential future warming. Phase III of this plan has just been awarded to Jerry Schnoor by Iowa's Department of Natural Resources, with funds coming from the U.S. Environmental Protection Agency. The plan, which was co-sponsored by CGRER, proposes a set of activities for reducing Iowa's greenhouse gas emissions to 1990 levels by the year 2000, a major goal of the 1992 Rio Earth Summit. Phase III focuses on implementing one or more of the plan's activities, in particular the Iowa Greenhouse Gas Inventory. The inventory will calculate the carbon dioxide equivalent (CO_2, CH_4, N_2O) emissions of each industrial producer in Iowa. These industries' efficiency (that is, the amount of CO_2 produced per unit product) will also be calculated. This smokestack-by-smokestack assessment will then be made available to the public — in the hope that identification of Iowa's largest greenhouse gas producers will shame these producers into cutting their emissions. Social pressure has been shown to rival legislative control in enticing private corporations into undertaking similar socially responsible actions. Thus the hopes are that this inventory and identification process will lead to a significant decrease in Iowa's greenhouse gas emissions.

Future scholarship at CGRER will be furthered by a newly awarded grant to Vicki Grassian and Greg Carmichael from the Camille and Henry Dreyfus Founda-

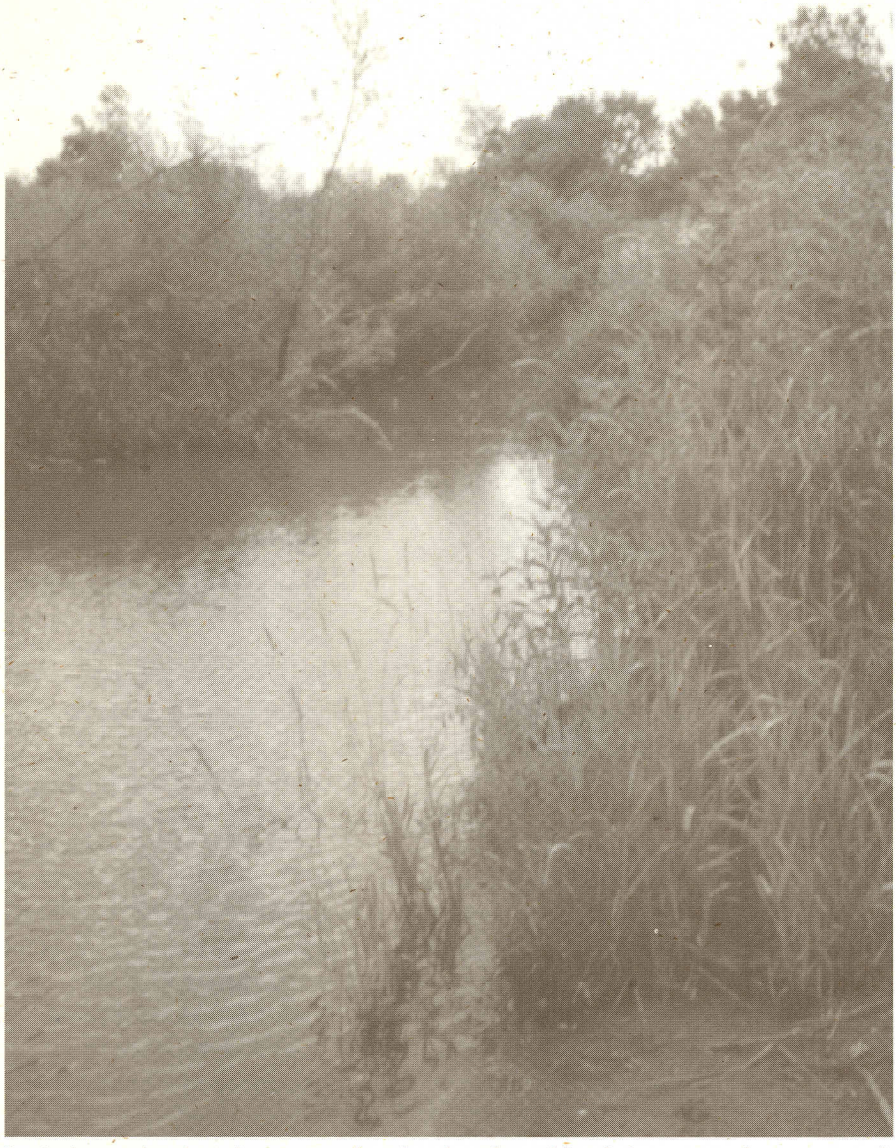
tion. The highly competitive grant will fund a two-year post-doctoral associate in environmental chemistry at CGRER, through a program intended to form an interface between chemistry and environmental chemistry.

CGRER welcomes three newly arrived visiting scholars this fall. Thorjorn Larssen, from Oslo, Norway, will be spending the coming year here modeling the acidification of soils in southwestern China.

Malva Andrea Mancuso from the University of Sao Paulo, Brazil, will be here for two years, examining and modeling the flow of nitrified groundwater from septic tanks into a lake that is becoming eutrophic in Rio de Janeiro.

A shorter visit will be paid by Maite Mendez-Gil from Spain, who will be here from mid-September through mid-November working on applying air quality models and GIS tools to studies in northern Spain.

CGRER also welcomes the following newly-elected Executive Committee members, all from the University of Iowa campus, to three-year terms: Garry Buettner (Electron Spin Resonance Facility), Rob Ettema (Iowa Institute of Hydraulic Research), Vicki Grassian (Chemistry), and Greg Ludvigson (Geological Survey Bureau, DNR). Dick Baker (Geology) and George Malanson (Geography) were reelected to the Committee. Many thanks to outgoing members Annmarie Eldering, John Fix, Witold Krajewski, and Frank Weirich for their years of service.



Certain plants, such as the reed canary grass shown here, have the capability of removing toxins from contaminated water. Such "phytoremediation" will be utilized and monitored by CGRER researchers in a newly created wetland at the Iowa Army Ammunition Plant.

This past summer, CGRER members were asked to share a single way in which they have addressed global change issues over the past year. Their responses portray the diversity of approaches that are being used to counteract the multiple alterations of our environment. Here are some examples of how professors at the University of Iowa and at Iowa State are addressing global change issues in the laboratory, field, and classroom.

Most are contributing to the knowledge base through their research. For example, **Witold Krajewski** (Iowa Institute of Hydraulic Research, UI) has been selected as a science team member of the joint US-Japanese, satellite-based Tropical Rainfall Measuring Mission, which is aimed at improving understanding of effects of the all-important tropical zone on global circulation and weather patterns. **Diane Debinski** (Animal Ecology, ISU) initiated a project using remotely sensed data to monitor temporal variation in the montane meadows of Yellowstone National Park, focusing on plant, bird, and butterfly communities. **Joe Simeonsson** (Chemistry, UI) is developing new analytical methods for the measurement and speciation of arsenic and selenium at "trace" and "ultratrace" levels. Such methods are necessary for understanding alterations in the natural cycling of these trace elements. And **Gene Takle** (Geological and Atmospheric Sciences, ISU) and **Bill Gutowski** and **Ray Arritt** have been instrumental in establishing an Earth Systems Simulation Laboratory at Iowa State, under the Project to Intercompare Regional Climate Simulations. This laboratory, with its ten high-performance work stations and other computer hardware, will prepare ten-year simulations of present and future climate, using three regional climate models, for the upcoming International Panel on Climate Change's Third Assessment Report.

Sharing new understandings with colleagues is equally crucial. Many CGRER members report that they have done so through papers that they published or presented orally. **Holmes Semken** (Geology, UI), looking at ancient mammal communities, co-authored a paper demonstrating that while the analysis of animal remains collected from archaeological sites is most greatly influenced by the site's prehistoric traits and uses, the influence of the ancient environment is also obvious. **Dick Baker** (Geology, UI), along with CGRER members **Art Bettis** (Iowa Geological Survey Bureau, DNR, Iowa City), **Luis Gonzalez** (Geology, UI), **Diana Horton** (Biological Sciences, UI), **Mark Reagan** (Geology, UI), and others, authored a major monograph that took a detailed look at past changes in vegetation, climate, and stream hydrology in northeastern Iowa.

These examinations of changes in the distant past help researchers such as **George Malanson** (Geography, UI) understand the probable responses of plant (and animal) communities to climate change in the future. Malanson participated in an international workshop on this subject and as a result co-authored an *American Scientist* article, "Plant Migration and Global Climate Change," and also was appointed as Task Leader for Dispersal Modeling on an International Geosphere-Biosphere Program committee.

Seeds

Other researchers have been examining current changes in the global environment. For example **Dale Zimmerman** (Statistics and Actuarial Science, UI) presented a paper on statistical methods that allow one to compare maps of environmental contaminants and to assess, with a known level of confidence, the changes in level or distribution of contaminants over time. The paper will appear in the *Journal of the American Water Resources Association* this fall. **Allen Bradley** (Iowa Institute of Hydraulic Research, UI) has authored two papers resulting from a CGRER seed grant on the effect of climate variability on extreme rainfall. These papers, submitted to the journals *Water Resources Research* and the *Journal of Hydraulic Engineering*, ask whether climate variability has, over time, changed the probability of extreme weather events, as many reports have speculated.

Direct human involvement with environmental change was addressed by **Tad Mutersbaugh** (Geography, UI), who attended a Mexican conference to present a paper examining why some native Latin American communities protect their forest resources and prohibit timber cutting, while other such communities are unable to prevent uncontrolled logging by wood products companies. At the UI's Public Policy Center, **David Forkenbrock** and a colleague have developed GIS-based methods to correlate levels of vehicle-generated air pollution with the presence of low income and minority populations. Their work is presented in a book-length monograph that comprehensively addresses the new U.S. Department of Transportation Environmental Justice Order.

Professors are also integrating their insights into the classroom. **Diana Horton** (Biological Sciences, UI) has added E.O. Wilson's book, *The Diversity of Life*, as required reading in both her Systematics and Biogeography courses. Diana considers this book, which explains the importance of preserving biodiversity through a readable presentation of fundamental biological concepts, to be a must for anyone with an interest in the environment and such issues as global change. **Mark Reagan** (Geology, UI) incorporates global environmental changes over the past 4.5 billion years, as well as present-day effects of greenhouse gasses and CFCs, into his class on Geological Hazards. He also conducts

research using U-Th disequilibrium to determine the timing of recent climate change for the midcontinental US.

Burton Kross (Preventive Medicine and Environmental Health, UI) traveled to Slovenia to teach a graduate class on the sources and control of air pollutants associated with global change. While comparing environmental policies for measuring and controlling such pollutants in several European countries and the U.S., he presented Iowa's Greenhouse Gas Action Plan as a case example. And **Edgar Folk** (Physiology and Biophysics, UI) taught a class Integrative Environmental Physiology to medical students. He covered climate change, natural adaptations to changing climate (acclimatization, habituation, etc.), and aspects of human ecology and evolution that relate to changing environments.

Finally, **Paul Greenough** (History, UI) placed himself on the receiving end of the learning spectrum when he participated in a study tour of the Sardar Sarovar dam and associated installations on the Narmada River in western India. There he heard about the social and economic issues of such mega-development projects, which can both instigate and result from large-scale environmental changes. In addition, local environmental experts taught participants about resulting large-scale shifts in agriculture, population, industry, climate, and pollution that slide the weight of development to the "overload" end of the scale. Closer to home, Paul co-coordinated the UI's Global and Environmental Health Task Force that stimulated the formation of CGRER's Climate Change and Human Health seminar held last fall (see "What's Up at CGRER" in the Spring, 1997 Iowatch).

References cited:

Baker, RG, EA Bettis III, DP Schwert, et al. 1996. "Holocene Paleoenvironments of Northeast Iowa." *Ecological Monographs* 66:203-234.

Forkenbrock, DJ, and LA Schweitzer. 1997. *Environmental Justice and Transportation Investment Policy.* Iowa City, IA: University of Iowa, Public Policy Center.

Pitelka, LF, and the Plant Migration Workshop Group. 1997. "Plant Migration and Climate Change." *American Scientist* 85:464-473.

Semken, HA, and RW Graham. 1996. "Paleoecologic and Taphonomic Patterns Derived from Correspondence Analysis of Zooarchaeological and Paleontological Faunal Samples, A Case Study From the North American Prairie/Forest Ecotone." *Acta Zoologica Cracoviensia* 39:477-490.

IOWATCH

THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

The University of Iowa's Center for Global and Regional Environmental Research (CGRER) promotes interdisciplinary efforts that focus on the multiple aspects of global environmental change, including its regional effects on natural ecosystems, environments, and resources, and on human health, culture, and social systems. Center membership is composed of interested faculty members at any of Iowa's colleges and universities.

Center goals are promoted by encouraging interdisciplinary research and dialogue among individuals whose disciplines touch upon any of the multifaceted aspects of global change. More specifically, the Center awards seed grants, fosters interdisciplinary courses, provides state-of-the-art research facilities and equipment, and holds seminars and symposia. The Center encourages students to broaden their studies and research through considering the multi-disciplinary aspects of global and regional environmental problems. Through such activities, the Center attempts to assist Iowa's agencies, industries, and citizens as they prepare for accelerated environmental change that may accompany modern technologies.

Housed in the Iowa Advanced Technology Laboratory at The University of Iowa, the Center was established by the State Board of Regents in 1990 and received funding from a public utility trust fund, as mandated by the State of Iowa's Energy Efficiency Act.

IOWATCH is published biannually for researchers, employees of state agencies and public utilities, members of citizen action groups, and other Midwesterners interested in environmental change and the actions of the Center. Newsletter articles may be reprinted with proper citation. Comments, questions, and requests for additional copies are welcomed; please contact:

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