

options

Fall/Winter '99

catastrophes, infrastructure, and poverty

IIASA



Science for Global Insight
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Contents

- 3** Editorial
- 4** Research Updates
- 6** *Feature: Natural Catastrophes, Infrastructure, and Poverty in Developing Countries*
- 17** Inside IIASA

Options is a magazine featuring the activities of the International Institute for Applied Systems Analysis (IIASA), located in Laxenburg, Austria. IIASA is an interdisciplinary, nongovernmental research institution sponsored by a consortium of National Member Organizations in Asia, Europe, and North America. The Institute's research focuses on sustainability and the human dimensions of global change. The studies are international and interdisciplinary, providing timely and relevant insights for the scientific community, policymakers, and the public.

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Cover photo: Eruption of Mount Pinatubo, the Philippines, 12 June 1991. The ash cloud reached a height of 20 km over the volcano's crater. Photograph by Philippe P. Martin.

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This edition of *Options* introduces a new project, Natural Catastrophes and Developing Countries (CAT), formally approved by the IIASA Council at its November 1999 meeting. Earlier work carried out by the Risk, Modeling and Policy project on the methodology of analyzing extreme events and on the geophysical character of these events provides the basis of the work of the new project. The establishment of the new project illustrates how basic research carried out in an ongoing project can lead to the development of an important new activity.

Global changes of various kinds have heightened the world's physical vulnerability to natural catastrophes. Movements of population and capital to high-risk areas such as floodplains and coastal regions exposed to windstorms, floods, and sea surges, and to earthquake-prone areas have contributed to increased economic losses. A forthcoming IIASA book, *Population and Climate Change*, by Brian C. O'Neill, F. Landis MacKellar, and Wolfgang Lutz, discusses in detail the shifts

of population and the reasons for them. Global land-use change, including deforestation, further heightens the devastating impact of natural disasters on poor nations. IIASA's ongoing research in these areas not only serves as a foundation for the new project, but will also provide continuous input as the CAT activities evolve.

As discussed in the Spring 1998 issue of *Options*, Munich Re estimates that from 1988 to 1997, natural catastrophes cost the world economies around US\$700 billion. A large fraction of these dollar costs was borne by the developed countries. However, the per capita cost of natural disasters in relation to gross domestic product is at least 20 times higher in the developing world than in the developed world. Therefore, natural catastrophes inflict a high cost on many developing countries, as investments destined for economic development have to be diverted to repair damaged infrastructure and thus cannot be used for poverty-relief programs.

Recognizing the role natural catastrophes play in perpetuating poverty, the World Bank and IIASA have entered into an agreement to develop methods that can help poorer nations to share largely unpreventable economic losses with insurers and the capital markets, rather than bearing these costs alone. The project will directly assist the World Bank in tailoring its lending program to the needs of borrower nations. IIASA has further entered into an agreement with Swiss Re, the world's second-largest reinsurer, whereby the company will make its estimates of worldwide risk available to IIASA researchers.

In addition to providing directed support to its partner organizations, the CAT project will challenge standard economic theories. In classical equilibrium economics, small losses—1 or 2 percent of invested capital and infrastructure—can be viewed as perturbations around an equilibrium point. However, if the losses amount to a significant fraction of the investment in capital stock, then they can no longer be described as mere perturbations. Large losses such as those Hurricane Mitch inflicted on Honduras and Nicaragua can shock the structure of the economy into a new state. Such large shocks to the economy raise questions that classical economists have routinely failed to address and present the need for new theories and new methodologies.

Natural catastrophes not only cause direct losses to the infrastructure, but also have a number of indirect effects. Damage to the health care system cannot be made up overnight, and long-term health costs may be high. Similarly, damage to the educational infrastructure may result in reduced investment in human capital. On the other side, the opportunity to invest in new and more modern infrastructure may lead to a more rapid rate of growth than could be sustained by the older infrastructure. Thus, the analysis of indirect impacts from large shocks suggests some intriguing new research paths.

The CAT project illustrates several elements of IIASA's strength in research and exemplifies IIASA's objectives in establishing exploratory activities. The project is based on careful work in methodology carried out by an existing project and draws on current areas of active research at IIASA in the sciences of population, land use, and forestry. The work also opens up new areas of investigation into the total economic consequences of natural catastrophes—questions that have been badly neglected in the past. All international agencies with responsibilities for assisting the fight against poverty, including the World Health Organization, the United Nations Development Programme, and several specialized UN agencies, in addition to the World Bank and other international lenders, will benefit from IIASA's research on these extremely important topics.

Gordon J. MacDonald, Director

How Sustainable are North American Wood Supplies?

An analysis by IIASA's Sustainable Boreal Forests project casts doubts on whether official estimated supplies of North American wood are sustainable. The IIASA study, described in the Interim Report *How Sustainable Are North American Wood Supplies?* (IR-99-003), by Sten Nilsson, Ralph Colberg, Robert Hagler, and Peter Woodbridge, found that current estimates do not take many implications of sustainable forest management into account, but instead are based strictly on the availability of timber.

The analysis cites instances where the shortcomings of wood supply estimates cause particular concern. For example, the US Forest Service projects that the southern United States will increase both the total magnitude of its timber harvest and its national share of timber production for several decades, yet one study on the growth-to-drain (harvest) ratio in this region found

that removals exceeded growth in almost half of the forests surveyed. Other timber inventory projections showed a dramatic drop of some 34 to 40 percent for Georgia and Mississippi between 1990 and 2010. US Forest Service drain estimates for the South differ from mill consumption figures by more than 20 percent.

In Canada, the lack of an efficient monitoring system creates great uncertainties as to the accuracy of estimated sustainable yields. For example, allowable annual cuts (AACs) for all tree species for 1993 and 1995 exceeded net annual increment (a key component for estimating sustainable yield) by some 15 percent. The discrepancy was largest for deciduous species, where the AAC outstripped the net annual increment by 40 to 45 percent.

To obtain accurate and relevant analyses of sustainable national wood supply in North America, IIASA's analysis suggests that the United States and Canada take the following steps:

- Establish and implement improved projection techniques for forest inventories. These new techniques should consider both market issues and political aspects affecting the wood supply.
- Incorporate generally accepted indicators of sustainable forest management in their wood supply analyses.
- Develop and implement a new generation of analytical tools for North American wood supply, based on a political-economic concept. Current tools and analyses do not take into account the development and impact of government decisions and priorities, including pressures for forest conservation and limited harvest. Without thorough analyses of sociopolitical concerns, the value of North American wood supply analyses remains limited.

These actions would eliminate many of the current distortions in the North American policy debate with respect to the future of the forest sector and would help to establish a constructive platform for sustainable development of the North American forests. In addition, these steps could promote North American leadership in the international debate on the development of global forest resources and would give the North American forest industry a relevant basis for setting long-term strategies.

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Comparison of estimates of total wood supply for the United States.

Forest type	2000	2010	2020	2030
Coniferous	Supply (million m ³ per year)			
Haynes et al. (1995) "Economic supply"	314	323	354	385
Apsey and Reed (1995) "Probable supply"	-	245	265	-
WRI (1998) "Probable supply"	-	275	308	351
Deciduous	Supply (million m ³ per year)			
Haynes et al. (1995) "Economic supply"	238	263	280	289
Apsey and Reed (1995) "Probable supply"	-	190	198	-
WRI (1998) "Probable supply"	-	186	185	185

Apsey, M. and Reed, L., 1995, *World Timber Resources Outlook, Current Perceptions. A Discussion Paper*, December 1995, Council of Forest Industries, Vancouver, Canada.

Haynes, R.W., Adams, D.M., and Mills J.R., 1995, *The 1993 RPA Timber Assessment Update*, General Technical Report RM-GTA-259, Rocky Mountain Forest and Range Experiment Station, United States Department of Agriculture, Fort Collins, CO, USA.

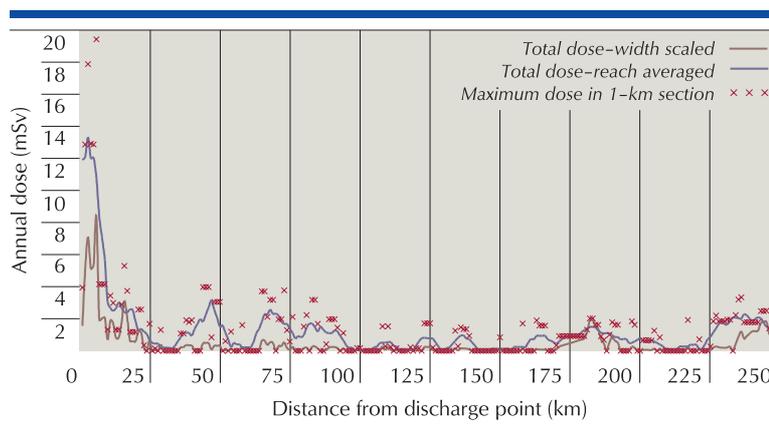
WRI, 1998, *The Global Timber Supply/Demand Balance to 2030—Has the Equation Changed?* Wood Resources International Ltd., Reston, VA, USA.

Radioactive Contamination in Two Russian Rivers: Consequences Less Serious than Feared

Following the political and social changes in the former Soviet Union (FSU) at the beginning of the 1990s, the Russian Federation began to make available data dealing with releases of radioactive materials from nuclear sites. Working with Russian in-country managers representing Minatom, the Russian Academy of Sciences, and the Kurchatov Institute, IIASA's Radiation Safety of the Biosphere (RAD) project conducted one of the first studies of contamination and radiation dosages resulting from releases of radioactivity from nuclear weapons production facilities in the FSU. The study focused on radioactive releases to the Tom River from the Siberian Chemical Combine at Tomsk-7 and to the Yenisei River from the Mining and Chemical Combine at Krasnoyarsk-26. Current riverine contamination has resulted primarily from the operation of single-pass reactors at both sites, which discharged reactor cooling waters into the rivers.

IIASA's study drew on published data from the West and previously unpublished data gathered from the sites and affected regions. The findings indicate that some areas of the Yenisei floodplain and island system are fairly heavily contaminated; however, conservative estimates of the potential doses along most of the river remain near or below the commonly accepted annual dose limit of one milliSievert (mSv). The Tom exhibits lower contamination levels; the annual allowable dose might be exceeded only within a few kilometers of the discharge point. The study also found that the concentrations of radionuclides in the water of both rivers have decreased greatly since the shutdown of the single-pass reactors.

To study potential impacts of surface water contamination on humans and the environment, RAD researchers constructed two hypothetical scenarios and developed hydrological models for calculating the consequences. The first scenario examined the possibility that a major flood might redistribute existing contamination and evaluated the dose levels that might occur as a consequence. This scenario showed no significant likelihood that the current pollution along the floodplains and islands would lead to new



Maximum and averaged annual doses from existing contamination of Yenisei River floodplains

contamination downstream. Moreover, any resulting contamination would remain well below background levels. The second scenario considered a release of radioactively contaminated sediments from surface storage basins into the adjacent rivers. In this case, the model projected a large and potentially dangerous increase in contamination levels and doses, particularly near the release point. These severe consequences may warrant further studies into the details of such a release, with a view toward minimizing the probability of this type of event.

The IIASA Research Report *Releases of Radionuclides to Surface Waters at Krasnoyarsk-26 and Tomsk-7* (RR-99-3), by Robert D. Waters, Keith L. Compton, Vladimir Novikov, and Frank L. Parker, provides background materials, site-specific data, and results on the two sites, and describes the methodology RAD used in its study. The report therefore represents one of the first independent and publicly available analyses of the impacts of contaminated sediment deposition and redistribution in the two rivers, and of the dose effects of consuming contaminated fish from the Tom River.

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Natural Catastrophes, Infrastructure, and Poverty in Developing Countries

From an emergency reconstruction perspective, many in the [World] Bank and among borrowers still see disaster management as traditionally being outside the normal business of development, as if it were an exceptional activity brought on by exceptional circumstances. It is indeed ironic that such “exceptional” activities are carried on almost regularly, year after year, in the most disaster-prone countries.

*World Bank Disaster Management Facility,
Learning from the World Bank’s Experience of
Natural Disaster Related Assistance, p. 37.*

Dramatic events of the past several years—including the Hanshin (Kobe) earthquake in 1995, Hurricane Mitch, which devastated Central America and the Caribbean in 1998, the severe earthquakes in Turkey, Mexico, and Taiwan in 1999, and the cyclone that struck the eastern coast of India also in 1999—have drawn worldwide attention to the destruction caused by natural catastrophes. Such disasters have an especially devastating effect on poorer nations, where they kill or injure more people and destroy proportionally far more property than similar events in the developed world. Despite the overwhelming concentration of capital assets in the richer nations versus the developing world, the economic impacts of catastrophes are relatively evenly split between the two regions: each group bears approximately US\$35 billion in direct costs annually. However, given the enormous differences in the gross domestic product (GDP), the per capita cost of natural disasters in relation to GDP is 20 times

higher in the developing world than in industrial nations. Moreover, even the most severe natural disasters in the wealthier nations result in far fewer casualties than equivalent events in the developing world. While property damage in the industrialized world may be enormous, many of these losses are insured and therefore have only a transient impact on the regional or national economy.

Sophisticated modeling techniques allow researchers to measure the vulnerability of societies to losses from catastrophes, thereby helping them to understand the potential consequences of these events. To develop in a sustainable manner, poor nations must prepare for catastrophic events before they occur. Meanwhile, the institutions concerned with reducing poverty must allocate their funding in ways that ensure that the country’s economic development programs will be interrupted as little as possible when a catastrophic

Catastrophe losses as a percentage of GDP.
These examples show that while absolute losses are higher in developed countries, disasters place a far greater burden on the economies of developing nations.

Event/Year	Country	Damages	% of GDP (est.)
Earthquakes, 1999	Turkey	US\$22 billion (est.)	5
Floods, 1998	China	US\$30 billion	0.7
Hurricane Mitch, 1998	Honduras	US\$3 billion	20
Hurricane Mitch, 1998	Nicaragua	US\$1 billion	8.6
Floods, 1998	Poland	US\$3.5 billion	3
Hanshin earthquake, 1995	Japan	US\$95 –\$147 billion	2.5
Hurricane Andrew, 1992	USA	US\$26.5 billion total US\$11 billion uninsured	0.5 0.25
Cyclone/Floods, 1991	Bangladesh	US\$1 billion uninsured	5

World Bank Disaster Management Facility

In July 1998 the World Bank created the Disaster Management Facility (DMF) to provide operational support, promote capacity building, and establish partnerships with the international and scientific community working on disaster issues. The DMF works with developing nations to improve management of risk and promote sustainable projects and initiatives that incorporate effective prevention and mitigation measures, thereby reducing vulnerability in the World Bank portfolio. At the same time, the facility promotes the inclusion of risk analysis and disaster prevention mechanisms in Bank activities. The DMF has already provided support to Bank operations including remediation after forest fires in Brazil, reconstruction after earthquakes and floods in Turkey, and disaster prevention initiatives for Central America and the Caribbean. Together with international and scientific partner organizations, the DMF sponsors training in disaster prevention, mitigation, and response, and supports research to identify policy, institutional, and physical interventions aimed at reducing catastrophic losses from natural disasters.

For more information on the DMF, contact:

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The Swiss Re Group

With 70 offices in 30 countries, the Swiss Re Group is the world's second-largest life and health reinsurer. Swiss Re has three primary business segments: risk transfer, risk retention financing, and asset management, of which the first remains the most important. The risk transfer activity seeks to minimize the total cost of the capital needed to deal with a risk by having clients share in the diversification effects of Swiss Re's worldwide, multibranch portfolio. Catastrophe reinsurance is becoming increasingly important for Swiss Re, but the associated risks are growing as the number and cost of claims grow. Swiss Re deals with the risk in three ways: by rejecting risks that are too high or that endanger the environment, by making its expertise and experience available to support governments and society in developing strategies for managing catastrophes, and by developing new, alternative risk transfer products to increase the ability of financial markets to handle major catastrophe risks.

The Catastrophe Peril Group at Swiss Re directs the interaction with IIASA.

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Earthquake aftermath: Taiwanese soldiers and a police officer walk past a collapsed 10-story hotel in Wu Fong City, Taiwan, 22 September 1999.

Source: AP/Itso Inouye.

event occurs. For that to happen, they need a fuller understanding of how natural catastrophes affect the countries least able to withstand them. This understanding will then provide an essential basis for designing policies to reduce the impacts of catastrophes on the poor.

Over the past several years, IIASA has studied various dimensions of natural catastrophes, including their statistical frequency, their effect on various aspects of land use, and their implications for designing insurance portfolios. IIASA scientists have also participated in World Bank initiatives to assess the ability of developing countries to deal with natural disasters and to identify ways of reducing the economic impacts. The studies completed for Mexico and Argentina provide the framework for establishing risk management programs for those countries with the potential assistance of the World Bank.¹

¹The findings and recommendations of the Mexican study are reported in *Managing Disaster Risk in Mexico: Market Incentives for Mitigation Investment*, by Alcira Kreimer et al., published by the World Bank Disaster Management Facility in 1999. Paul Freeman, leader of the CAT project, served as a coauthor.

Building on the relationships established through this prior work, IIASA and the World Bank signed an agreement on 9 June 1999 to collaborate in analyzing the direct and indirect economic impacts of catastrophes on developing countries. Swiss Re, the world's second-largest reinsurer, joined the partnership in July. The World Bank will incorporate the improved input and economic assumptions into the tools it uses to plan effective loan packages for its client nations, while Swiss Re will use the results to design improved insurance offerings for developing nations.

To accomplish these tasks, IIASA has created a new project: Natural Catastrophes and Developing Countries (CAT). The CAT project, formally approved at the November 1999 Council meeting, fits logically into IIASA's Environment and Natural Resources theme because natural disasters wreck both man-made and natural resources. Moreover, their impact is significantly influenced by the ways in which populations interact with the natural environment. The project also exemplifies IIASA's emphasis on policy-relevant research because the results will help developing countries and those that support them to identify and implement the best strategies for managing risk and reducing the impact of catastrophes on the poor.

Financing Natural Disaster Reconstruction

Beyond the immediate impacts on individual lives, physical structures, and landscape, natural catastrophes have far-reaching consequences for the entire economic structure of a nation. For poor countries, losses caused by natural catastrophes significantly limit progress toward sustained economic growth by absorbing domestic savings and eroding international development assistance. A large catastrophic loss may force both individual citizens and national governments

Severe floods, lasting from July to October 1998, endangered the livelihoods of more than 20 million people [in Bangladesh]. Food grain production fell by 4 million tons, forcing Dhaka to triple its normal food grain imports and placing severe pressure on Bangladesh's balance of payments. The floods increased the country's reliance on large-scale international aid.

*US Central Intelligence Agency,
The World Factbook 1999*

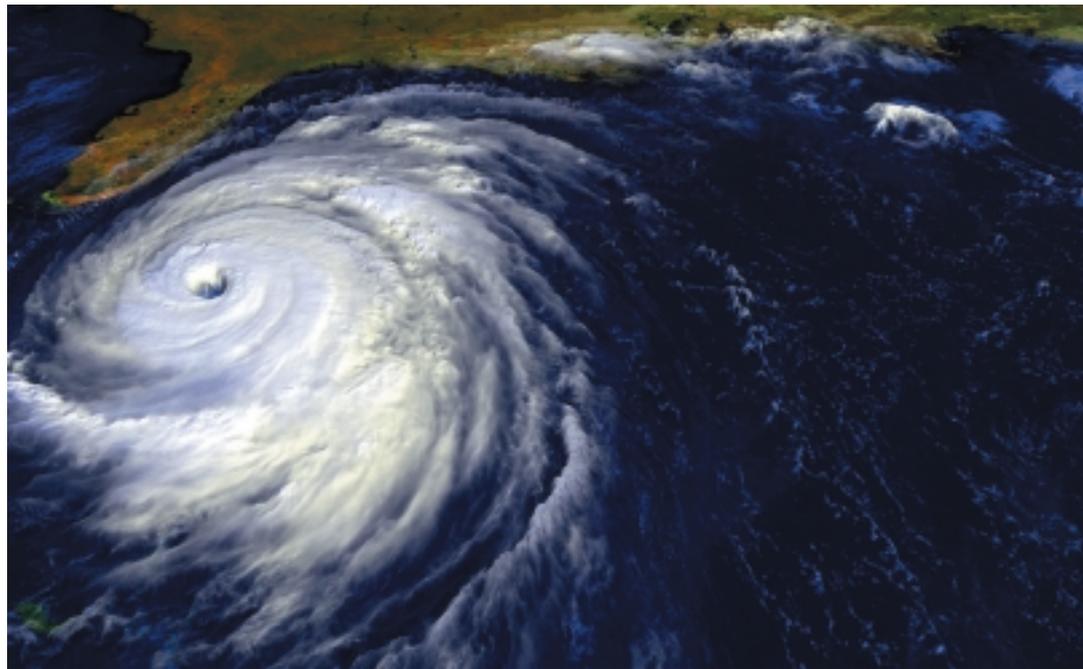


into debt. The Asian Development Bank has estimated that from 1988 to 1998, 5.6 percent of its development loans were for disaster rehabilitation, rather than for growth-oriented programs. In the past 20 years, the World Bank has expended US\$14 billion in natural-disaster-related projects, accounting for a majority of the Bank's reconstruction operations.

The 1998 floods in northeastern China affected 16.1 million people, killing 3,600 and destroying 1.3 million houses. They also degraded 8.5 million hectares of land and reduced the incomes of wide sectors of the regional economy. The annual per capita incomes in the affected parts of one province—where incomes already averaged only 56 percent of urban incomes—fell by some 15 percent as a result of the floods. In Heilongjiang, GDP shrank by some 1.5 percent instead of growing by 11 percent, as projected; in the most severely affected area in Jilin province, GDP contracted by 3.2 percent, rather than growing by 10 percent.

Source: Asian Development Bank

Of even greater concern, the World Bank has determined that significant portions of the funds it loans, other than the funding explicitly allocated to disaster relief, have been diverted to deal with emergency needs. As much as 30 percent of Bank-financed funds earmarked for water sector projects in Mexico have been reallocated to disaster-related programs. Such diversions of funds undermine development assistance programs; moreover, they leave the lending institution open to criticism for poor planning or even for wasting money. Many countries are reducing their foreign aid budgets,



Left: Hurricane Mitch, 26 October 1998.
Right: Hurricane Floyd, 14 September 1999.
Both were large storms, containing a huge volume of water; as a result, most of the damage they caused resulted from flooding rather than from the high winds themselves. Source: US National Aeronautics and Space Administration (NASA).

making it more difficult to convince donor nations to contribute to assistance projects. With both the frequency and severity of natural disasters increasing, the burden of financing the losses from catastrophes can be expected to increase.

These examples illustrate how disasters may quickly foil the most painstaking efforts taken to alleviate poverty. These diversions provide an additional impetus for the international lending institutions to address the implications of natural catastrophes and seek mitigation measures.

Poverty in the Developing World

Underlying the need to support a country's planned economic development path is the widespread realization that world poverty constitutes the greatest challenge of the 21st century. The United Nations Development Programme (UNDP) estimated that in 1998 one-third of the total population of the developing world were poor, and 18 percent of these people were extremely poor, or destitute, that is, lacking the basic necessities of life. More than 20 percent of the people in developing and transitional economies live on less than US\$2 a day. According to the UNDP:

Of the 4.4 billion people in developing countries, nearly three-fifths lack basic sanitation. Almost a third have no access to clean water. A quarter do not have adequate housing. A fifth have no access to modern health services. A fifth of children do not attend school to grade five. About a fifth do not have enough dietary energy and protein.

UNDP, Human Development Report 1998

The world leaders who attended the 1995 World Summit for Social Development identified the eradication of poverty as "an ethical, social, political and economic imperative of human kind." In response, the UNDP designated the reduction of poverty as its top priority and has undertaken a wide-ranging program to achieve this goal through programs at both the national and supranational levels. The United Nations Conference on Trade and Development established a Standing Committee on Poverty Alleviation in 1993 and designated 1996 as the International Year for the Eradication of Poverty.

The World Bank, whose declared aim is a "world without poverty," has instituted its Poverty/Net, exploring linkages between poverty and economic development in its client countries. The reason for the Bank's interest is evident: countries that must combat lingering poverty will continue to rely on international donors, rather than on their own resources, to support any economic growth. At the same time, many donor nations have become increasingly concerned about ensuring that any aid they provide leads to the greatest possible benefit. But compassion and good intentions cannot ensure the best allocation of development funding.

Why are developing countries especially vulnerable, socially and economically, to the effects of natural disasters? As the statistics cited above show, many of the world's poor people already live in precarious conditions. Their dwellings are likely to be relatively flimsy structures in exposed or otherwise vulnerable locations, unable to withstand high winds, floodwaters, earthquakes, or mudslides. The diseases that often follow upon a natural catastrophe have the greatest impact on people whose health is already fragile. Thus, while extreme events affect rich and poor alike, they have the potential to shatter the quality of life of populations in developing countries over decades or even generations.



Flood damage from 1999's Hurricane Floyd at an electrical plant in Goldsboro, North Carolina, USA.
Source: US Geological Survey, US Department of the Interior.

At the national level, developing countries lack the budgetary resources that would enable them to undertake various preventive measures. IIASA's earlier studies show that the appropriate measurement tools and risk modeling techniques are a key building block for demonstrating why and how planning and management of risk transfer would benefit those emerging economies vulnerable to natural hazards. Through the CAT project, IIASA seeks to develop these essential cornerstones for more effective risk management in developing nations and more cost-effective lending by donor institutions.

Infrastructure

In its *World Development Report 1994*, the World Bank detailed the close linkages between poverty and infrastructure—those physical structures that facilitate economic production, such as transportation, energy, and communication. These links have at least three different components. Access to infrastructure—especially the services that provide sanitation, electricity, and clean water—often tips the balance between subsistence and want. Modern infrastructure is a key component of economic growth, and the loss of infrastructure may have significant indirect and secondary costs that directly affect the poor.

Infrastructure also represents the key connection between natural disasters and poverty. Although world attention generally focuses on the human consequences of extreme events, natural disasters exert their most profound effect through the destruction of physical infrastructure.

From the Bank's perspective, infrastructure projects that affect rural agricultural production,

primarily transportation, irrigation, and provision of electricity, help to reduce poverty. World Bank studies indicate that investment in agricultural infrastructure increased average household incomes by over 30 percent, crop income by 24 percent, and wage income by a remarkable 92 percent. In addition, the Bank estimates that, on average, a 1 percent increase in the stock of infrastructure translates directly into a 1 percent increase in GDP. Yet floods and droughts devastate agriculture both in the short term, by ruining the current year's crops, and over a longer period, by destroying cropland or forcing farmers to consume their seed stocks. Moreover, they can cut access to water, shelter, or employment by destroying roads and bridges. As the reverse side of the relationship between infrastructure and development, a relatively small decrease in income as the result of a natural catastrophe might shift a far larger percentage of a country's people into poverty.

The 1997 floods that swept away this Seattle bridge also damaged other infrastructure, including sewage and water pipes, and cables for electricity and telephone.

Source: Reuters and Ringier Dokumentation Bild.



In the developing world, the cost of building infrastructure—whether a road, an electric power grid, a hydroelectric dam, a bridge, or an office building—absorbs a considerably higher proportion of a nation’s or a firm’s resources than it does in the industrialized world. Thus, when developing countries lose infrastructure, the resources will be both more difficult and more costly to replace. In addition, these infrastructure losses have a greater economic impact because developing countries are less likely to build redundancy into key systems. Therefore, the loss of one resource, such as a power plant, will have a greater and longer-lasting effect than it would in wealthier nations. At the same time, the lack of expertise or institutional controls in various areas may make capital stock more vulnerable. For example, experts agree that the damage from the August and November earthquakes in Turkey would have been far less severe had the houses in the affected areas been built to current standards of earthquake safety.

New Risk Transfer Mechanisms

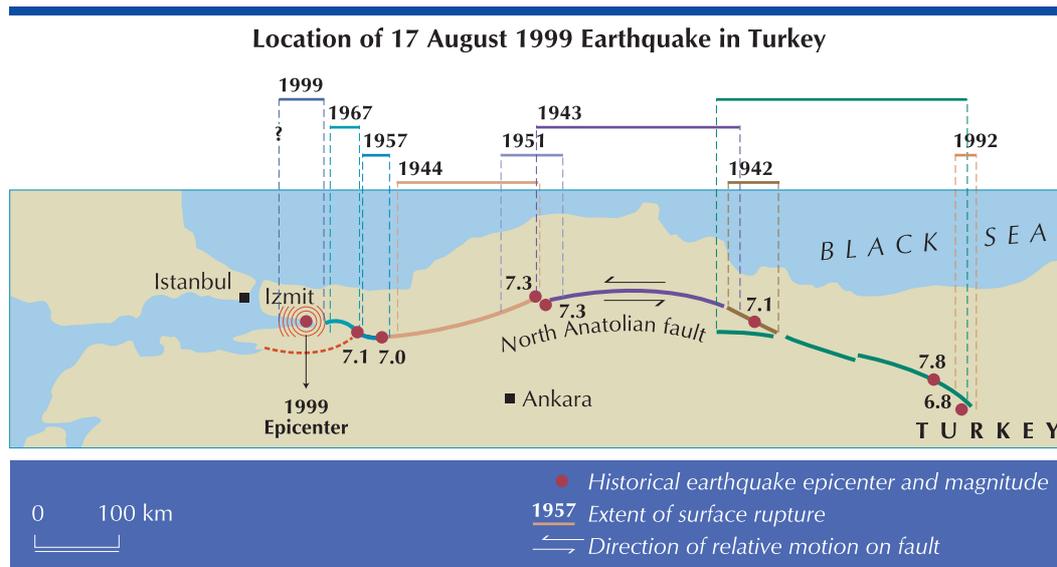
Catastrophe modeling has provided the planning basis for a new generation of risk transfer tools, known as catastrophe bonds, that capture the financial risks of catastrophic events and transfer them directly to the capital markets. These bonds pay if a described event occurs, such as an earthquake above 7.1 on the Richter scale at a defined epicenter during a specified period. Because the parameters of the obligation to pay are the size and location of the event rather than the level of damage, the structures used in indemnity reinsurance may not be needed. As a result, these instruments may present a viable option for developing countries; however, as yet no developing country has used such bonds to cover any form of risk.

Another option for using the capital markets is contingent credit with long maturities. In this case, the lender charges a fee that the borrower pays as long as the trigger event does not occur. If a catastrophe does occur, the borrower can draw the funds down rapidly.

Risk Mitigation and Risk Transfer

What happens when extreme events ravage the infrastructure so critical to development? After the initial emergency response, resources must be mobilized for longer-term reconstruction. In the industrialized world, insurance helps individuals and

commercial firms to absorb losses, including any losses from natural disasters, by providing a reliable source of financing for post-catastrophe reconstruction. Such services remain limited in developing countries. In the industrialized world, up to 50 percent of the cost of



Location of earthquakes in Turkey, 1939–1999. The North Anatolian fault has produced seven large (MS 7.0) earthquakes, which have ruptured the fault progressively from east to west. The changing stresses within the Earth mean that earthquake events need not be independent; an earthquake at a given time can result in another earthquake a few months or a year later, as happened in Turkey in 1999. Source: K. Okumurea, T. Yoshioka, and I. Kuscü, 1993, *Surface Faulting on the North Anatolian Fault in These Two Millennia*, US Geological Survey Open-file Report 94-568, pp. 143–144, US Geological Survey, US Department of the Interior.

reconstruction is financed by insurance put in place before a catastrophe occurs; the corresponding figure for the developing world is less than 2 percent, leaving cash-strapped governments as the only possible source of assistance. There are several reasons for this gap.

IIASA's earlier studies confirm that governments tend to respond to catastrophes after they occur (ex post measures) either by diverting funds from existing programs or by increasing external borrowing. They undertake few, if any, efforts to mitigate risk or transfer the financial burden to insurers or to the capital markets (ex ante measures), although some developing countries, such as Mexico and Turkey, have established limited disaster funds to provide some resources to meet the needs arising from natural catastrophes.

The World Bank, too, has so far used a strategy of post-catastrophe rehabilitation financing and is concerned that this approach may not be efficient. The Bank is interested in exploring alternative responses to gain greater insight into the long-term development impact of natural disasters—insight that IIASA's expertise in designing computerized models can provide. Based on the results of CAT's research, the World Bank can modify its planning packages for disaster-prone countries to address the issues explicitly.

CAT's Goal: A More Complete Picture

The developed world draws on a common set of tools in preparing for catastrophes. Models of natural hazards and of vulnerability to those hazards provide two of the fundamental inputs; integrating these models lays the cornerstone of financial planning for post-disaster reconstruction. So far, however, the developing world has had limited access to such information and has therefore been unable to benefit fully from the resulting knowledge and risk transfer options.

The long-term objective of the CAT project is to create scenarios that realistically reflect how the impact of a catastrophe would flow through various sectors of a country's economy. The developing nations could draw upon these detailed scenarios to evaluate options for minimizing damage from natural catastrophes and for decreasing or transferring the costs that result from such disasters. The World Bank and other international lenders, insurers, and donor nations could incorporate them into their own models to identify the most effective investments to promote sustained economic growth in the poorer



Improved building standards for post-earthquake reconstruction, 1989. *Managing Disaster Risk in Mexico: Market Incentives for Mitigation Investment*, The World Bank, 1999.
Photograph: Frederick Krimgold.

nations. Because these models will isolate the financial impacts of catastrophes, they will assist planners in weighing the benefits of different policy options by comparing their costs to the potential benefits. In the tradition of IIASA's Transboundary Air Pollution project, the CAT project intends to serve as a resource for policymakers as they deal with a significant threat to long-term development.

The CAT team is developing scenarios to simulate the direct and indirect costs of natural catastrophes in developing countries. To create this capability, CAT's analysts must identify and describe the disaster-specific variables that affect economic growth and poverty reduction in emerging and developing countries and how those functions are impacted by catastrophes.

The equations that model these processes must also estimate the vulnerability of key components of a country's economy to losses from natural catastrophes. This task requires that CAT understand the dynamics of different natural catastrophes, primarily floods, windstorms, and earthquakes. A major challenge for CAT will be to develop a methodology for using the frequency and intensity of less severe events as a basis for predicting much less frequent, but more significant, events. The equations must reduce the complex dynamics governing the frequency and magnitude of catastrophes to understandable measures of potential economic consequences.



Working Models

CAT has developed its research plan and reviewed it with the World Bank. The next task will be to transform these concepts into inputs that can be tested in an operational system. Specific research objectives include modeling catastrophe risks and performing macro-economic analyses.

Both the World Bank and Swiss Re now employ models for specific subtasks and have made them available to CAT's research team. The World Bank has supplied CAT with its Revised Minimum Standard Model (RMSM), a financial accounting framework that allows the Bank to evaluate macroeconomic conditions in a country. RMSM solutions are driven by calculations of the investment resources necessary to meet a specified GDP growth target. Using this model, CAT can examine the economic repercussions of catastrophe-induced capital stock losses. CAT will use RMSM to incorporate its analysis into the World Bank's existing planning framework. In the longer term, the project also hopes to develop scenarios that other organizations could incorporate into their own modeling.

The Bank's goal is to obtain more realistic assumptions about the effects of natural catastrophes that can become inputs to RMSM. These would also allow the Bank to identify the likely sources of replacement investment more accurately—in other words, how much a country might be able to supply through borrowing or increased exports, and how much the Bank and other donors could expect to incur as obligations.

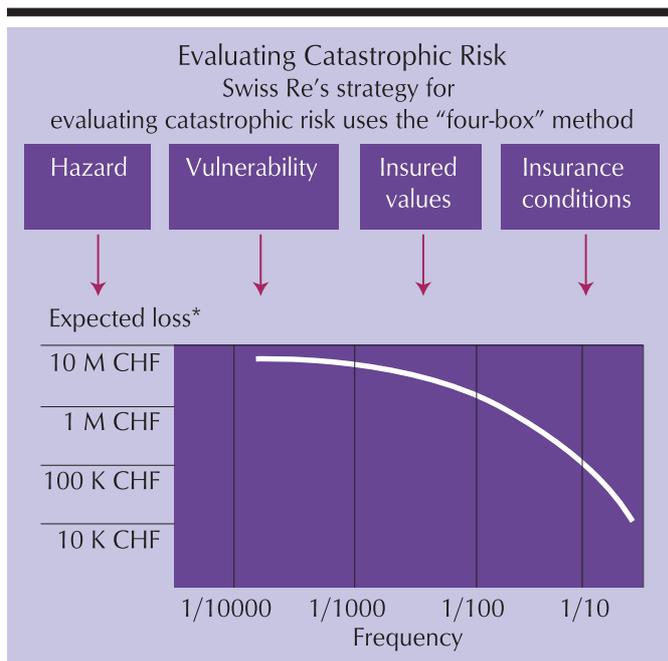
Case Studies

As described below, CAT will construct detailed case studies, which will be used to test and evaluate different approaches to modeling how catastrophes flow through a country's economy. These studies will center on countries where disasters have occurred and where longer-term economic effects are known. CAT will seek to develop scenarios and functions that can reproduce the actual outcomes from the actual starting conditions. Policymakers can then use these scenarios for predictive purposes in countries where natural catastrophes are likely to take place.

CAT's preliminary approach has two key components: (1) analysis of critical components of developing country growth and their vulnerability to natural disasters, and (2) simulated natural hazard shocks that impact the macroeconomic model. CAT will perform the analysis for selected countries, such as Argentina, by inputting simulated natural catastrophes into RMSM and evaluating how the output reflects economic conditions and needs following a particular type of disaster. Based on the outcomes, the project will apply simulations of alternative risk mitigation and risk transfer policies to the models and again evaluate the results. CAT hopes that this will serve as a prototype for future work with the Bank.

The project has already tested RMSM on an illustrative scenario to assess the impacts of losses from natural catastrophes in a developing economy. The results showed that even crude catastrophic loss data can provide a basis for meaningful macro-economic analysis of natural disasters. Under the new partnership, Swiss Re, which may have the most extensive database in the world on the maximum possible direct losses from natural catastrophes in developing countries, will provide improved risk analysis of natural catastrophes. Swiss Re uses this information as input to its models to analyze catastrophic risk in a target area. The models yield a probability that a country will lose a certain amount of capital stock if a natural disaster occurs. CAT will draw upon Swiss Re's detailed data, as well as on its modeling approaches, as it explores alternative scenarios that give detailed accurate descriptions of how the impacts of a catastrophe actually flow through a country's economy.

As CAT improves the accuracy and comprehensiveness of these data, it will extend the range and reliability of its economic analysis. This work will assist the Bank in avoiding the loss of precious



Within the "four-box" method, analysts quantify

1. Hazard: estimates the frequency of occurrence of hazards of different magnitudes
2. Vulnerability: expresses the degree of damage caused by a hazard of a given intensity
3. Insured values: represents the geographical distribution of insured values across subnational zones
4. Insurance conditions: determines the extent to which the policyholder, insurer, and reinsurer will bear the expected loss

The four elements are combined into a loss-frequency relationship. This relationship then determines the premiums that Swiss Re should charge to cover their expected losses.

*Figures given in Swiss francs

planning and financial resources when catastrophes force rechanneling of development loans. In addition, the incorporation of catastrophes into financial planning for vulnerable countries should smooth the way for economic recovery when events do occur.

In the next stage of research, CAT will extend its analysis of how the effects of natural catastrophes flow through a country's economy. CAT will test different paths, each of which may have many possible branches, breaking each down to the most detailed level possible. An area of particular interest is infrastructure. The researchers will disaggregate infrastructure into different components that have various impacts on economic growth and separate the effects on infrastructure from the effects on other components of the economy. The overall objective will then be to identify the amounts and types of additional resources needed to compensate for a given level of destruction.

Over the next year, CAT will integrate these efforts into four case studies, using them as an opportunity to test approaches and hypotheses, and refine them for future work. When the first case study, on Argentina, is complete, the World Bank will incorporate this work into its country assistance strategy—the first time that the Bank will explicitly include natural catastrophe risk in its planning process. As the case studies progress, they should reveal the strengths and weaknesses of each process model and indicate areas for improvement. Future steps will involve extending the analysis of losses to include secondary effects of catastrophes, such as the impact on human health and literacy, as well as tertiary effects on the macroeconomic structure of emerging economies.

Eventually, the CAT project hopes to create an integrated modeling approach that will produce detailed economic information on the direct and indirect effects of catastrophes. Policymakers will be able to provide country-specific data and then use the results of the analysis as a basis for estimating the consequences of a given catastrophe in a given area. This analysis, in turn, will enable them to evaluate alternative policy options that balance prevention, mitigation, and risk transfer. The results will help them as they work with international lenders, development organizations, and commercial companies such as insurance providers to develop an optimum economic policy package for their countries.

CAT's research partners will benefit from the ability to add functions to their models that better reflect reality. Such improvements should enable the World Bank to make more accurate predictions regarding the expected economic development of its client countries and to design the most effective package of loan and development programs for each borrower nation. In the case of a significant loss from a catastrophe, the Bank can evaluate not only how much money or other resources would be needed to maintain a country's planned economic growth, but also where those resources might be found.

At the same time, Swiss Re will use the results to examine and create innovative risk transfer products for emerging and newly industrialized countries. Swiss Re's primary interest lies in supporting the development of well-organized and efficient insurance solutions that will foster the development of economically sound and sustainable societies in emerging nations.

Other Activities

The World Bank has recently approved a flood reconstruction loan for Poland. One component of the loan is the development of a risk transfer strategy, including insurance. Because CAT's modeling work could be important in selecting the most cost-effective options, IIASA has approval to submit a proposal to perform this analysis for Poland. Based on initial conversations with the Bank, CAT believes that similar possibilities for testing the model may develop in Turkey and Mexico during 2000.

In addition, the Bank has asked IIASA to prepare a working paper describing how its modeling research can contribute to alleviating poverty. The Bank plans to include this paper in the next *World Development*

Report, which will focus on poverty. This publication will represent the first incorporation of natural catastrophes as a component of the Bank's poverty-reduction strategy.

CAT will devote additional effort to identifying other collaborators for the project and to building a consortium of long-term partners to support the work. CAT has already made contacts with several prominent institutions and anticipates that all three groups will participate in the research effort. Most of these proposed collaborators have developed modeling capabilities or data sources that could help the CAT project considerably.

Construction equipment arrives to remove the overturned section of the Hanshin Expressway following the 1995 Hanshin (Kobe) earthquake. Source: O. Médias.



Conclusion

In the past three decades, the number and frequency of catastrophic events have tripled and the financial costs have grown by a factor of nine. Therefore, any economic planning effort, whether conducted by a national government or by an international development organization, must address natural catastrophes as an intrinsic component.

The success of the CAT project will ultimately depend on whether or not IIASA succeeds in applying the results of its analysis in ways that benefit developing nations, international lenders, and insurance providers by identifying optimum strategies for dealing with the consequences of natural catastrophes. Multilateral agencies, including several of IIASA's sponsors, as well as governments and nongovernmental organizations around the world agree that poverty constitutes the fundamental problem facing the global community. By suggesting methods for countering some of the most severe impacts of unavoidable natural events, the CAT project can make an important contribution to the worldwide effort to alleviate poverty and promote sustainable economic well-being throughout the world.

Research Team

Natural Catastrophes and Developing Countries (CAT)



Paul Freeman
Project Leader



Leslie Martin



Reinhard Mechler



Koko Warner

Other IIASA Publications Related to These Topics

Johannes Stripple, 1998, *Securitizing the Risks of Climate Change: Institutional Innovations in the Insurance of Catastrophic Risk*, IR-98-098.

Boris V. Digas, Yuri M. Ermoliev, and Arkadii Kryazhimskii, 1998, *Guaranteed Optimization in Insurance of Catastrophic Risks*, IR-98-082.

Boris V. Digas, 1998, *Generators of Seismic Events and Losses: Scenario-Based Insurance Optimization*, IR-98-079.

Hans-Jörg Albrecher, 1998, *Dependent Risks and Ruin Probabilities in Insurance*, IR-98-072.

Lisa A. Korf, 1998, *Insurer's Portfolios of Risks: Approximating Infinite Horizon Stochastic Dynamic Optimization Problems*, IR-98-061.

Yuri M. Ermoliev, Tatiana Y. Ermolieva, Gordon MacDonald, and Vladimir I. Norkin, 1998, *On the Design of Catastrophic Risk Portfolios*, IR-98-056.

Tatiana Ermolieva, 1997, *The Design of Optimal Insurance Decisions in the Presence of Catastrophic Risks*, IR-97-068.

Love Ekenberg, Magnus Boman, and Joanne Linnerooth-Bayer, 1997, *Catastrophic Risk Evaluation*, IR-97-045.

Tatiana Y. Ermolieva, Yuri M. Ermoliev, and Vladimir I. Norkin, 1997, *Spatial Stochastic Model for Optimization Capacity of Insurance Networks under Dependent Catastrophic Risks: Numerical Experiments*, IR-97-028.

Yuri M. Ermoliev and Vladimir I. Norkin, 1997, *Stochastic Generalized Gradient Method with Application to Insurance Risk Management*, IR-97-021.

These publications are available on the IIASA Web site or can be ordered from IIASA's Publications Department (publications@iiasa.ac.at).

Council News

At its November 1999 meeting, the IIASA Council approved the Long-Range Plan that will guide the Institute's activities during its fourth decade.

The Council also officially changed the name of the Risk, Modeling and Policy (RMP) project to Risk, Modeling and Society (RMS), effective 1 January 2000. RMS will continue the work of RMP in addressing the socioeconomic and methodological issues involved in managing risks to public health, safety, and the environment; the new name reflects the project's stronger emphasis on social risks stemming from various aspects of global change.



Schloss Laxenburg

Meetings

The Future of Decision Analysis and Support

5–7 September 1999

Organizer: Decision Analysis and Support (DAS)

Contact: Freerk Lootsma (lootsma@iiasa.ac.at or f.a.lootsma@twi.tudelft.nl)

13th JISR–IIASA Workshop on Methodologies and Tools for Complex System Modeling and Integrated Policy Assessment (CSM'99)

9–11 September 1999

Organizer: Risk, Modeling and Policy (RMP)

Co-organizer: Japan Institute of Systems Research

Contact: Marek Makowski (marek@iiasa.ac.at)

Workshop on Building the Virtual "House of Solomon": Digital Collaboration Technologies, the Organization of Scientific Work and Economics of Knowledge Access

3–5 December 1999

Organizer: Dominique Foray,

European Science Foundation

Contact: Dominique Foray

(dominique.foray@dauphine.fr);

Paul David (paul.david@economics.ox.ac.uk)

Harnessing Remote Sensing to Accomplish Full Carbon Accounting

9–11 December 1999

Organizer: Sustainable Boreal Forest Resources (FOR)

Contact: Sten Nilsson (nilsson@iiasa.ac.at)

The Formation of Biodiversity through Adaptive Speciation

10–13 December 1999

Organizers: Adaptive Dynamics Network (ADN);

Michael Doebeli, Department of Zoology, University of British Columbia; Diethard Tautz, Institute of Genetics, University of Cologne

Co-organizer: European Science Foundation, Programme on Theoretical Biology of Adaptation

Contact: Hans Metz (metz@iiasa.ac.at);

Ulf Dieckmann (dieckman@iiasa.ac.at)

Regional Workshop of the Regional Technical Advisory Committee for Central and Eastern Europe (CEETAC)

17–18 December 1999

Organizer: Janusz Kindler, Global Water Partnership, Swedish International Development Agency

Contact: Janusz Kindler (jkindler@iis.pw.edu.pl)

IIASA Hosts High-Level Chinese Visitors

Professor Siwei Cheng, Vice Chairman of the Standing Committee, National People's Congress of China, and Director General, Department of Management Sciences, China National Science Foundation, visited IIASA on 9 July 1999 to learn firsthand about the Institute and its research activities. During his one-day visit, he received briefings on selected IIASA projects, conferred with Chinese students participating in IIASA's Young Scientists Summer Program (YSSP), and addressed a gathering of more than 80 researchers, YSSP fellows, and representatives of the Chinese diplomatic community in Vienna. His speech focused



Professor Siwei Cheng describes "Management Science in China" during his July visit to IIASA.

on the evolving nature of management in China's growing economy, noting that, "Chinese management scientists are playing an important role in China's transition from a central planning system to a socialist market system." According to Professor Cheng, government support for management science is growing steadily, as is the demand for MBA students: China currently graduates some 5,000 MBAs annually and would like to increase that number tenfold.

On 13–14 September, IIASA hosted a delegation of 21 senior scientists from the Chinese Ministry of Land and Resources, a visit that further demonstrated China's

continuing interest in IIASA. The delegation's leader, Professor Xiaohu Huang, director of the China Institute of Land Surveying and Planning, gave a seminar for the staff on "An Introduction to Research on Land Use and Planning in China." Thereafter, the leaders of the LUC, FOR, RMP, ECS, TAP, and POP projects briefed the visiting scientists on their respective research activities. The Chinese delegation also met with representatives from the Office of the Austrian Prime Minister and from the Austrian Institute for Regional Studies and Spatial Planning.

EuroConference Explores Management of Flood Risk

The EuroConference on Global Change and Catastrophe Risk Management: Flood Risks in Europe, organized by IIASA's Risk, Modeling and Policy (RMP) project with support from the European Commission and the Geneva Association, examined how to spread the costs of flood response and rehabilitation as well as the possible influence of global change on the number of devastating floods in Europe. The conference, held 6–9 June at IIASA, attracted 100 insurers, researchers, and policymakers from all over Europe as well as from Japan, Taiwan, and the United States.

Although several papers focused on the effect that possible global warming might have on the frequency and intensity of future floods, participants concluded that the increased movement of population, capital, and infrastructure into vulnerable regions contributes far more to increased losses from natural catastrophes. Conference sessions also covered integrated risk management and modeling and management of financial risk, with particular attention paid to flood risk in Poland. In 1997, Central Europe suffered flood-related economic losses of US\$5.3 billion, of which only US\$800 million was compensated by insurance. Poland's share of the losses amounted to approximately 3 percent of its gross domestic product. The most effective government strategy to reduce risk and mitigate potential losses would be

to enhance preparedness measures. Participants also discussed the potential for reinsurance and catastrophe bonds to both reduce long-term losses and improve the spread of the losses.

On the day following the conference, RMP offered a training session for young researchers on the project's systems modeling techniques. The journal *Risk Analysis* has expressed interest in publishing selected full-length conference papers. Several organizations, including Italy's National Research Council and the Disaster Prevention Research Institute of Kyoto University, plan further cooperation with IIASA on themes related to the conference, and RMP is already exploring the possibility of conducting a case study on Poland in cooperation with a Polish partner.

HISAP '99 Assesses Legacy of Nuclear Age

The Second International Symposium on the History of Atomic Projects (HISAP '99), held 4–8 October 1999, attracted 114 participants to IIASA to discuss the sociopolitical, environmental, and engineering lessons learned from the nuclear power programs of the 1950s. The conference highlighted critical events in the second nuclear decade, which witnessed both the development of the thermonuclear bomb and initial efforts to control the arms race and apply nuclear technology to civilian uses. Featured speakers included senior scientists from Russia and the United States who had participated in the atomic programs of the 1950s, as well as their successors, who were able to assess their achievements from a historical perspective.

Each day's program focused on a different aspect of the second atomic decade. The first day's presentations focused on the Russian and US nuclear weapons programs of the 1950s, the expansion of the nuclear club, the Cold War, and movement toward nuclear parity. An especially intriguing talk presented materials newly released on the occasion of the 50th anniversary of the first Soviet nuclear explosion, including correspondence between Josef Stalin and Lavrenty Beria that demonstrated the extent of nuclear

intelligence provided by spies Donald Maclean and Klaus Fuchs. The second day's discussions addressed the transition from strictly military uses of atomic power to the development of nonmilitary applications of atomic energy and evaluated the often detrimental effect of the military heritage on civilian uses of nuclear power. This theme led into the third day's discussions, which centered on social and institutional changes, including the emergence of efforts to slow the arms race. Environmental issues, including ecology, radiobiology, and nuclear medicine, dominated the fourth day's program; speakers included Frank Parker and Keith Compton of the Radiation Safety of the Biosphere (RAD) project, who presented results from RAD's comparative studies of contamination of the Clinch and Techa Rivers. The final day's program addressed the development of monitoring tools for nuclear tests and nuclear incidents, and focused on memories and biographies of some of the participants in these early atomic projects.

IIASA's RAD project organized the meeting in collaboration with the Kurchatov Institute in Russia; HISAP '99 also received support from both governmental and nongovernmental organizations of the Russian Federation, the US Department of Energy, and IIASA. A collection of 98 abstracts of some of the HISAP '99 presentations was available at the meeting; the conference steering committee plans to publish selected full-length papers in an edited proceedings volume.



Participants in HISAP '99 listen intently as Lev Ryabev, first deputy minister of atomic energy of the Russian Federation, describes materials newly released for the 50th anniversary of the first Soviet nuclear explosion.

Research Grants and Contracts

Project	Sponsor	Study
Adaptive Dynamics Network (ADN)	European Science Foundation	Symposium: Linking Ecology to Evolution: Non-Equilibrium Processes and Adaptive Dynamics
		Workshop: Adaptive Speciation
		Workshop: Fisheries-Induced Genetic Change
Dynamic Systems (DYN)	Fujitsu Research Institute	Comparative Analysis of the Trajectory of Techno-Metabolism: Japan, USA, and Europe
	Russian Academy of Sciences	General support
Economic Transition and Integration (ETI)	Austrian Ministry of Science and Transport	Workshop: The Time Pattern of Costs and Benefits of European Union (EU) Accession
	Austrian Institute of Economic Research (WIFO)	PREPARITY: Structural Policy and Regional Planning along the External European Union (EU) Frontier to Central Europe: Preparing for Eastern Enlargement
	Austrian National Bank European Commission (EC), DG-II	Workshops: The Macroeconomic and Microeconomic Implications of Currency Boards in Transition Economies
	Swedish Council for Planning and Coordination of Research (FRN)	Catching Up and European Union (EU) Accession – Prospects for First and Second Wave New Members
Environmentally Compatible Energy Strategies (ECS)	Austrian Ministry for Environment, Youth and Family Affairs	Intergovernmental Panel for Climate Change (IPCC) meeting, June 1999
	Austrian Ministry of Science and Transport National Bureau of Economic Research, Inc.	International Workshop on Induced Technological Change and the Environment
	Central Research Institute of Electric Power Industry (CRIEPI)	Asian Energy Perspectives with Emphasis on Nuclear Development and Utilization
	Electric Power Research Institute	International Energy Workshop
	Japan Gas Association	Global Natural Gas Perspectives
	New Energy and Industrial Technology Development Organization (NEDO)	Pre-Feasibility Study for Eurasian Infrastructures
	General Research (GEN)	The Rockefeller University
Modeling Land-Use and Land-Cover Changes in Europe and Northern Asia (LUC)	Japan Institute of System Research (JISR)	JISR–IIASA Joint Program on Global Environmental Modeling in Collaboration with National Institute for Environmental Studies (NIES) (Phase III). Joint project with RMP.
	New Energy and Industrial Technology Development Organization (NEDO)	Current State of Biomass Energy and Technological Development Trends for Utilization in Europe and Russia
	Potsdam Institute for Climate Impact Research (PIK)	Socioeconomic data
	World Resources Institute	PAGE – Pilot Analysis of Global Ecosystems

Project	Sponsor	Study
Radiation Safety of the Biosphere (RAD)	US Department of Energy Russian Science and Technology Association	Second International Symposium on the History of Atomic Projects (HISAP '99)
Risk, Modeling and Policy (RMP)	Geneva Association	Euroconference on Global Change and Catastrophe Risk Management: Flood Risks in Europe
	Japan Institute of System Research (JISR)	JISR–IIASA Joint Program on Global Environmental Modeling in Collaboration with National Institute for Environmental Studies (NIES) (Phase III). Joint project with LUC.
Social Security Reform (SSR)	The Futures Group International, The Policy Project	Eastern Europe and Newly Independent States (ENI) Regional Reproductive Health Financing Workshop
Sustainable Boreal Forest Resources (FOR)	Austrian Ministry of Science and Transport	Database for Assessment of the Austrian Carbon Balance
Transboundary Air Pollution (TAP)	European Environment Agency (EEA)	Determination of Environmental Impacts of EEA Transport and Agricultural Projections
	European Commission (EC), DG-XI	Emission Limit Values for “Existing” Large Combustion Plants (LCPs) Calculations of Abatement Scenarios for the Second Nitrogen Protocol
	Finnish Environment Institute	European Union/Life Project
	French Ministry of the Environment	Further analysis of RAINS model results
	German Federal Environment Agency	Assessment of emission reduction strategies
	German Federal Ministry of Environment, Youth and Family	Impacts of an Accession of Central and Eastern European Countries to the European Union on European Air Quality
	Swedish Environmental Research Institute (IVL)	Calculations of Abatement Scenarios for the Second Nitrogen Protocol
	UK Department of the Environment, Transport and the Regions	Further Development of the European Scale Integrated Assessment Modeling (IAM)

IIASA Recognizes Outstanding YSSP Fellows



Janica Ylikarjula



Lily Panyacosit



Kevin Wheeler

A selection committee composed of the IIASA director and the dean and vice-dean of the Young Scientists Summer Program (YSSP) has awarded the 1999 Peccei Scholarships to Janica Ylikarjula and Lily Panyacosit, and the 1999 Mikhalevich Scholarship to Kevin Wheeler. The scholarships will enable these exceptional students to continue their research during an additional three-month stay at IIASA in 2000.

This year, 49 students participated in the YSSP; 15 of them were nominated for awards by their immediate supervisors. To reach its decision, the selection committee weighed the oral and written reports prepared by the scholarship candidates, supporting input from the candidates' supervisors, and evaluations by outside reviewers. The winners were chosen for their scholastic achievements, general contributions to IIASA's overall objectives, and professional interactions with IIASA staff and the other summer students.

Ms. Ylikarjula, a doctoral student in applied mathematics at the Helsinki University of Technology, worked with the Adaptive Dynamics Network project, where she studied the potential causes, mechanisms, and consequences of stunted growth in species of freshwater fish. At the policy level, her findings can contribute to sustainable fisheries management; in the research context, they also suggest new directions for ecological modeling of populations with fluctuating dynamics.

Lily Panyacosit, who received her master of science degree in environmental health sciences from the University of California, Berkeley, in 1999, performed her research with the Transboundary Air Pollution project. She analyzed the effects of airborne particulate matter on human health, with a special focus on developing countries. Because most data collected so far reflect conditions in developed countries, her work fills an important gap in the understanding of the social costs that particulate matter may impose.

The Mikhalevich Scholarship, which recognizes innovative methodological research, went to Kevin Wheeler, who will receive his master of science degree in water resource/environmental engineering from the University of Colorado in December 1999. Within the framework of IIASA's Land-Use Change (LUC) project, he developed a simplified model of regional water quality, based on geographical information system tools and LUC's spatial databases on population, industrial activity, and agricultural production. The resulting methodology for water quality assessment can help policymakers determine the waste treatment required to reach specific water quality standards.

IIASA established the Peccei Scholarships in 1984 in memory of Dr. Aurelio Peccei, who helped to inspire the original concept of the Institute and contributed actively to its realization. The Mikhalevich Scholarship was set up in 1995 in memory of Academician Vladimir S. Mikhalevich, who chaired the IIASA Council from 1987 to 1992.

New Staff

Staff Member	Project	Country
Atsushi Akisawa	Environmentally Compatible Energy Strategies (ECS)	Japan
Andrei Bykov	Office of Information (INF)	Russia
Rogier De Kok	Risk, Modeling and Policy (RMP)	Netherlands
Sanja Drinkovic	Office of Information (INF)	Croatia
Olaf Rune Godø	Adaptive Dynamics Network (ADN)	Norway
Mikko Heino	Adaptive Dynamics Network (ADN)	Finland
Matti Pekka Johansson	Transboundary Air Pollution (TAP)	Finland
Anke Lükewille	Transboundary Air Pollution (TAP)	Germany
Leslie Martin	Natural Catastrophes and Developing Countries (CAT)	USA
Reinhard Mechler	Natural Catastrophes and Developing Countries (CAT)	Germany
Masamichi Murakawa	Risk, Modeling and Policy (RMP)	Japan
Simon Quijano Evans	Risk, Modeling and Policy (RMP)	Colombia
Jan Sendzimir	Risk, Modeling and Policy (RMP)	USA
Paul Voss	Population (POP)	USA
Koko Warner	Natural Catastrophes and Developing Countries (CAT)	USA
Devin Wolfe	Publications Department (PUB)	USA

In Memoriam



Heinrich Antoni, a member of the Technical Services staff for 21 years, died on 12 October 1999 from complications following an operation for cancer. IIASA staff members will miss his dedication, his sense of humor, and his constant readiness to assist his colleagues.



Winfried Lang died in Brussels on 12 May 1999. A career diplomat and professor of law and international relations at the University of Vienna, Dr. Lang was a founding member of the Processes of International Negotiation (PIN) Project in 1988 and served on the PIN Steering Committee. A special memorial conference in Dr. Lang's honor will be held at IIASA in February 2000.

Hugh Jordan Miser, leader of IIASA's Survey Project from 1980 to 1982, died of cancer on 22 June 1999. Dr. Miser had a distinguished career as a practitioner, consultant, educator, and editor in the fields of mathematics, operations research, and systems



analysis. During his stay at IIASA, he co-edited the three-volume *Handbook of Systems Analysis*, supervised the editorial staff, and together with Edward Quade published numerous other studies in the general areas of operations research and systems analysis.