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options

summer 2006

A Secure World

How science can help

editorial

Leen Hordijk
Director, IIASA

Freedom from Fear; Freedom from Want

When IIASA was established in the midst of the Cold War, security was essentially a state-centered notion and self-defense against external hostilities was the mainstay of many countries' security strategy.

The foundation of IIASA in 1973 was, in itself, a signal that this narrow "national security" mindset was beginning to change, as scientists from the East and the West came together in a spirit of cooperation to look for solutions to the problems besetting the whole of humanity. It perhaps took the epoch-making 1994 Human Development Report of the United Nations Development Program (UNDP) to give voice and definition to the new paradigm of human security. Nevertheless, the realization had begun to dawn that the world could never be at peace unless people had security in their daily lives. Security thus began to be equated with people rather than territories and with development rather than arms.

From the very beginning of its existence IIASA has worked on the issues whose place is now taken for granted on the human security agenda: energy, food and water security, international negotiation, transboundary air pollution mitigation, forestry, population, risk management, and many more. As well as keeping the Human Development Report's goals of "freedom from fear" and "freedom from want" clearly in view, however, IIASA also offers unique and important support to the world community in terms of its scientific work and insights. Today, in a more interconnected and interdependent world, where issues are increasingly complex and uncertain, a multidisciplinary—not to say quantitative—approach is frequently required to resolve problems, especially those of a medium- or long-term nature. The scientific work carried out by IIASA is ideally placed to confront such issues.

For policy makers wishing to base decisions on the most accurate projections possible, IIASA has many innovative tools, which it constantly refines and develops in line with newly emerging methodology. In this issue of *Options*, you will read how we are using new multistate population projection dynamics to more accurately predict the effects on economic growth of investments in education. Another article shows how IIASA modeling techniques are being applied to create ways of mitigating air pollution and greenhouse gases in Asia, without putting a brake on economic development. Moreover, IIASA scientists are co-sponsoring talks among the five littoral states of the Caspian Sea on issues, such as the environment and land and water use.

I think you will find the stories in this issue eye-opening in terms of the large diversity of the contributions that IIASA is making to human security through its scientific and research endeavors. Wherever possible, we have provided links to further information which space does not permit us to provide. I would also urge you to stay updated on our work by bookmarking the IIASA Web site: www.iiasa.ac.at.

Leen Hordijk

About IIASA
IIASA is an interdisciplinary, nongovernmental research institution.

IIASA's scientists research
- energy and technology;
- environment and natural resources; and
- population and society.

IIASA produces
- data, models, and research tools;
- refereed scientific literature; and
- policy-relevant information.

IIASA helps
- countries make better-informed policy;
- develop international research networks; and
- support the next generation of scientists.

IIASA is funded and supported by scientific institutions and organizations in the following countries:

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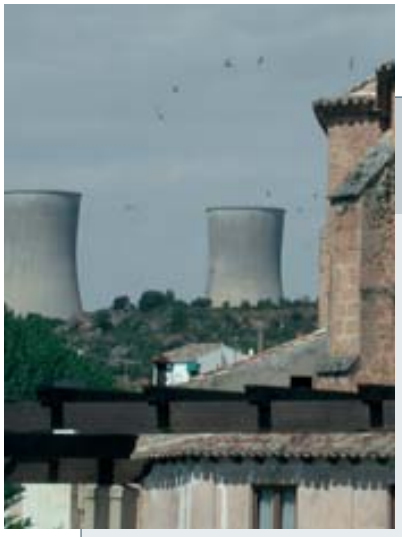
A Secure World
How Science Can Help

Regular News about IIASA Research



THE URBAN NUCLEAR LEGACY

Waste Disposal

IIASA has contributed financial and human resources to a project to assess the problems of the nuclear legacy in urbanized areas, in particular, Moscow. The research, carried out jointly with scientists from the Russian Research Center, the Kuratov Institute (RRC-KI), will be published this year under the title, *The Nuclear Legacy in Urbanized Areas: Generic Problems and Moscow Case Study*.

Because of nuclear weapons production and accidents at nuclear enterprises, several countries now have vast quantities of radioactive waste and numerous radioactively contaminated sites. Moreover, rapid urbanization has meant that radioactive waste disposal facilities—once sited in the vicinity of cities—are now in densely populated areas.

Though urban-based facilities account for only a small (one percent) fraction of the total nuclear legacy, minimizing the radiological impact to population and site workers is a social priority. The RRC-KI, for example, is situated only 100 meters from the nearest residences.

The joint research identifies several countermeasures for minimizing radionuclide migration within and from such sites, including special drainage systems, adequate fencing of waste storage sites, soil compaction using concrete or polymers, and meteorological interventions to reduce precipitation.

The report concludes that countries with similar nuclear legacy problems in urban environments could benefit from experience sharing and cooperation in this field. ■

LAND USE CHANGE

Watertight in China

A new IIASA research report aims to improve the analysis of global and regional water resources. It develops a new methodology to include developmental and economic concerns in the calculation of water availability. It uses the methodology to examine the impact of climate change on the supply of water from storage in China.

According to coauthors, David Wiberg of IIASA and Kenneth Strzepek of the University of Colorado, a number of recent attempts to study which regions and countries could be facing serious water scarcity problems have failed to take into account the costs of developing and supplying water, the potential water losses due to development, and the relationship between supply and demand.

The methodology developed in this paper aims to improve estimates of water availability, or supply, by accounting for those factors. In the process it also analyzes and develops a new methodology for aggregating reservoir storage-yield curves.

Relying on the Climate- and Human Activities-sensitive Runoff Model (CHARM), a spatially explicit hydrologic model that is sensitive to land-use and climate changes, Wiberg and Strzepek develop model scenarios and create economic cost and supply curves. These suggest that China will benefit from increased runoff in regions of water scarcity and high demand. However, increased evaporation and flow variability will take its toll in some regions, increasing the frequency of floods and droughts and thus the need for and cost of storage in those regions. ■

David Wiberg and Kenneth Strzepek (2005) *Development of Regional Economic Supply Curves for Surface Water Resources and Climate Change Assessments: A Case Study of China* is available at www.iiasa.ac.at/Admin/INF/recent-pubs/luc/rr-05-001

EVOLUTION OF COOPERATION

Back-Scratching Science

An article entitled "Evolution of Indirect Reciprocity," co-authored by Karl Sigmund of IIASA's Evolution and Ecology Program and Martin A. Nowak of Harvard University, was published in the 27 October 2005 edition of *Nature*.

The Evolution and Ecology Program is among world leaders in researching indirect reciprocity, which explores how biological systems—especially human societies—that are based conventionally on "selfish" natural selection, are in fact organized around altruistic, cooperative interactions.

The authors argue that while it is easy to make sense of direct reciprocity (You scratch my back, I'll scratch yours), understanding indirect reciprocity (I scratch your back and someone else will scratch mine) is more problematical, complicated by the fact that humans display "a large amount of cooperation between non-relatives."

The authors conclude that a person's reputation and the moralistic assessment of other members of the population provide "a power tool for channeling support towards those who cooperate, and an incentive to join group efforts."

The authors also see further opportunities for a better understanding of human traits in future theoretical and experimental work in this field using game theoretical models for cooperative interaction. ■

More information: www.nature.com/nature/journal/v437/n7063/abs/nature04131.html

SIBERIA II PROJECT

Study by Satellite

IIASA, through its Forestry (FOR) Program, was one of 14 international scientific and academic institutes taking part in Siberia II, a European Commission-funded project designed to demonstrate the viability of full carbon accounting on a regional basis. The project ran from 2001 to 2005.

To collect and interpret data, Siberia II, which was conducted in a 300-million-hectare forest region in central Siberia, used advanced sensors on 15 satellites coupled with sophisticated vegetation models and a landscape Geographic Information System developed by FOR.

The vast Siberian forests are the largest terrestrial carbon reservoir in the northern hemisphere, where changes in the carbon balance are driven mainly by climate change. The wealth of information on terrestrial vegetation, soils, water bodies, disturbances, and climate data accumulated during the project, as well as the methodological and modeling findings of Siberia II, will have multiple

uses and benefits. The data will, for example, advance our understanding of the effect of forest fires, global warming, freeze and thaw, and biomass decomposition on greenhouse gases. It will also help determine the direction of future climate policies.

A local benefit will be more effective and more sustainable management of the region's natural resources now and in the future. Internationally, results of the full greenhouse gas accounting will be an essential verification tool for the Kyoto Protocol, following ratification of the instrument by Russia in 2004. ■

More information: www.siberia2.uni-jena.de/index.php

MOSUS PROJECT

Is Europe Sustainable?

Efficient use of natural resources—fossil fuels, metals, industrial and construction minerals, and biomass—is a key objective in advancing sustainable development. A Europe-wide project, "Modelling Opportunities and Limits for Restructuring Europe towards Sustainability" (MOSUS), coordinated by IIASA's land use experts, has just concluded a detailed assessment and quantification of European natural resource use.

Using a multicountry, multisectoral macroeconomic simulation model, the team found that, contrary to popular assumptions, Europe can develop policies that, while conducive to economic growth, are less environmentally taxing. In sustainability scenarios, GDP increases in 2020 by 2–4 percent (compared to the reference level), energy use decreases by 5–10 percent, total domestic material extraction by 6–12 percent, and CO_2 emissions by 9–17 percent. However, certain energy-intensive and materials-related sectors, such as agriculture, are negatively affected by scenario measures, although growing more combustible biomass as renewable energy sources would partly offset economic and employment losses. Moreover, sustainability scenarios are characterized by faster structural changes in national economies, with both benefits and disadvantages for employment.

The MOSUS project concludes that sustainable development solutions cannot be implemented without introducing new instruments and strengthening many existing ones. It recommends a radical improvement in eco-efficiency, for example, by introducing an environmental fiscal reform to shift the tax burden from labor to the use of natural resources, removing environmentally (and socially) harmful subsidies that encourage resource overuse (particularly in agriculture, fisheries, transport, and energy), stimulating knowledge and information transfer, and fostering voluntary environmental agreements among industries. ■

More information: www.mosus.net

POPULATION AND SOCIETY

Cutting School

What would be the impact of an education reform that cuts the age of school entry by one year and then compresses the duration of schooling by a further year? In new IIASA research published in November 2005, IIASA research scholar Vegard Skirbekk argues that a reform which lowers the school-leaving age could have social and individual benefits: rejuvenating the workforce, lengthening the working life, increasing the amount of contributions paid into pension funds, providing more years to achieve fertility intentions, and encouraging an earlier age at childbirth, with positive implications for the health of mother and child.

To analyze the effects of such a reform, Skirbekk ran projections of the Norwegian public pension system using the large-scale microbased dynamic model, MOSART. From detailed case studies of compulsory schooling in Sweden and Switzerland (both investigated by Skirbekk), he concludes that an earlier school-leaving age (Sweden) and a shorter schooling length (Switzerland) do not harm human capital formation. Moreover, he argues, policies that aim to lower the school-leaving age while maintaining educational quality could play a role in expanding the labor force and may represent an important contribution to the sustainability of the public pension system in aging economies such as that of Norway. ■

Vegard Skirbekk (2005) *Why Not Start Younger? Implications of the Timing and Duration of Schooling for Fertility, Human Capital, Productivity, and Public Pensions* is available at www.iiasa.ac.at/Admin/INF/recent-pubs/pop/rr-05-002

UNCOVER PROJECT

Fishing for Answers

The Evolution and Ecology Program (EEP) of IIASA is a contributor to UNCOVER (UNderstanding the mechanisms of stock reCOVERy), a new four-year EU project aimed at rebuilding exploited fish stocks in European waters. The purpose of UNCOVER is to develop recovery strategies for EU fish stocks that are no longer within safe biological limits. These strategies will be area- and ecosystem-specific and tuned to key species and their fisheries in the Barents Sea, North Sea, Baltic Sea, and Bay of Biscay.

Although, according to IIASA scientists, commercial exploitation has been altering the genetic composition of fish stocks around the world for the last 50 years, this perspective has been overlooked or downplayed by fisheries scientists and managers for decades. Particularly affected by the fisheries are genetic characteristics determining maturation, and this is having serious economic and ecological implications for sustainable yield, stock stability, and recovery potential.

With a number of exploited fish stocks in European waters currently at a historical low and in danger of collapse, EEP will document the worldwide extent of fisheries-induced evolution and help fisheries scientists and managers to cope with the resulting challenges for the sustainable exploitation of living marine resources. ■

Further information: www.uncover4fish.net

NEGOTIATED RISKS

PIN on the Case

International negotiation among states involves taking, using, avoiding, and managing risks. Risks may become an obstacle in a negotiation and increase the degree of complexity in multilateral talks. Taking a risk may also be positive, helping negotiating parties get out of an impasse. Although the need to consider risks makes communication more cumbersome and time-consuming, effective risk avoidance or risk management may become critical to a successful negotiation outcome. Yet, the important topic of negotiated risks has hitherto been neglected by the literature.

IIASA's Processes of International Negotiation (PIN) Program has just concluded a book on negotiated risks. The project was organized as a cross-sectoral, comparative case study looking at environment, economy, and security. It covered radioactive spills from the Kola Peninsula, continued operation of the Temmelin nuclear plant, the climate change talks, water pollution in the Danube, confidence building between

the two superpowers during the Cold War, disarmament in the biological weapons sphere, development of a collective regional security regime in the Baltic area, and preventive diplomacy.

The comparison of case studies indicates various basic approaches that may be used separately or in combination to deal with the special problems of negotiated risks, such as harmonizing risk perceptions by including technical experts in the negotiation, taking institutional measures to ease risk communication, and trust building by means of regular meetings in contact groups.

The new book will be published in late 2006. ■

MODEL ANALYSIS

EU "NEEDS" IIASA Modeling Expertise

The Integrated Modeling Environment Project (IME) of IIASA is participating in the EC-funded project, New Energy Externalities Development for Sustainability (NEEDS). The project, which is designed to evaluate the full environmental, social, and economic costs and benefits of energy policies and future energy systems for individual EU countries and the EU as a whole, runs from 2005 to 2008.

IME is contributing its expertise in multicriteria model analysis (MCMA) to the project, leading one of the NEEDS work packages and participating in a second. The IME group organized

a workshop at IIASA in January on the multicriteria methods and tools to be used in the NEEDS project.

Multicriteria model analysis, of which IIASA has been a major exponent since the 1980s, tackles the complex and scientifically challenging problems created by global change and rapid technological growth. Such problems, characterized by endogenous risks and uncertainties, cannot always be addressed by traditional scientific approaches. Consequently, the NEEDS project will not only use conventional "hard" data from historical observations, but will also consider the results of possible experiments, model simulations, "soft" expert opinions, and future learning perspectives. Risks and uncertainties will thus be taken into account in an explicit and consistent way for the NEEDS project, permitting robust policy design. ■

Further information: www.needs-project.org

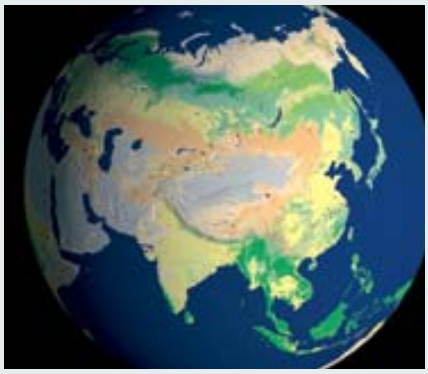
GEO-BENE PROJECT

Taking the Planet's Pulse

The European Union has awarded IIASA's Forestry Program a three-year contract to coordinate the project "Global Earth Observation—Benefit Estimation: Now, Next, and Emerging" (GEO-BENE). The project, which will include 12 partner institutions, started in May 2006.

The objective of GEO-BENE is to develop methodologies and analytical tools to make the first integrated economic, social, and environmental assessment of the nine benefit areas specified by the Global Earth Observation System of Systems (GEOSS), a 10-year plan launched in 2005 to "take the pulse of the planet." The nine benefit areas are disaster, health, energy, climate, water, weather, ecosystems, agriculture, and biodiversity.

Global earth observation, consisting of measurements of air, water, and land made on the ground, from the air, or from space, are instrumental to achieving sustainable development goals and have a major influence on how the society–technology–environment system is managed. GEO-BENE will look at these elements together and study their interactions so as to understand and address global environmental and economic challenges.



It is envisaged that GEO-BENE will particularly benefit, among others, disaster reduction, integrated water resource management, ocean and marine resource monitoring and management, weather and air quality monitoring and forecasting, biodiversity conservation, and sustainable land use and management. ■

REACHING CONSENSUS

In All Fairness

A book on fairness is being jointly undertaken by IIASA's Risk and Vulnerability Program, the Stein Rokkan Centre of the University of Bergen, Norway, and the James Martin Institute for Science and Civilization, Oxford, United Kingdom. *In All Fairness. Ideas Of Fairness And Their Global Implications* examines how a workable consensus is frequently reached even though there is no moral 'code' in place to oblige people or institutions to commit to a fair distribution of rewards and burdens.

The mechanisms behind the fairness principle have tremendous practical implications, especially in a world in which many benefit- and burden-conferring systems—the Internet, anthropologically enhanced carbon cycles, insurance systems, capital flows, and migrant streams, to mention a few—have now gone global.

Fairness does matter. There are numerous instances of people withdrawing their consent when others threaten to undermine their way of living with one another and with nature. Some parties to the negotiations in the Kyoto Round, for example, have rejected agreements, such as tradable permits, that appear to be the least costly way of achieving greenhouse gas reductions.

Theories on fairness do exist, a current favorite being the economic efficiency resulting from Pareto improvements. *In All Fairness* will examine such intriguing theories and tease out some of their practical implications. ■

Further information: www.iiasa.ac.at/Research/RAV

GLOBAL ENERGY CHALLENGES

Creating Sustainable Systems

The enhanced greenhouse effect and depletion of fossil fuel resources are just two of the challenges with a worldwide dimension that will be faced by Europe's energy system in the coming decades. The strategies for tackling these issues must thus be designed taking worldwide developments into account. IIASA scientists are participating in a project to address these challenges, "Case Study Comparisons And Development of Energy Models for Integrated Technology Systems" (CASCADE–MINTS).

The project has two specific parts. The first focuses on modeling, scenario evaluation, and detailed analysis of the prospects for the hydrogen economy to the year 2100 and assesses under what conditions transition to an energy system dominated by hydrogen is possible.

The second focuses on the potential impact of new technologies and the evaluation of possible policy options. Modeling teams from both inside and outside the EU are using a wide range of existing Energy–Economy–Environment (E3) models to evaluate how different technology options, such as renewables and carbon capture and storage, can affect the global energy system, and their implications for Europe.

CASCADE–MINTS is a European energy research project funded by the EC 6th Framework Programme. ■

NEW RESEARCH AREA

Negotiating with Terrorists?

Officially, we do not negotiate with terrorists. There are, however, negotiations and negotiations—just as there are terrorists and terrorists. Negotiating with terrorists is possible, within limits. But an official negotiator's task—to give a little to get the terrorist to give a lot—is a difficult balance to obtain.

How, then, does one negotiate with terrorists? How are terrorists categorized and which can one negotiate with? What does dealing with terrorists have to do with the negotiation process? First, one must distinguish between absolute and contingent terrorists.

Absolute terrorists commit a self-contained act that is not a step to a second action. Absolute terrorism expresses the frustration of the "suicider" with his asymmetrical power position and his inability to change it by any other means. His sense of injustice may come from revelation (fundamentalists), revolution (social revolutionaries), or revulsion against a discriminatory or corrupt world that he feels owes him something (nationalists and criminals, respectively). It is not just suicide tactics that make for truly absolute terrorism, but the unlimited cause.

But among absolutes there are differences. Total absolutes have nothing to negotiate about or with; any attempt at negotiation only encourages them. As contact and communication are basic conditions of negotiation, their inaccessibility puts them beyond negotiation.

Conditional absolutes are suiciders whose tactics, while self-contained and absolute, are designed to seek finite goals. Conditional absolutes do have something to negotiate about—territory, independence, conditions, but that goal is usually too broad to be negotiable.

Contingent or instrumental terrorists, much cited in the literature, rely mainly on hostage taking or other violent contingencies. Contingent terrorists seek negotiations to exchange their victims for publicity, ransom, and release of comrades, using others' lives as bargaining chips. They appropriate something belonging to the other side, then try to trade on the other side's efforts to get it back.

All terrorists are hostage takers and all are their own victims. The standard hostage-taking terrorist takes identifiable hostages; the suicidal terrorist holds the people around him hostage, adding to the terror by never revealing if or when they will become victims. But just as the suicider is as incapable as his hostages of escaping from the hideout or hijacked plane and thus kills himself along with his victims, so the hostage taker takes himself hostage.

The problem with contingent terrorists is not that they are uninterested in negotiating but that the world does not accept their deal. Thus, there are essentially two appropriate negotiating strategies: reduce terrorists' terms or change them. Negotiators need to construct legitimacy for a negotiated agreement and persuade the terrorists to think in terms of lowered expectations and thus lowered demands. Negotiators can also show terrorists that their future personal situation is open for discussion, even if their original demands are not. As in any negotiations, when terrorists realize that a search for a solution is legitimate and acceptable to both sides, they will join the search for a solution.

This does not mean that terrorists' demands should be considered legitimate or that concessions may not encourage terrorism. It all depends on how many of the terrorists' demands can be considered acceptable. If negotiating leads the terrorist to a purely symbolic result or to a bargain for his escape, he is not likely to feel encouraged to do it again. The negotiator's answer to public fears of appeasing and legitimizing terrorism thus clearly lies in the kind of deal he is able to extract. ■

Further information IIASA's Process of International Negotiation Program (PIN) at www.iiasa.ac.at/Research/PIN

Professor I. William Zartman is a member of PIN's steering committee.

FORESTS AND SECURITY

Insecurity Branching out of Forests

Timber's role in conflicts around the world

Forest resources themselves do not contribute to the emergence of conflicts. Rather, it is the nature of their scarcity and abundance as well as their importance to particular interests that can drive conflicts. Demand and supply scarcity or structural scarcity, which means a concentration of forest resources in a few hands, often play a role in disputes. The nature of conflict can take the form of simple argument, non-violent protest, legal action, civil violence and military action. With structural scarcity there is a greater probability that acute conflicts may turn into violence. Conflicts in forestry can be an inherent and legitimate part of social and political life. But, in many places, the costs and consequences of conflict crises and failure have become unacceptably high.

Conflict Timber

Some groups involved in armed conflicts use timber to finance the fighting. This is known as conflict timber and is attractive as a conflict commodity because not only are there difficulties in tracking extraction, but low investments are needed for extraction, and timber is rather simple to transport. Timber can also be transformed into a variety of end products making it highly marketable. Conflict timber, for example, helped finance the national and regional conflicts in so-called Africa's First World War that was centered around the Democratic Republic of Congo but involved five to six Central African countries. This conflict killed 3.5–4.5 million people.

The forests can also serve as safe havens for armed groups providing refuge and food for combatants. In some cases forests have been part of the military strategy such as in Vietnam. Governments in many developing countries do not have a significant presence in all their vast forested territories and this can lead to guerilla groups moving in to fill the power vacuum as the Revolutionary United Front have done in Sierra Leone.

Developing Country Conflicts

Large-scale logging and changed land use in forested areas can contribute to so-called low-scale conflicts, which can be found in China, Cambodia, and Liberia among others. These conflicts often spring from unclear/unfair tenure and access rights, weak state institutions, inefficient policy frameworks, poor governance, weak regulation of the financial sector, and corruption. This category of conflicts mostly takes place in developing countries and countries with transition economies, but can also affect the developed world when conflicts escalate and affect the latter countries' interests.

Similar conflicts can also occur when governments decide unilaterally, often with international donors involved, to protect forests from logging or other uses or to restrict access for local communities without prior consultation.

The symbolic value of forests can lead to conflict. For example, in the case of the Jerusalem Forests the parties involved in the conflict are seeking to cast the space of the forests as critical to their particular national vision.

Illegal Logging

There is often a link between conflicts in forestry and illegal logging, which is the process of extracting forest resources in disregard of national law. Illegal logging not only harms the long-term sustainable supply of timber and leads to losses of biodiversity; it also drives corruption and avoidance of tax payments, presses prices and economic results downwards, and contributes to social conflicts. Estimates suggest global illegal logging may be of the order of 350-650 million m^3 per year.

No Silver Bullet

Conflicts over timber are difficult to resolve and often resurface in other forms, and there are no silver bullet solutions. Studies of past conflicts are probably the best learning indicator of future forest conflicts. Information plays a catalytic role in conflict management. The process of exposing, sharing, and validating information about the status of the forest resources is a crucial first step. The establishment of new institutions is vital for solid solutions as well as the establishment of strong civil societies. Protecting violent conflict areas along borders by establishing so-called peace parks seems to be a way of promoting peace through transboundary conservation. ■

Further information This article is based on a presentation on "Forests: Conflict and Security" given by Sten Nilsson at the IIASA Day in Stockholm, Sweden on 10 May 2006 and is available at www.iiasa.ac.at/Research/FOR/presentations/sn-swe-10may06.pdf .

Professor Sten Nilsson leads IIASA's Forestry Program and is Deputy Director of IIASA.

Illegal loggers in this Indonesia forest float the newly felled logs downstream

Photo: Yayorin

INTERNATIONAL NEGOTIATIONS

The Caspian Dialog

Science for International Understanding

The Processes of International Negotiation (PIN) Program of IIASA has just opened a Dialog among representatives of the five littoral states of the Caspian Sea to discuss matters of a nondivisive nature pertaining to environmental and energy security.

The strategic and financial importance of the Caspian Sea's rich resources, including oil and natural gas, has given rise to an often contentious debate among the five Caspian littoral states—Azerbaijan, the Islamic Republic of Iran, Kazakhstan, the Russian Federation, and Turkmenistan. Unsurprisingly, no overarching agreement has yet been reached on the division of the Sea and its resources. Moreover, the Caspian, though historically known as a sea, is classified by most geologists as a lake, and there is no precedent for determining its international legal status as one or the other.

Photo: Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC

IIASA's Processes of International Negotiation Program (PIN) are no strangers to the Caspian debate. In the course of PIN's 2003 Roadshow in Tehran, a seminar on the topic was organized in conjunction with the School of International Relations in Tehran, and PIN Steering Group members Victor Kremenyuk and Paul Meerts subsequently edited a report on negotiating a Caspian regime.

It was former IIASA Director Howard Raiffa who first encouraged the Institute to deploy scientific information and systems analysis in the service of international understanding, and thereby contribute to conflict management. It was thus a natural step for PIN to open discussions, not about divisive issues like the partition of the Caspian, but on important topics such as pollution, environmental regimes, land use, water, and energy security. The first Caspian Dialog—the precursor, it is hoped, to a series of biannual meetings—took place from 13 to 15 May at the Topkapi Palace in Istanbul. The meeting was co-sponsored by IIASA and the Hollings Center which operates under the auspices of the Council of American Overseas Research Centers.

The Dialog opened with wide-ranging discussions on the Caspian's regional and global importance. Its legal and security status have remained undetermined since the breakup of the Soviet Union in the early 1990s, making it a potential source of enormous conflict in an already insecure region. Professor I. William Zartman of PIN looked at the Caspian's future under a sea or lake regime: how its mineral and biological resources would be handled, as well as its function as a linchpin in security and transportation issues.

The serious ecological decline of the Caspian, caused by toxic waste dumping, agricultural runoff, and overfishing of the caviar-producing sturgeon fish, was covered by other IIASA scientists: David Wiberg of the Land Use Change Program, Fabian Wagner of the Atmospheric Pollution and Economic Development Program, Ulf Dieckmann of the Evolution and Ecology Program, and Yaroslav Minullin of the Environmentally Compatible Energy Strategies Program.

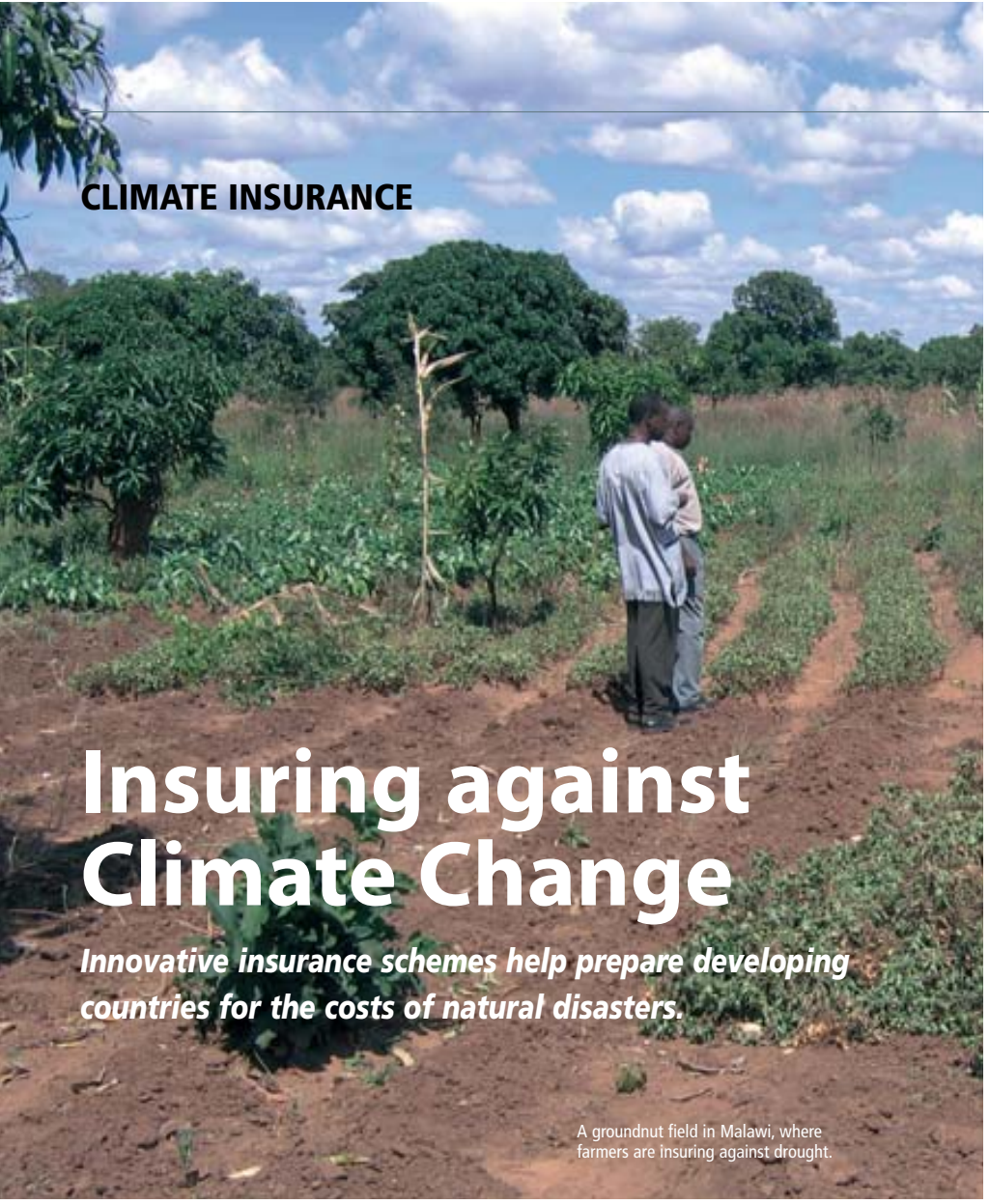
The Caspian Dialog has immediate practical implications and direct interest not only for the five littoral states but also for the largest oil contractor, the United States, as well as Turkey and the United Kingdom, two of which (Turkey and the United States) acted as observers.

Common brainstorming about various approaches to many topics can lead to the creation of a problem-solving attitude that, eventually, can prepare the terrain for constructive approaches to the more divisive issues. The first Caspian Dialog in Istanbul can certainly be seen as an important start to this new venture in conflict management. ■

Further information IIASA's Process of International Negotiation Program (PIN) at www.iiasa.ac.at/Research/PIN

Professor Rudolf Avenhaus, H.E. Ambassador Franz Cede, Professor Guy Olivier Faure, Professor Victor Kremenyuk, Paul W. Meerts, Professor Gunnar Sjoestedt and **Professor I. William Zartman** make up PIN's steering committee.

The Caspian Sea's rich resources, including oil and natural gas, have given rise to an often contentious debate among the five Caspian littoral states—Azerbaijan, the Islamic Republic of Iran, Kazakhstan, the Russian Federation, and Turkmenistan.



CLIMATE INSURANCE

Insuring against Climate Change

Innovative insurance schemes help prepare developing countries for the costs of natural disasters.

A groundnut field in Malawi, where farmers are insuring against drought.

IIASA economists proposed two insurance-related mechanisms designed to help developing countries adapt to climate change during the 11th Conference of the Parties (COP11) to the United Nations Framework Convention on Climate Change (UNFCCC).

The IIASA proposal will help international governments achieve the UNFCCC's Article 4.8 which calls on developed countries to consider actions, including insurance, to meet the specific needs and concerns of developing countries in adapting to climate change. Evidence is growing that climate change influences the frequency and intensity of weather-related hazards. IIASA's proposal of affordable insurance would help people in developing countries to become more financially prepared for all natural disasters whether these are a consequence of climate change or not.

The losses from natural disasters are increasing as more people and economic value become concentrated in cities and other areas, such as coastal regions, that are exposed to natural hazards.

The scale of these losses makes it very difficult for disaster-prone nations, particularly small developing countries, to finance economic recovery. For example, losses during the 2004 hurricane seasons in the Cayman Islands and Grenada amounted to 183 and 212 percent of GNP, respectively. But the high costs of insurance instruments are prohibiting their uptake in developing countries.

IIASA's Risk and Vulnerability Program outlined a practical approach to lowering the costs of insurance that would also encourage developing countries to take more preventive measures to reduce their vulnerability to disaster. And with studies suggesting that for every euro invested in risk management broadly two to four euros are returned in terms of avoided or reduced disaster impacts on life, property, the economy and the environment; this approach could help lift people out of a cycle of poverty that sees them failing to financially recover from disasters.

The first tier of the IIASA approach is a global relief fund to cover losses that are either uninsurable or for which insurance cover is unaffordable in poor countries. Supported by discretionary contributions from developed countries, the fund would provide assistance for relief and recovery following a disaster. Eligibility could be tied to whether a country has made credible efforts to reduce disaster risks.

The second tier is a global insurance facility that supports insurance initiatives taken by developing countries or regions themselves. Precedents already exist for donor-supported insurance mechanisms which have shown the practicality and feasibility of this approach.

For example, the World Bank with Swiss development cooperation helped develop a weather insurance product for groundnut farmers in Malawi who face the risk of drought. Farmers, who borrow money to improve their productivity, also pay a weather insurance premium with the interest on the loan. In the event of a severe drought, as measured by the rainfall index, the borrower pays only a fraction of the loan due, and the rest is paid by the insurer. Without the insurance, many farmers would either default or possibly mortgage or sell their land, or take emergency loans from money lenders to repay the original loan. In this way, the drought would lead to a cycle of poverty, as victims borrow more and more money.

Without this insurance, banks rarely loan to high-risk low-income farmers, which means few farmers can afford the seeds and other inputs necessary for higher-yield crops. Moreover, because of the physical trigger, farmers will have an incentive to reduce potential losses, for example, by diversifying their crops.

IIASA's proposal was one of two climate-insurance schemes suggested at the COP11 side event, which was organized by members of the Munich Climate Insurance Initiative. This initiative, set up in April 2005, brings together insurers, experts on climate change and adaptation, NGOs, and policy researchers to share expertise and develop insurance-related mechanisms to play a role in adaptation to climate change. IIASA was one of the Initiative's seven founding organizations. ■

Further information IIASA's Risk and Vulnerability Program at www.iiasa.ac.at/Research/RAV

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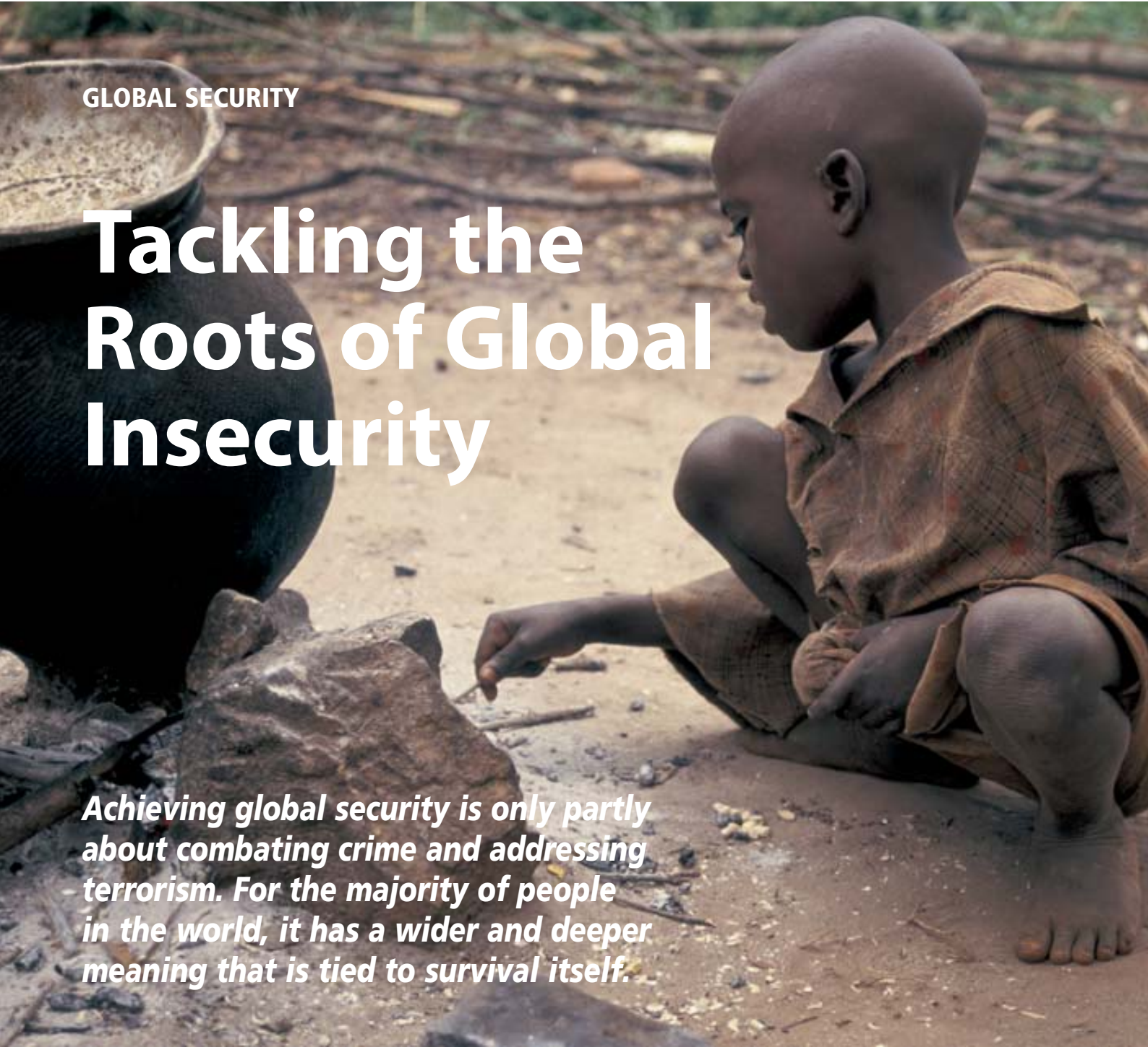
Tackling the Roots of Global Insecurity



Achieving global security is only partly about combating crime and addressing terrorism. For the majority of people in the world, it has a wider and deeper meaning that is tied to survival itself.

Today, many people live with a pervasive sense of insecurity. It is not just fear of crime, violence, conflict, and terrorism that causes global insecurity; a lack of food, water, education, health, energy, clean air, and the means to earn a living are also among its root causes. Unless we tackle not just some but all of these, global security and a sustainable future will remain beyond our reach.

Widening Gap

The lack of progress in addressing so many causes of global insecurity is dispiriting. We live in a world of disparities, where one-fifth of the global population is socially, economically, and environmentally vulnerable. The poor lack tangible assets, formal education, and technical skills, and often they have inadequate access to such basic needs as food, water, health care, and safe shelter. They do not have a voice and are politically and socially discriminated against. Moreover, despite the very many remarkable scientific and technological achievements of the twentieth century, the gap between rich and poor is widening.

Food Security

If security is based on access to the basic necessities of life, should we be surprised that so many people feel their existence to be threatened? At present, over 840 million people go hungry every day. Every minute, 15 children and 15 adults die of hunger. Yet, in the developed countries and among the rich in the developing world, obesity is a growing problem affecting more than one billion people. And, disparities such as this pervade every area of modern life.

Water Security

As with food, water insecurity is also a pressing problem in many developing countries, with over a billion people currently lacking access to clean water. This insecurity further compounds other constraints on human well-being and socioeconomic development including, for example, poor sanitation, and the prevalence of disease and malnutrition, and the resultant low productivity. While water is globally recognized as a universal human right, the recent trends in water privatization are a cause for concern.

It costs one-half of the average annual wage in Bolivia to be connected to a privatized piped water supply and just two weeks' wages in the United Kingdom. Explicit consideration thus needs to be given to ensuring access to clean and affordable water by the poorest of the poor.

Transnational Corporations

The results of two decades of economic globalization are mixed. The difference in per capita GNP between developed and developing countries has increased from fortyfold in the early 1980s to over seventyfold at present. One-fifth of the world's population receives some 80 percent of global income, while one-half of the world's population lives in poverty on less than $2 per day. And, of the 192 independent nation states in the world, over one-third have a GNP of less than $10 billion. Compare this with some 500 transnational corporations, each with a turnover of $10 billion. Moreover, essential commodities such as water and energy are being privatized, and many of the poorest are unable to access these essential needs which, in turn, puts their health at risk.

Internet Access

Nor are such disparities simply economic—there is an increasing digital divide. Today the most promising armory at our disposal is knowledge. In the past 10 years the number of Web sites has increased from 1,000 to 20 million. Around 50 percent of the population of the United States and the European Union are Internet users, but less than one percent of the population of Asia and Africa have Internet access. And there are wide cost differences, with twice the average monthly income being needed to access the Internet in Bangladesh, compared with just one percent in the United States.

Science and Climate Change

Similar disparities exist in the number of scientists and researchers. There are 2,700 scientific researchers per million population in the United States compared with 130 in India and fewer than 70 in Africa. What is more, continuing trends in the privatization of scientific knowledge will only further divide developed and developing countries, increasing inequities and hindering progress toward equitable and sustainable development goals.

Disparities can be found, too, in the pressing issue of global climate change and its projected impact on food systems. Forecasts suggest that while a number of developed countries in temperate zones will substantially gain agricultural production potential because of higher temperatures and greater precipitation, significant production losses will occur, for example, in sub-Saharan Africa.

Fairness and Justice?

Of particular concern are some 40 least-developed countries that may lose one-fifth of their food production potential by the 2080s because of climate change. These are currently food-insecure and poor countries with the least capacity to cope. Take Mozambique, for example, a country of 18 million people, including 14 million who are undernourished. Mozambique produces just 100 kg of CO_2 per capita annually, while countries of the Organization for Economic Cooperation and Development (OECD) produce 11,000 kg. Yet Mozambique may lose 25 percent of its food production potential by the 2080s through climate change—as a result of the global warming caused by other countries.

If such inequities continue, the prospect for global security is bleak. Not only will growing numbers of the population be trapped in everyday struggles against poverty, hunger, and disease but such an environment will further encourage the types of violence that threaten the security of all.

Global Commitment?

How then do we link science, knowledge, policy and management, and grass roots actions in ways that will make a real difference to world security? Certainly, our experience to date of global commitment to eradicating human food insecurity is not encouraging. For example, in 1974 the First World Food Conference in Rome declared its goal of eradicating hunger within a decade. Twenty-two years later at the 1996 World Food Summit, the goal was revised to reduce hunger by one-half by 2015. This same goal was reiterated at the Millennium Summit in 2000, despite the knowledge that, at the current rate of progress, it would take another 60 years to reach this target.

The Future?

Science, the insights it can provide and its many applications, is playing a key role in addressing human security issues, and IIASA, with its multidisciplinary, cross-cutting approach to problem solving, is providing vital insights to policy makers at the national, regional, and global level.

From whatever angle we approach global security, however, one thing is clear. If, in the twenty-first century, we are to achieve a sustainable future for everybody, then attaining human security is no longer an option. It is imperative. It is the key to our survival. ■

Further information International Institute for Applied Systems Analysis at www.iiasa.ac.at

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GLOBAL ENERGY ASSESSMENT

Securing Our Global Energy Future

How can adequate, equitable, secure, and sustainable energy services for all be achieved? Without widespread access to safe, clean, and affordable energy the world cannot achieve sustainable economic, social, and environmental development. Hence appropriate answers to the world's wide-ranging energy challenges are urgently required. To this end, IIASA has initiated a new Global Energy Assessment (GEA). This Assessment aims to unravel the world's complex energy challenges. It will go beyond earlier studies, building on the achievements of the World Energy Assessment (see box), by providing integrated and comprehensive analysis of what is needed to achieve secure and sustainable global energy systems in this century and beyond.

The world's energy challenges are varied, complex, and pressing. At the most basic level, energy services are indispensable for human well-being. Yet, despite unprecedented economic growth, more people are now subject to "energy poverty" than a century ago. Estimates suggest that two billion people have no access to modern energy services and a further two billion people have insufficient or unreliable access to energy. Inadequate energy services are linked not only to poverty and poor health but to lack of opportunity and education.

Nevertheless, humankind faces many important energy challenges that go beyond questions of "energy poverty" alone. There are pervasive linkages between energy and almost all activities: not just economic and social activities but areas as diverse as foreign affairs, poverty alleviation, industrial policy, and competitiveness. And demand for energy is growing. Estimates suggest that global energy needs will be almost 60 percent higher by 2030 and many times higher by the end of the century.

To fully understand the challenges facing the global energy system, only an integrated study incorporating broader social, political, and economic issues, and the forces driving demand for energy services, will identify effective options for a way forward. The GEA will adopt this approach to investigate the host of inextricably linked energy concerns, many of which can be characterized as challenges resulting from either "too little" or "too much."

The problem of "too little" affordable energy, for example, is compounded by "too little" investment in energy infrastructures and research in both developing and developed countries alike. Widespread energy sector deregulation and market liberalization have been accompanied by a dramatic decline in energy infrastructures, capital-intensive

facilities and, crucially, a decline in energy research, development, and demonstration (RD&D) both from public and private sources.

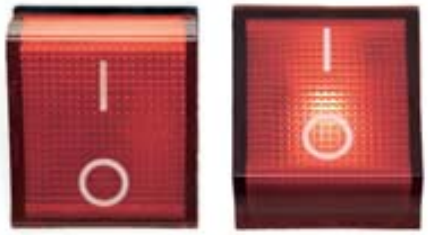
"Too little" investment poses further challenges. How, for example, can the world's future energy requirements be met? The fear of imminent resource scarcity no longer grips with the intensity that prevailed in the mid-1970s. Indeed, estimates suggest that oil and gas resources could last at least 50 to 100 years, whereas fossil energy resources could last at least several hundreds of years. Yet, the world's current dependence on relatively few geological deposits of cheap crude oil is vulnerable to geopolitical threats, "too much" market volatility, and other potential risks to reliable supply.

However, the continued expansion of fossil resources use is problematic. About one-third of the carbon currently in the atmosphere results from accumulated emissions from the combustion of fossil fuels and is already producing a discernable influence on the climate system. In other words, the capacity of the planet to assimilate ever-increasing energy-related emissions seems more limited than the geological availability of hydrocarbon resources themselves. Current and projected carbon emissions are simply "too much." Other pollutants produced by energy systems bring further environmental and health challenges, from oil spills to premature deaths caused by the indoor air pollution from burning traditional biomass fuel for cooking.

The need to address such multifaceted, diverse yet interlinked issues is pressing. Without fundamental changes in current trends and policies, global vulnerability to the whole range of energy challenges will increase.

Policy change, however, cannot be achieved without pertinent scientific information and a comprehensive, systematic, and integrated analysis of the issues involved. And such policy-relevant analysis is exactly what GEA aims to achieve. Initiated in 2005, this Assessment will bring together leading international experts from academia, business, governments, and intergovernmental and nongovernmental organizations to build on IIASA's existing reputation in the field of global and long-term energy research.

The new Assessment will go beyond existing energy-related studies. It will provide a strong technical and scientific basis for decision making by evaluating simultaneously the whole range of social,



economic, development, technological, environmental, security, and other issues linked to energy. It will identify options for the way forward—both on a global and regional level—and inform policy makers, the business and investment sector, and society at large, on the key opportunities and challenges facing the global energy system on the road to longer-term sustainable development—which represents a fundamental transition in our approach to energy.

The GEA has been initiated by IIASA's new Energy Program which began in March 2006 and will maintain IIASA's position at the forefront of cutting-edge assessments of challenging issues of global change (see box). ■

Further information IIASA's Energy Program at www.iiasa.ac.at/Research/ENE

IIASA's Role in Previous Energy Assessments

1973–1981 Energy in a Finite World
At IIASA, 140 scientists from 20 countries work to produce Energy in a Finite World, the first comprehensive, truly global assessment of energy issues. Analyses of historical data, some going back more than a century, reveal pervasive regularities in the diffusion of technologies and the development of energy systems.

1992–1998 Global Energy Perspectives
The World Energy Council partners with IIASA in a unique study on Global Energy Perspectives. It analyzes how current and near-term energy decisions will have long-lasting implications throughout the 21st century. The study presents its findings at the World Energy Congresses in 1995 and 1998, and publishes its results in a book with Cambridge University Press in 1998.

1998–2001 Word Energy Assessment and 2004 Update
The United Nations Development Programme, the UN Department of Economic and Social Affairs, and the World Energy Council establish the World Energy Assessment. It provides the scientific and technical basis for discussion in international forums and intergovernmental negotiation on the role energy can play in sustainable development. Professor Nebojsa Nakicenovic of IIASA is a member of the editorial board and a convening lead author.

IIASA's contribution to some other Global Assessments

1995, 2001, and 2007 (forthcoming) Second, Third, and Fourth Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC)
Five IIASA scientists were appointed to be convening lead authors or lead authors for the IPCC's Second Assessment Report. Since then, eleven IIASA scholars have played leading roles in the IPCC's Third and Fourth assessment reports that provide the world with the most scientifically advanced, comprehensive, and rigorous analysis of the state of climate change.

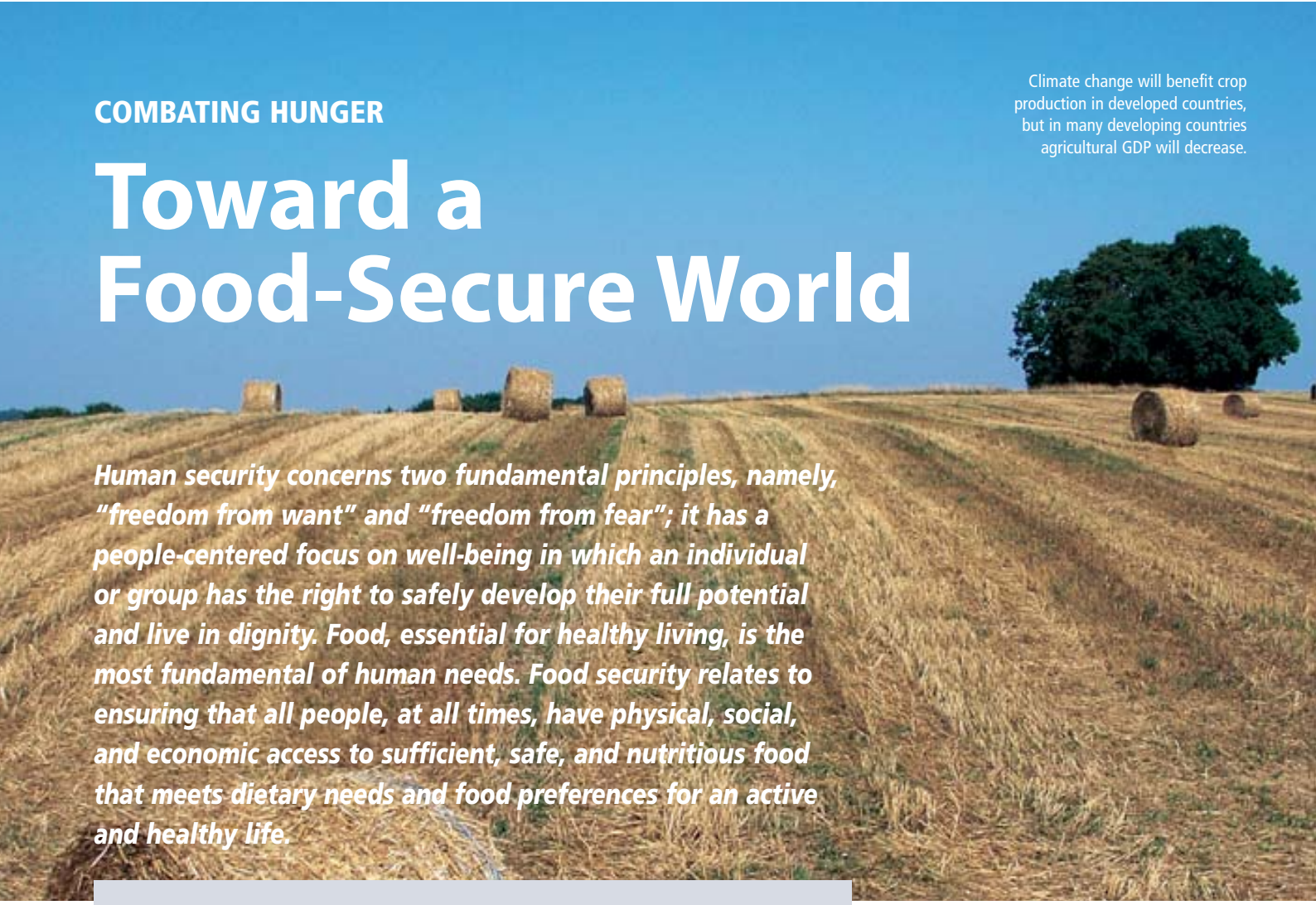
2005 and 2006 Millennium Ecosystem Assessment
Ten IIASA scientists contributed to the Millennium Ecosystem Assessment, a global research project set up by UN Secretary-General Kofi Annan, to assess the planet's environmental health.

2004–2006 United Nations-Sigma Xi Scientific Expert Group
The group will recommend the most promising technologies and methods the world can effectively employ to address climate change, to the UN Commission on Sustainable Development. Professor Nebojsa Nakicenovic of IIASA is an expert in the group.

2005–2007 Transitions to Sustainable Energy Systems
The InterAcademy Council launched this in-depth study on how to achieve global transitions to an adequately affordable, sustainable, clean energy supply in 2005. Professor Nebojsa Nakicenovic of IIASA is a member of the organizing group and the study panel.

COMBATING HUNGER

Toward a Food-Secure World



Climate change will benefit crop production in developed countries, but in many developing countries agricultural GDP will decrease.

Human security concerns two fundamental principles, namely, "freedom from want" and "freedom from fear"; it has a people-centered focus on well-being in which an individual or group has the right to safely develop their full potential and live in dignity. Food, essential for healthy living, is the most fundamental of human needs. Food security relates to ensuring that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets dietary needs and food preferences for an active and healthy life.

The International Hunger Debate

The world's political leaders have debated the issues of food shortages and hunger for over a century.

1905: International Institute of Agriculture founded to study agricultural conditions and disseminate relevant statistical, technical, and economic information in pursuance of a food-secure world.

1941: United States Conference for Defense calls on countries to conquer hunger.

1943: Hot Springs Conference on Food and Agriculture declares: "There must be an expansion of the whole world economy to provide the purchasing power sufficient to maintain an adequate diet for all."

1945: Food and Agriculture Organization founded "to raise levels of nutrition and standards of living, to improve agricultural productivity, and to better the condition of rural populations."

1963: World Food Program founded "to assist the poor in developing countries through combating hunger and poverty."

1973: First World Food Summit aims to "eradicate world hunger within a decade."

1977: International Fund for Agricultural Development established "to finance agricultural development projects, primarily for food production, to combat rural hunger and poverty in developing countries."

1996: Second World Food Summit reaffirms the right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and "the fundamental right of everyone to be free from hunger" and "reduce world hunger by half by 2015."

2000: Millennium Development Goals: reduce world hunger by half by 2015.

2002: Third World Food Summit: reduce world hunger by half by 2015.

While political goals have a role and relevance, there is a limit to the trust of the millions whose lives are spent coping with debilitating hunger and have no hope for a better life for their children.

Today at the global level there is sufficient food to meet everyone's need and yet, some 850 million are chronically undernourished. Such a violation of human security is ethically and morally unacceptable.

IIASA has developed an integrated ecological, economic, and social policy modeling framework to assess the world food system in the twenty-first century. One of the main components is the agro-ecological zone (AEZ) model developed by the FAO and IIASA, shown in Figure 1. This computes the spatial extent and productivity of agricultural resources and related crop and livestock production under various agricultural technology assumptions on a 5′ x 5′ latitude/longitude global grid. These detailed biophysical results are fed into national and regional general equilibrium economic models, embedded in the world agricultural economy—the basic linked system (BLS).

The IIASA AEZ–BLS enables an analysis of policy related to future demographic and economic development pathways, and of the potential impacts of climate change on food production, prices, trade and consumption, and an assessment of the scale and location of risks of hunger and malnutrition (Figure 1).

This analysis in turn permits an evaluation of constraints on land and water resources, assesses where agricultural science and technology can be used to enhance productivity, the ways in which globalization affects agricultural livelihoods, the impacts of future climate change on food security, and how policy options can be used to foster food security at the subnational, national, regional, and global levels.

What the IIASA Analysis Shows

ON Agricultural Resources Security

According to the IIASA analysis, of the unused cultivable land available in the world today, 70 percent is found in just seven countries in South America and Africa. There is little prospect of expanding arable land in Asia, making research essential to enhance agricultural productivity in the continent. Currently more than 30 countries with a total population of over 500 million are regarded as water-scarce. By 2025 some 50 countries with a total population of about 3 billion may be in that category. The analysis provides levels of potential food production according to agricultural natural resources and technology—important information for national policy makers concerned with agricultural resource planning and investments. Moreover, climatic changes will further undermine agricultural resource security in many poor and least-developed countries in Africa—a possible 60 percent reduction in boreal and arctic ecosystems is forecast, together with an expansion of tropical zones to cover most of Africa.

ON Agricultural Science and Technology Security

The IIASA results highlight the yield gaps in areas currently under cultivation and evaluate ways of closing them. The future environmental constraints projected—for example, higher temperatures and water restrictions due to climate change—show where investments in targeted agricultural research are needed to develop suitable and location-specific crop varieties.

In the twenty-first century the challenge is to mobilize and utilize the best of agricultural science and technology in support of sustainable food systems. The rapidly increasing privatization and patenting of agricultural research is shown as a particular cause for concern where the hungry and poor are concerned. A stronger public sector role is required to prevent "scientific apartheid," whereby cutting-edge science becomes oriented toward industrial countries and large-scale farming.

ON Globalization and Livelihood Security

IIASA results show that agricultural GDP in parts of the developed world will benefit from climate change, whereas in many developing regions it will decrease. The net cereal imports of developing countries will increase within the 170–430 million ton range, depending on the future demographic and economic development pathway and climate change. Such a substantial increase in world cereal trade also needs to be considered in the context of the economic and environmental cost of food transport over long distances, and the inability of many food-insecure countries to finance long-term essential food imports.

IIASA is currently formulating scenario analysis to assess the worldwide food security implications of agricultural subsidy reforms, international food prices, globalization of diets, and the impact on international food supplies and prices of, for example, droughts and crop failures in major production and food deficit regions.

ON Global Environmental Change and Hunger

For 2080 IIASA results show little progress toward reducing hunger in the period to 2020, even in a situation of high economic growth. Figure 2 shows the additional number of people at risk of hunger in the world, plotted against different levels of atmospheric CO_2 concentrations and associated climate change. Figure 3 shows a regional comparison of the additional number of undernourished people, according to projected future demographic and economic development pathways and climate change. According to these results some 175 million will be at risk of hunger as a result of future climate change.

Climate change and variability will result in irreparable damage to arable land, water, and biodiversity resources, with serious consequences for food production and food security. And most of these losses will occur in developing countries with low capacity to cope and adapt. While the international community has focused on climate change mitigation, the issue of adaptation to climate change is equally pressing. This is of critical importance to many developing countries that, to date, have contributed little to greenhouse gas emissions but whose food systems will bear the brunt of the negative impacts of climate change and variability. The IIASA analysis has relevance for assessing crop–land–water adaptation options. ■

Further information IIASA's Land Use Change Program at www.iiasa.ac.at/Research/LUC

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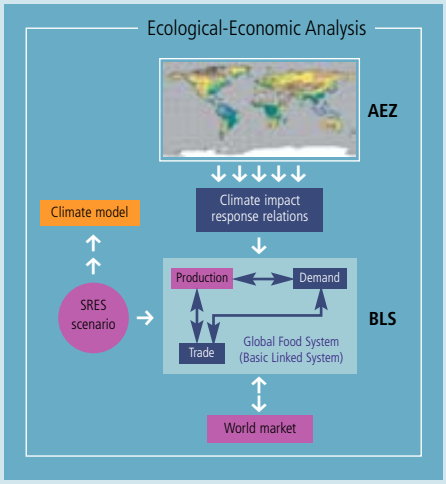

Figure 1. The IIASA Integrated Ecological–Economic Food and Agriculture Policy Analysis.

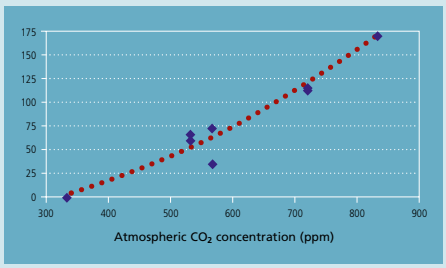

Figure 2. Increase in undernourished due to climate change (millions).

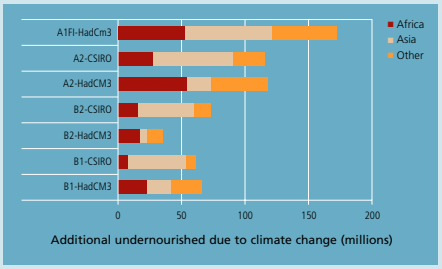

Figure 3. Additional number of undernourished by region, climate model, and future demographic and economic development IPCC pathways.

Planning for Disaster

Can natural disasters be avoided or their consequences made less catastrophic? If so, how can we measure which preventive actions are most effective and efficient? These questions are critical to developing countries that find themselves particularly vulnerable to natural disasters and their effects. A series of IIASA studies highlight how countries and people can make themselves not only more secure against natural disasters but also less vulnerable to their consequences.

IIASA's work aims to contribute to a better balance between pre-disaster prevention and post-disaster relief and reconstruction.

The benefits of prevention and challenges for implementation

Disaster prevention pays dividends. Studies to date, while limited, show that for every euro invested in risk management roughly two to four euros are returned in terms of avoided or reduced disaster impacts on life, property, the economy, and the environment. Despite these benefits, preventive measures are relatively rarely taken in developing countries and disaster management still relies heavily on after-the-fact approaches. Why, for example, do bilateral and multilateral donors allocate 98 percent of their disaster management funds to relief and reconstruction and only the remaining two percent for prevention?

One reason, suggests IIASA research, is a lack of understanding and user-friendly tools for assessing the benefits and challenges of disaster risk prevention. These benefits are more difficult to assess than say the benefits of building another road or bridge. As the UN Secretary-General Kofi Annan said: "While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible; they are the disasters that did not happen."

In addition, disaster management is often neglected by development policy or it is poorly implemented because all relevant stakeholders are not adequately consulted.

Assessing the benefits: Evidence from Indonesia and Peru

One decision-supporting tool that could play a more significant role in disaster risk prevention is cost-benefit analysis (CBA). CBA is a technique used to organize, appraise and present the costs and benefits, and the inherent tradeoffs of projects undertaken to increase public welfare. Although, CBA has been subject to criticism when used as the sole decision criterion, it can be a useful tool when regarded as an explicit and rigorous accounting framework for a more transparent appraisal of projects.

Approached by a development agency, IIASA's Risk and Vulnerability Program devised a practical manual for using CBA in disaster risk management, which the program then applied to two case studies. One assessed flood protection for the city of Semarang, Indonesia. The other investigated protection against the impacts of El Niño in the province of Piura in Northern Peru. In both cases, the study reveals that undertaking prevention would offer substantive positive returns beyond reducing the immediate threats to life and property in terms of furthering development. The manual has been made available to disaster management practitioners and is being applied in the field.

To date, lack of concrete information on the costs and benefits of natural disaster risk management projects has made many policy makers reluctant to commit significant funds to risk reduction. IIASA researchers hope that by outlining the benefits of risk management in terms of damages avoided and by explaining how to include risk into project appraisals, techniques such as CBA could help to change such attitudes.

Assessing how to reduce financial vulnerability

In a similar vein, a scientific tool, the CATSIM model, is helping governments to assess the benefits and challenges of effective pre-disaster management planning for reducing the impacts of disasters on public finances. Developing country governments frequently lack the liquidity, even including international aid and loans, to fully repair critical infrastructure or provide sufficient support to households and businesses for their recovery following a disaster.

The IIASA CATSIM tool is an interactive simulation model for building the capacity of policy makers to assess and reduce public sector financial vulnerability by employing pre-disaster financial instruments such as insurance, contingent credit, reserve funds, and catastrophe bonds. Catastrophe bonds are financial market instruments that give the investor an above market return if a specific catastrophe does not occur in a specified time but sacrifices interest or part of the principal following an event. Mexico has recently become the first government to issue such bonds and CATSIM analysis helped inform the decision.

Preventive measures designed with stakeholders

Involving stakeholders via model-based participatory processes in the design and implementation of risk management measures such as disaster insurance pools is another area of IIASA work. In a joint study with the Hungarian Academy of Sciences and Stockholm University such a process was implemented to help design a nationwide flood insurance pool with a focus on the highly vulnerable Upper Tisza region of northeastern Hungary.

After extensive interviews with the public, the local authorities, government ministries and private insurers, a public survey, and stakeholder workshop, this participatory approach resulted in an imaginative suggestion for a new insurance system. Under this system, only households with private insurance would qualify for government assistance after a disaster; however, the government would heavily subsidize poor households to help them purchase voluntary, private flood insurance.

This participatory approach, researchers suggest, could prove a suitable way for governments to institute disaster loss-sharing systems that both gain public support and are politically viable.

Building a better balance

Justifying the current imbalance in investment in post-disaster relief and reconstruction as opposed to disaster prevention, however, no longer seems sensible now that this range of tools and techniques for managing disaster risk are coming on stream. As shown in the examples outlined, these tools can make a significant contribution to policy makers who wish to reduce the vulnerability of their country or region to the long-term consequences of natural disasters. ■

Further information IIASA's Risk and Vulnerability Program at www.iiasa.ac.at/Research/RAV

Dr Joanne Linnerooth-Bayer is the leader of IIASA's Risk and Vulnerability Program. **Dr Reinhard Mechler** is a research scholar in IIASA's Risk and Vulnerability Program.

Novel approaches to assess disaster management

1 **Cost-benefit analysis (CBA).** This well-established technique for measuring the economic efficiency of investment projects is not widely used for disaster risk management due in part to a lack of reliable data and difficulties in accounting properly for the risk of a disaster happening and its potential impacts. In a new report, IIASA provides for the first time a practical manual and set of guidelines for development practitioners wishing to assess the costs and benefits of disaster management while specifically accounting for risk and uncertainty.

2 **The IIASA CATSIM model.** A user-friendly, interactive computer model enables policy makers in developing countries to assess natural disaster risks on public finances and assess the benefits of hedging these risks via risk financing mechanisms. With the CATSIM simulation model, users can explore the impact of different pre-disaster risk transfer instruments (insurance or catastrophe bonds) on response variables such as public sector debt, the budget, and GDP under a range of different disaster scenarios.

3 **Model-based participatory processes for assessing risk financing options.** In a study on the River Tisza in Hungary, IIASA researchers offer an innovative approach to designing a disaster insurance pool. This approach combines sophisticated risk modeling with a participatory approach that helps stakeholders reach consensus and "buy in" to the resulting insurance system. This process can provide important insights into the political viability of disaster loss-sharing systems.

Reducing Vulnerability

A lethal influenza pandemic has been classed as by far the most likely "transformational" catastrophe (ahead of nuclear war, being hit by a meteorite, and other cataclysms) that might change the course of history (Smil, 2005). Scaling up the global population (1.8 billion) at the time of the 1918–1920 pandemic to current levels, it is not inconceivable that 200 million or even more people would die in the event of a hyper-virulent pandemic. Nor would this be only the second time: a pandemic in 1830–1832 was as deadly, relatively speaking, as the one in 1918–1920.

Discussions surrounding the global spread of the H5N1 avian influenza virus have bordered on hysteria. This is not surprising—the toolkit for response to an established influenza pandemic is frighteningly ineffective. For example, using traditional approaches, it takes the global pharmaceutical industry six to eight months to develop an influenza vaccine from the time that the viral strain to be protected against is isolated. Millions might already have died by then, and millions more might die if vaccine production fails to meet global need.

Influenza pandemics are an evolutionary certainty. But H5N1 notwithstanding, the next influenza pandemic may begin next month, next year, or ten years from now. It may be mild, as in 1957–1958 and 1968–1969, or hyper-pathogenic, as in 1918–1920. Therefore, in addition to gearing up for a possible immediate crisis, policy makers should be taking a wider perspective and considering measures to reduce vulnerability. There are concrete steps that can be taken, none with dramatic near-term effects, but that would pay off handsomely within five to ten years.

Prevent the emergence of zoonoses and improve epidemiological surveillance. The galloping growth of the swine and poultry population in Asia, mostly in unmonitored and unsanitary conditions, is the major source of risk for the emergence of pandemic influenza. Yet, there are well-understood policies to lessen the risks of zoonoses. No rocket science is involved—they consist of improving farm conditions and building modern, well-lit, refrigerated, frequently hosed-down, and

Wildfowl (ducks, geese, and swans) are particularly sensitive to the H5N1 avian influenza virus. As they often mix with domestic poultry in China and Southeast Asia, they are implicated in some of the transfer of the virus between countries.

disinfected indoor markets. There are well-defined protocols for the control of disease outbreaks in farm animals when they occur.

But epidemiological control presupposes epidemiological surveillance of both animal and human populations. Some countries in the Southeast Asia region (e.g., Cambodia and Laos) have virtually no veterinary epidemiological surveillance capacity at all. Throughout the region, farmers are reluctant to report disease outbreaks, and local officials are inclined to suppress the news, because livelihoods are at stake. Rural insurance schemes to improve the compensation paid to farmers whose flocks are slaughtered would improve the situation.

Put more resources into the public health systems of low-income countries. A highly pathogenic influenza pandemic will exact a heavy toll, no matter how healthy people are before they get sick. But other diseases will not go away when pandemic influenza hits, and the danger is that pandemic influenza will paralyze under-resourced public health systems. We are already experiencing this, less spectacularly, with HIV/AIDS in low-income countries.

The key to increasing resource availability in the health sectors of poor countries is to accept that it is primarily national governments and households that will need to generate these resources. The World Health Organization Commission on Macroeconomics and Health (2001) estimated that US$27 billion in additional international assistance would be needed in order to provide a reasonable level of health in poor countries, compared with actual aid of about US$6 billion. But this is a hortatory estimate designed to make headlines and serve as a focus for political advocacy, not a figure to be taken seriously. Nowhere near this amount will be forthcoming from donor countries. In the long term, only economic growth, rising household income, and better tax collection can resuscitate collapsed public health systems. In the near term, only realignment of government priorities can generate substantial additional funding for health. Despite rhetoric to the contrary, the health ministry in low-income countries usually has, among the various line ministries, one of the weakest claims on resources. This should change.

Speed up the world vaccine system. Early development of candidate vaccines is a prudent step, and several candidate vaccines generated from H5 isolates are already under study. However, rapid mutation of the virus means that vaccines developed from currently known virus strains may not be effective when a new strain emerges. Increasing the speed with which a new vaccine can be developed from scratch is still important. Genetic engineering techniques ("reverse genetics") might permit scientists to speed up vaccine development, allowing a vaccine to be developed within weeks after the viral strain has been identified. However, reverse genetics raises issues of intellectual property rights and consumer acceptance. Technical, legal, and regulatory issues need to be addressed.

Improve health contingency planning and initiate a discussion of priorities. Calls for preparedness are heard on all sides, but deserve to be taken with a grain of salt. No health system, in any country, was ever designed to handle a situation in which one-quarter of the population is seriously ill at the same time. While disruptions cannot be eliminated, they can be anticipated and their impact minimized by improved contingency planning. Once the inevitability of shortages is admitted, the discussion of priorities and triage can begin. Yet, there is little sign that this is occurring. It is striking that, at the time of writing, the United States still does not have national guidelines on how scarce influenza vaccine supplies should be allocated during a shortage.

Between the limited number of doses of vaccine available and the concentration of vaccine manufacturing capacity in less than a dozen countries, there will be thorny questions of how to allocate inadequate vaccine stocks among countries. The stark fact is that national policy makers in wealthy countries will be under enormous pressure to hoard vaccine, even as needs arise elsewhere. This tendency can already be seen. One of the few steps that could be taken immediately to reduce the probability of a pandemic would be to administer "normal" influenza vaccinations to people, especially those exposed to poultry, in areas where the H5N1 avian influenza is endemic. This would reduce the likelihood of genetic reassortment in a human host (genetic reassortment is felt to be the origin of the 1957 and 1968 pandemics, albeit not the 1918 pandemic). That this reallocation of scarce vaccine stocks from relatively low value-added to higher value-added uses is not being pursued does not speak well for the international response to the threat of pandemic influenza.

To conclude, there can be few greater threats to human security than pandemic influenza. Influenza, like floods, earthquakes, and other natural catastrophes, is characterized by a policy cycle in which there is a flurry of activity when the event hits, accompanied by loud recriminations of indifference, incompetence, or worse, followed by a period of neglect during the interval between events. H5N1 may prove a blessing in disguise if it convinces decision makers to take some of the longer-term steps described above to reduce our vulnerability to these inevitable events. ■

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Dr Landis MacKellar leads the new IIASA Health and Global Change Project.
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Reconstructing the Past

IIASA's World Population Program is using its model of multistate population dynamics to reconstruct consistent time series by age, sex, and level of educational attainment for 115 countries for 1970–2005. It is now possible, for the first time, to assess empirically how different levels of education affect economic growth.

While it has been established beyond doubt that private investment in the education of an individual pays off in terms of higher lifetime income, greater opportunities, and even better health, there is no firm statistical evidence so far that at the macro (e.g., country) level investing in education leads to higher economic growth.

A large number of studies do relate human capital indicators to economic growth rates—mostly choosing the mean years of schooling of the adult population. However, recent findings based on this indicator have, in the main, been inconclusive (1), suggesting that length of education may have an insignificant positive or even negative effect on economic growth.

Some authors attribute the lack of convincing findings on the returns to education at the macro level to the lack of consistent and detailed data on past trends in education. It is indeed true that, to date, there have been no consistent time series on populations by age, sex, and level of educational attainment for many countries in the world. And where data series from national censuses or surveys do exist, they frequently suffer from changing definitions of educational categories which makes comparisons over time difficult, if not impossible.

Moreover, previous attempts to reconstruct consistent time series for a large number of countries—such as a much-used data set (2) that provides mean years of schooling for the population over the age of 25—furnish neither the required age detail for the human capital of the working-age population nor the distribution by different levels of educational attainment. The situation regarding data is plainly unsatisfactory.

IIASA's World Population Program (POP) is about to complete a major new effort to reconstruct consistent time series by age (using 5-year age groups), sex, and level of educational attainment (four categories: no education, primary, secondary, and tertiary education) for 115 countries of the world for the period 1970–2005. This project, which is being carried out in collaboration with the UNESCO Institute of Statistics, the World Bank, and the Vienna Institute of Demography, uses the demographic model of multistate population dynamics developed at IIASA during the 1970s and 1980s.

This demographic method can deal with subgroups of the population that have different fertility, mortality, and migration rates and certain transition rates among the subgroups. While this method is a perfect fit for the task of reconstructing (and projecting) population by level of education, it is evidently not well known to the

numerous economists who have tried to reconstruct the educational structure using less appropriate methods (i.e., methods that have no age detail and fail to consider the important fact that death rates tend to differ by level of education).

The fact that the transition to higher education usually takes place at a younger age and then typically does not change over the life course makes the task of reconstruction easier. This transition results in a big momentum in the educational composition of the adult population, as illustrated in Figure 1 relating to Singapore, a country that has probably experienced the most rapid educational expansion in recent history.

Figure 1 shows an age pyramid for the year 2000 for each age group, color-coded to indicate the number of people with different educational attainment. Given that Singapore is one of the most developed countries in Asia today, it may come as a surprise that the overwhelming majority of women over 60 (coded white) have never attended school. The simple reason is that Singapore was still a very poor developing country with low school enrollment rates when these women were of school age (before 1960). In sharp contrast, their daughters' generation (aged 20–30 in 2000) is among the best educated in the world, with more than one-half having some sort of tertiary education.

This not only illustrates very impressively the momentum in the improvement in adult educational attainment mentioned above; it also shows how we perform the back projection along cohort lines.

In essence we are moving down the pyramid in five-year steps, with the cohort of women aged 60–65 in 2000 being the same as that aged 30–35 in 1970. Assuming that education is typically completed before the age of 30, the educational composition of the 60–65 age group in 2000 and 30–35 age group in 2000 should be the same, except for the effects of mortality and migration differentials by level of education. Making reasonable assumptions regarding these differentials and using the historical age and sex structures (without level of education), as given by the United Nations Population Division, in five-year steps, we reconstruct the educational pyramids for 115 countries back to 1970. These reconstructed data, together with a description of the methodology, will soon be available on the IIASA Web site.

Once this new data set is fully tested and compared with the other available data sets, we will start (in collaboration with the Vienna Institute of Demography) to rerun the economic growth regressions with the new data which, for the first time, will contain detail on age groups and the distribution of educational attainment. It is plausible to expect that a significant increase in the proportion of young adults with a better education is more likely to result in economic growth than, for instance, improvements for the segments of the population that are already beyond working age. We can now differentiate between the two—unlike in the earlier estimates for the mean years of schooling of the total population above the age of 25.

At a purely descriptive level Figure 2 shows the trends in two different education indicators (mean years of schooling of the entire adult population and the proportion with tertiary education in the 25–34 age group) and compares them to the trend in GDP per capita growth for Singapore. Visually at least, this confirms the expectation described above. But we look forward to new comprehensive statistical analyses of this important question using our new data. Some first regressions seem to indicate, indeed, that these new data show significant positive effects of education on economic growth. ■

1 Romer (1989), Barro (1997), De la Fuente & Domenech (2002), and Krueger & Lindahl (2001); **2** Barro and Lee (2000)

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Professor Wolfgang Lutz is the leader of IIASA's World Population Program.

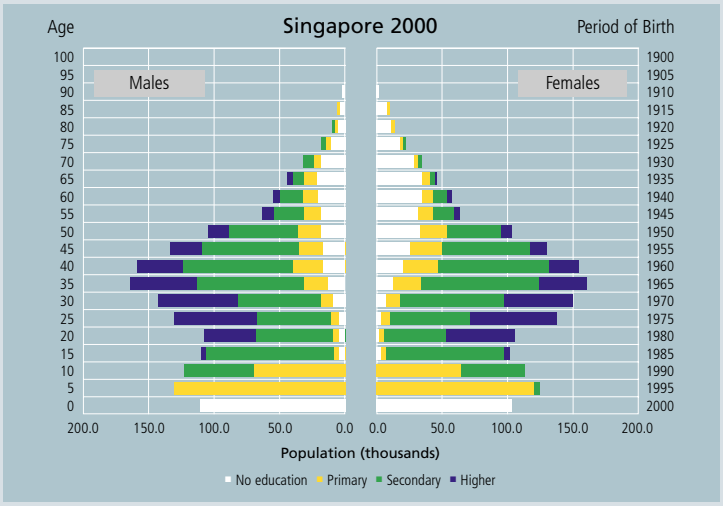


Figure 1. Age pyramid for the year 2000, color-coded to indicate the number of people with different educational attainment.

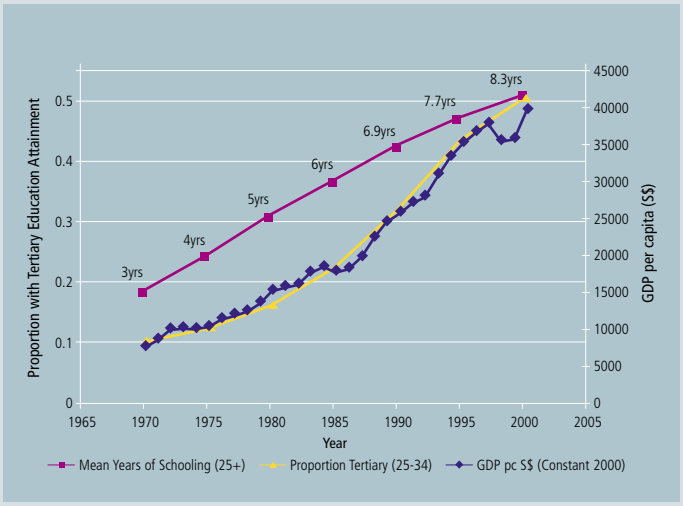


Figure 2. Mean years of schooling of population aged 25+; proportion of population with tertiary education in the 25-34 age group; educational attainment of population aged 25-34; per capita GDP (S$) in Singapore, 1970–2000.

CLEAN AIR

GAINS for China and India

Reducing air pollution and greenhouse gas emissions over Asia

Throughout the Asian continent, air pollution from smog, soot, small particles, and ozone are adversely affecting health and reducing the quality of life. Blue sky days are becoming the exception rather the norm in many Asian cities.

Many Asian countries have begun taking advanced technical measures to reduce emissions and improve local air quality. These measures affect different economic sectors (e.g., vehicles, power generation, industrial activities), different pollutants (SO_2, NO_x, PM, VOCs, CO), and aim at reducing different air quality problems. They will lead to improved protection of human health, more sustainable conditions for natural ecosystems, and to improved agricultural practices.

While a first generation of such technical measures is now being implemented on a large scale in Asia, their impacts on actual air quality are being counteracted by rapid economic growth. So much so, that without targeted measures air pollution emissions from human activities will rise dramatically over the next 20 years.

To actually improve air quality, more stringent pollution control measures will be necessary. However, since the cheapest measures have been consumed, the remaining options are more costly. Simple policies—taken on an ad hoc basis—might place a high burden on further economic development.

At the same time, the rapid economic development in Asia is also leading to a strong increase in greenhouse gas emissions. Asia is becoming one of the largest emitters of greenhouse gases worldwide, and action at Asian sources must constitute an integral part of any effective global approach to protect the global climate.

Air pollution and greenhouse gases are often generated by common sources and interact in the atmosphere through complex chemical reactions. Simultaneous air pollution and greenhouse gas mitigation is considered by air pollution and climate experts to be the most economically efficient method of improving both local air quality and addressing climate change.

IIASA's Atmospheric Pollution and Economic Development Program is now working with Indian and Chinese partners to implement a state-of-the-art scientific model that will assess the environmental and economic benefits of simultaneously reducing major air pollutants and greenhouse gases. The Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model identifies the most economically beneficial approaches that will further improve local and regional air quality impacts as well as control emissions of the various greenhouse gases. The model addresses the near- to medium-term planning horizon (5-20 years) and covers all provinces in China and all states in India.

The GAINS model examines local health impacts associated with fine particulate matter and ozone, vegetation damage to natural ecosystems and agricultural crops, and greenhouse gas emissions. It considers more than 1500 concrete options for reducing air pollution emissions of PM, SO_2, NO_x, NH_3 and VOC and 200 options for reducing CO_2, CH_4, and N_2O. It also takes full account of the interactions between these measures, and assesses their local application potentials and costs.

The GAINS model is an extension of IIASA's Regional Air Pollution Information and Simulation (RAINS) model, which has been successfully used for policy analyses in Europe, and the RAINS-Asia model, which has been implemented for Asia. The two year project, funded by the European Commission, began in 2005. ■

Further information IIASA's Atmospheric Pollution and Economic Development Program at www.iiasa.ac.at/Research/APD

Dr Markus Amann is the leader of IIASA's Atmospheric Pollution and Economic Development Program. **Adam Chambers** is a research scholar in IIASA's Atmospheric Pollution and Economic Development Program.

The international team and scientific models

The GAINS-Asia project combines the expertise of the following international teams and established economic and environmental models:

- The International Institute for Applied Systems Analysis, Austria, and its RAINS air pollution integrated assessment model, its MESSAGE global energy scenario model, and its GAINS-Europe model.
- The Energy Research Institute of the National Development and Reform Commission, China, and its IPAC energy model for China.
- The Energy and Resources Institute, India, and its MARKAL energy model for India.
- The Institute for Environment and Sustainability of the Joint Research Centre of the European Union, Italy, and its TM5 hemispheric atmospheric chemistry and transport model.
- The University of Bern, and its BernCC carbon cycle model.

ENERGY SECURITY

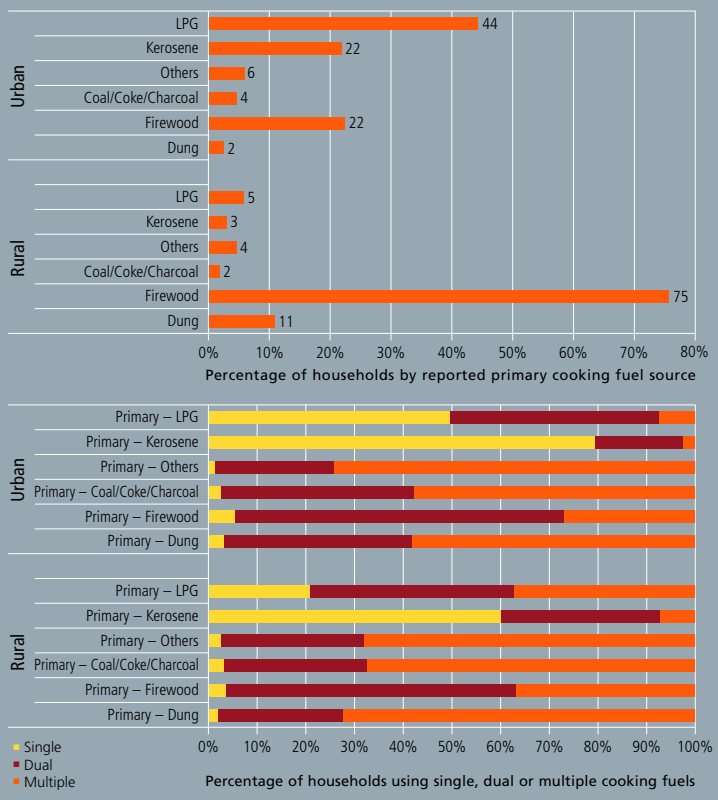
Strategies of the Energy-Poor in India

There is an urgent need to secure modern energy supplies for the large number of poor and rural Indian households.

Recent research within IIASA's Population and Climate Change (PCC) Program has focused on analyzing energy poverty and energy-use patterns, together with multiple fuel use, from a micro perspective within Indian households. Energy security is a multidimensional problem that has spatial, temporal, and socioeconomic perspectives. Relatively speaking, there have been more efforts to look at energy security at the national level but fewer to analyze it from the micro perspective of individual households.

In poor households in developing countries, energy security is particularly significant. Such households often lack access to modern, efficient energy sources and appliances; they remain dependent on poor-quality energy types (less efficient and more polluting, like biomass and coal) to meet their basic energy needs.

To secure reliable and continuous supplies of energy, they have a variety of coping mechanisms, one being the use of multiple fuels. Indeed, a dominant feature of energy-use patterns in households in many developing countries is the tendency to use multiple energy–technology combinations. This may be due to culture and tastes; however, it may also stem from a rational decision to maximize energy security.



Source: Author's calculations based on data from the 55th Round of the National Sample Survey Organisation's Household Expenditure Survey for 1999–2000

Analysis

To analyze energy-use patterns in Indian households, we carried out a statistical analysis of data from a nationally representative household expenditure survey conducted by the Indian National Sample Survey Organisation (NSSO), which also reports on actual energy consumption by energy type.

We compared data on the distribution of households by their reported primary source of cooking energy with the percentage share of those using single, dual, or multiple cooking fuels (see figures). The analysis showed that most households reported using one or more fuels to supplement their primary source of cooking energy. In the full sample for all Indian households in 1999–2000, less than 15 percent used a single cooking fuel, about 46 percent used two fuels, and the rest used three or more cooking fuels.

A more detailed breakdown revealed that dual and multiple fuel use is more frequent in poorer households that are more dependent on less efficient noncommercial fuels. Thus, rural and urban households reporting dung, firewood, or coal/charcoal as their primary cooking energy source were more likely to cook using other fuels as well. Households reporting their primary source of cooking energy as commercial fuels like liquid petroleum gas (LPG) or kerosene were more likely to use only a single cooking fuel—perhaps because supplies of commercial fuels are easier to access, particularly in urban areas.

Poorer households face greater uncertainty about their energy supplies. There are bigger seasonal variations in the biomass fuels on which they usually depend, and households are less likely to have access to more secure commercial fuel supplies, particularly in rural and more remote regions.

In the course of its work on projecting future energy and emissions trajectories for India, the PCC program aims to develop scenarios related to energy access and security. Securing modern energy supplies for the large number of poor and rural Indian households is and will remain an important challenge for the future. ■

Further Information

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Dr. Shonali Pachauri is a research scholar in the Population and Climate Change Program of IIASA

Stopping Deforestation

Conserving Forests through Financial Incentives

Estimates suggest that 13 million hectares of forests are cut down every year. Deforestation not only destroys biodiversity—and thus the livelihoods of many of the world's poorest people—but it is also a major source of greenhouse gas emissions.

Through an international trade of emissions allowances, the Kyoto Protocol rewards countries for making carbon sinks by means of carbon emissions allowances. Putting a value on conserving forests through financial mechanisms that price the carbon that forests absorb from the atmosphere thus has a great potential for reducing deforestation. This is just one of the results that is emerging from the Integrated Sink Enhancement Assessment (INSEA) project, an international network of researchers coordinated by IIASA's Forestry Program in collaboration with IIASA's Greenhouse Gas Initiative.

The INSEA network was established in 2004 to carry out a thorough integrated economic and environmental assessment of the economic and sustainable potentials of greenhouse gas abatement measures in agriculture and forestry. Research by INSEA shows that even relatively low carbon prices of around US$10/tC (per ton of carbon released into the atmosphere) over five years would make conserving many forests more financially competitive than changing forests to other land uses. However, to cut the world's deforestation by half would require exceptionally high prices of around US$40/tC.

Such reductions are unrealistic. Thus, other tactics are needed to solve the deforestation problem such as combating illegal logging, forest fires, forest degradation, and poverty in rural areas. Moreover, measures such as planting forests, stopping deforestation, or changing land use remove carbon from the atmosphere by acting as carbon sinks.

For INSEA, the models and data from 14 international partners are combined into three major modeling blocks: bio-physical modeling, forest modeling, and economic modeling. This is the first time that such an integration of models has been carried out. The final stages of the integration are currently taking place to deliver an analytical tool box that will assess policies to mitigate greenhouse gas emissions.

The project's integrated approach means that it will not just identify policy actions that enhance carbon sinks in the forest and agricultural sectors; it will also identify and quantify any side effects of the policy that could be beneficial or detrimental. In addition, the tool box's ability to cross different scales from farm-level and forest-plot models to regional and national models allows users to experiment with policies at local, regional, and national levels. Countries will find this a practical tool as they continue to implement their Kyoto Protocol commitments and negotiate post-Kyoto. ■

Integrated Sink Enhancement Assessment

The Integrated Sink Enhancement Assessment (INSEA) project develops analytical tools to assess economic and environmental effects of enhancing carbon sink and greenhouse gas abatement measures on agricultural and forest lands. Funded by the EC 6th Framework Programme, the research is carried out by an international network of 11 partners from seven European countries and three associate members from Europe and Japan. IIASA's Forestry Program researches for and coordinates the network. The network brings together a critical mass of researchers from different disciplines. The team covers the broad fields of agricultural sciences, forest science, energy engineering, economics and political science, geostatistics, mathematics, informatics, and geosciences.

Further information www.insea-eu.info

The INSEA coordinators, **Dr Michael Obersteiner** and **Mr Florian Kraxner**, are research scholars in IIASA's Forestry Program.

Demography and the Security of Pensions

As the European population is aging significantly, policy makers need to know, for instance, how likely their pension systems are to remain viable in the future. The viability, and thus security, of pension systems depends not only on the number and age distribution of future pensioners, but also on the age distribution of the contributors.

As there are uncertainties in the future fertility, mortality, and migration paths, the forecasts must also consider patterns of uncertainty in the ratio of pensioners to contributors. However, predicting the future security of pension systems is impossible without probabilistic population projections, pioneered by IIASA's World Population Program.

Figure 1: EU-25, Old-Age Dependency Ratio (65+ / 15-64)

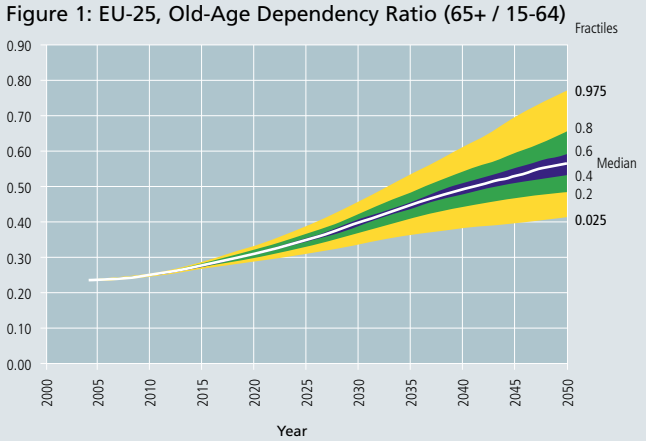
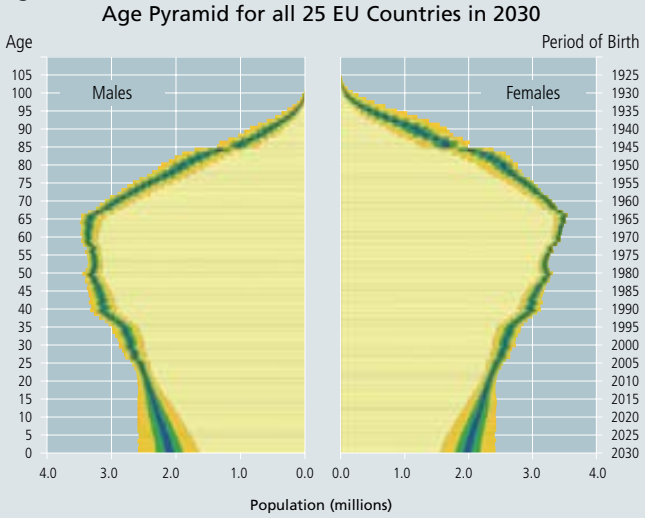


Figure 2

Age Pyramid for all 25 EU Countries in 2030



How future trends in fertility, mortality, and migration will shape the pattern of population aging in Europe is uncertain within plausible ranges. Recently, however, methods of making probabilistic population projections have been developed to describe these uncertainty ranges in an explicit and quantitative way.

Figure 1 shows the future trend in the old-age dependency ratio for all 25 European Union (EU) member countries taken together. The yellow area refers to the 95 percent uncertainty range and the blue area to the trend considered to be the most likely. This indicator currently stands at 0.25 which means that there will be four people in the 15–64 age group (considered as the potential working age) for each person aged 65 or older. As the figure shows, this ratio is bound to increase significantly over the coming decades, and there is little uncertainty about this trend because most of the increase is already preprogrammed in today's age structure.

There is an 80 percent chance that the ratio will more than double by 2050, which implies that there will be fewer than two people of working age per person aged 65 plus. Moreover, at the high end there is about a 20 percent chance that there will only be three people of working age for any two people above the age of 65.

As not everybody between 15 and 64 will be actually working—they may be in full-time education, taking maternity or paternity leave, unemployed, or have taken early retirement—the actual ratio of contributors to beneficiaries of the pension system is likely to be even less favorable. While future trends in fertility, mortality, and migration can only marginally alter this pervasive population aging, the actual ratio of workers to pensioners can also be influenced by policies affecting labor force participation rates and the retirement age.

There is significantly more demographic uncertainty as to the future trend in the proportion of the population above the age of 80. At the moment only 4 percent of the population are of this advanced age. Over the next 20 years this proportion might well increase to about 6–7 percent, but after that the increase will accelerate because of the strong baby boom cohorts gradually entering this age group. At the same time, the uncertainty range rises considerably. This results from the high uncertainty regarding the path that old age mortality will take in the future and reflects the controversy among scientists, some of whom think that the recent gains in life expectancy may even accelerate in the future, while others believe it will diminish. Thus, the 95 percent interval for 2050 ranges from a low 7 percent to a population in which one in five persons is aged 80 plus.

Figure 2 shows the probabilistic age pyramid for 2030 which clearly illustrates that the uncertainty differs by age, with the highest uncertainty about the future number of children and the lowest one for the cohorts born around 1970 which are beyond their prime migration age but who are as yet unaffected by the uncertainty about future old age mortality. ■

Further information IIASA's World Population Program at www.iiasa.ac.at/Research/POP and www.populationeurope.org

Professor Wolfgang Lutz is the leader of IIASA's World Population Program and **Dr Sergei Scherbov** is a senior research scholar in IIASA's World Population Program.

How Did We Do This?

Representing a scientific model with a three-dimensional graph

In summer 2004 Alexey Smirnov, a young IIASA scientist, began to develop an approach to analyzing dynamical optimization models with the help of a well-known concept in control theory—attainability domains. This approach, attainability analysis, helps scientists observe all the possible states of the model, compare different strategies, and perform sensitivity and uncertainty analysis.

With the help of mathematicians from IIASA's Dynamic Systems Program along with experts from IIASA's Forestry and Population and Climate Change Programs, Smirnov created a specialized software package able to simulate attainability domains and applied it to a very well known model of the economics of global warming. This is the DICE-94 model (Dynamic Integrated model of Climate and Economy), which investigates the economic impacts of climate change and the costs for emission reductions.

The graph illustrates this approach. The green area is the model's attainability domain for the year 2020. The attainability domain shows all the states that are potentially reachable by the dynamical model at some future time. The red surface is the model's utility surface, formed using the values of the model's cost function which, in this case, is social welfare.

For any given state in the green attainability domain, the utility surface gives the maximum possible value for the model's cost function. The yellow spot shows the highest point on the utility surface and represents the state at which welfare is maximized for all the possible combinations of economic development and accumulations of greenhouse gases that may have happened by 2020. Moreover, this state is, in fact, the solution of the optimization model that can be found based on the usual numerical methods.

Attainability analysis (attainability domains and utility surfaces) can, however, provide more information on the model's behavior than the usual numerical methods. We simultaneously observe all the system's states reachable at the final time and can identify sets of the final states that, not being fully optimal, are appropriate (suboptimal) in terms of the utility. Having identified these sets, we are free to choose within a variety of suboptimal control modes.

In the DICE case, the flatness of the utility surface around the yellow spot immediately highlights that a range of possible combinations of economic development and greenhouse gas accumulations will provide a level of welfare that is only slightly less than the maximum attainable. By indicating such a range of outcomes, the model provides a useful range of options for policy makers and other stakeholders for negotiating a mutually acceptable target. ■

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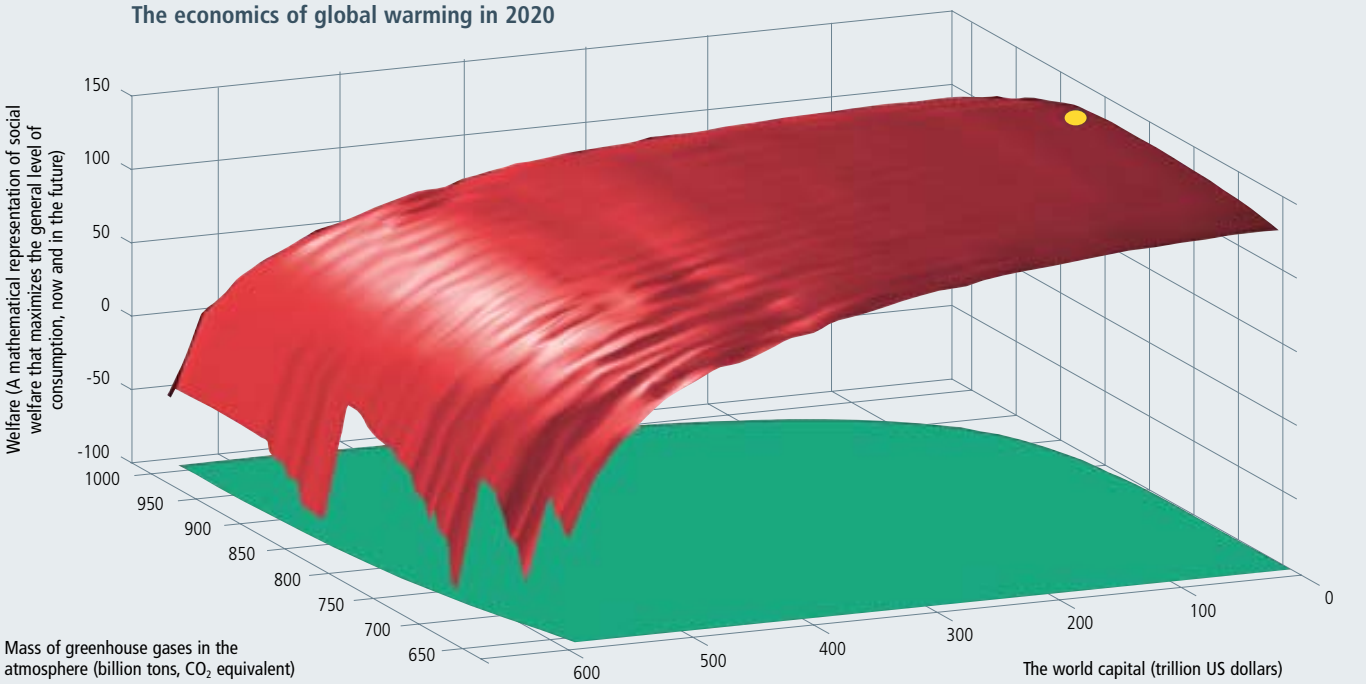
Dr Alexey Smirnov was a research scholar in IIASA's Dynamic Systems Program and is now a research scholar in both IIASA's Forestry Program and Greenhouse Gas Initiative.

The economics of global warming in 2020



The yellow spot on the utility surface (red) marks the point at which welfare can be maximized for all the possible combinations of economic development and accumulations of greenhouse gases that may have happened by 2020.

GLOBAL ENERGY ASSESSMENT

IIASA at UN

On 2 May 2006 IIASA held a side event at the 14th session of the UN Commission on Sustainable Development at UN Headquarters, New York. The focus of the event was the Global Energy Assessment (GEA), a major initiative established by IIASA in late 2005.

The aim of the GEA is to assist decision makers address the challenges of providing energy services for sustainable development, while ameliorating existing and emerging threats associated with, for example, security of supply, access to modern forms of energy for development and poverty alleviation, local, regional, and global environmental impacts, and securing sufficient investment. Addressing these issues simultaneously to achieve the multiple objectives of sustainable development in both developing and industrialized countries requires detailed knowledge based on comprehensive and integrated analysis of energy challenges. The GEA will provide a strong technical and scientific basis for decision-making by evaluating the range of social, economic, development, technological, environmental, security, and other energy-related issues.

The side event was opened by Professor Dr. Nebojsa Nakicenovic of IIASA who, along with a panel of distinguished speakers, gave an overview of the background and context of the GEA. The side event closed with a discussion. ■

More information:
www.iiasa.ac.at/Research/ENE/GEA/

Photo: UNA, Brizzi

Photo: Courtesy IISD/Earth Negotiations Bulletin

COP 11, MONTREAL

Risks and Stumbling Blocks

IIASA hosted two side events at the eleventh session of the United Nations Conference of the Parties (COP 11) to the Climate Change Convention, held from 28 November to 9 December 2005 in Montreal, Canada.

In a year that set a record in terms of hurricanes in the North Atlantic, and with scientific global-climate models projecting an increase in the frequency and severity of heat waves, droughts, wildfires, tropical and extratropical storms, tornados, hailstorms, floods, and storm surges in many parts of the world, IIASA's Risk and Vulnerability Program organized a session related to the use of insurance mechanisms in managing climate risk.

In another event, the Processes of International Negotiation Program explored the stumbling blocks that negotiators have to avoid to reach agreement in climate change negotiations—talks that are characterized by great scientific complexity and uncertainty. This session proved highly significant, given that post-Kyoto negotiation continued to be a difficult and controversial topic in Montreal.

Side events are usually organized by Parties, observer states, the United Nations, and observer organizations (such as IIASA) for the sole benefit of COP participants. The Montreal Conference was the largest since Kyoto in 1997, and both IIASA events were well attended. ■

More information:
http://unfccc.int/meetings/cop_11/items/3394.php

ZAYED PRIZE

Power of Ten

Ten IIASA scientists are among the recipients of the 2005 Zayed International Prize for the Environment for their contributions to the Millennium Ecosystem Assessment, a global research project set up by UN Secretary-General Kofi Annan, who is the main prize winner.

The aim of the project, completed in March 2005, was to produce a definitive snapshot of the planet's environmental health to provide decision makers and the public with scientific information regarding the consequences for human well-being of ecosystem changes and options for responding to those changes.

The IIASA scientists honored are: Günther Fischer, Eva Hizsnyik, Ian McCallum, Nebojsa Nakicenovic, Sten Nilsson, Brian O'Neill, Mahendra Shah, Anatoly Shvidenko, Harrij van Velthuizen, and David Wiberg.

This is the third cycle of the Zayed Prize, one of the world's most prestigious environmental awards. It was established to acknowledge the environmental commitment of the late President of the United Arab Emirates, Sheikh Zayed Bin Sultan Al Nahyan. ■

More information: www.zayedprize.org.ae

IIASA news

CIVIL G8

Keeping Focus

IIASA researchers Leo Schrattenholzer and Yaroslav Minullin participated at the first Civil G8 meeting in Moscow in March as advisers to the working group on global energy security. The recommendations of the working group will be passed by Russian Industry and Energy Minister Viktor Khristenko to other G8 energy ministers for discussion in the run up to the July G8 Summit in St. Petersburg.

The Civil G8 is an initiative on the part of the Russian Federation, host of the 2006 G8, to involve civil society in the debate on G8 agenda issues. Global energy security is among the Russian priorities for the summit, and by far the greatest preoccupation among NGOs at the meeting was nuclear energy use and the safety issues surrounding it.

According to the organizers of Civil G8, the presence of IIASA experts in the working group was an important factor in keeping the discussions on track. While there was general agreement that the dominant energy paradigm must be changed in favor of sustainable energy production, there were many diverging views regarding nuclear energy use. The IIASA scientists were able to provide a bridge between the scientific and policy-making worlds, keeping the debate between civil society delegates focused and thus much more relevant. ■

More information: http://en.civilg8.ru

POPULATION AND DEVELOPMENT

Sustainability Talks

An International Conference on Population and Development in Asia, co-organized by IIASA's World Population Program and the Asian MetaCentre for Population and Sustainable Development Analysis, took place in March in Phuket, Thailand. The event marked the end of the first six-year program of the Asian MetaCentre, which is being funded as a Regional Centre of Excellence by the Wellcome Trust.

As demographic factors are closely linked to the remarkable social, economic, political and environmental progress in the Asian region in the last decade, the conference focused on people—their

rights, capabilities, and opportunities—to highlight, understand, and assess the most critical population issues for sustainable development in the new millennium. Aging, migration, post-tsunami challenges, ethnicity and violent conflicts, reproductive health, skilled diasporas, and the globalization of households in Pacific Asia were among the theoretical issues and practical case studies considered by delegates.

Keynote speeches were delivered by Professor Graeme Hugo of the University of Adelaide, Australia, and Professor Geoffrey McNicoll of the Population Council, New York. ■

More information: www.populationasia.org

IIASA IN JAPAN

Contacts Renewed

An international symposium, "Global Warming and Sustainable Development," was held in Tokyo on 27 February. It was co-organized by IIASA and the Research Institute of Innovative Technology for the Earth (RITE), a Japanese nonprofit organization, established to develop innovative environmental technologies. The leaders of three IIASA programs gave talks. Sten Nilsson (Forestry) asked "Can we see the forest for all the trees in the greenhouse gas debate?" Nebojsa Nakicenovic (Transitions to New Technologies) spoke on "Future energy transition from a historical perspective," and Wolfgang Lutz (World Population) discussed "The end of world population growth and the importance of human capital for sustainable development."

On the following evening a reception for Japanese IIASA alumni and close collaborators as well as representatives from European Union embassies, was hosted by Dr. Peter Moser, Austrian Ambassador to Japan. This was the second such event sponsored by the Austrian Ambassador, organized together with the association for IIASA alumni, IIASA Society, and the Japan Committee for IIASA. On this occasion, Ambassador Moser was presented with a certificate making him the first honorary member of the IIASA Society.

At the reception, Professor Yoichi Kaya, Chairman of the Japan Committee for IIASA, and other members of the Japan Committee spoke about the positive cooperation between Japan and IIASA. Sten Nilsson, Deputy Director of IIASA, brought IIASA's greetings and Nebojsa Nakicenovic summarized the major contributions of the scientists who participated in the RITE Symposium. ■

More information: : www.iiasa.ac.at/IIASA_Society/

Discovering the Stories that Data Tell

Dr. Shonali Pachauri
Energy and environmental economist in IIASA's Population and Climate Change Program

It is a hot May morning, and Dr. Shonali Pachauri is in her office on the top floor of the Schloss Belvedere, scrutinizing data. Two floors below her is the private courtyard where, it is said, the weighty Empress Maria Theresa used to alight from her carriage away from the gaze of her inquisitive subjects.

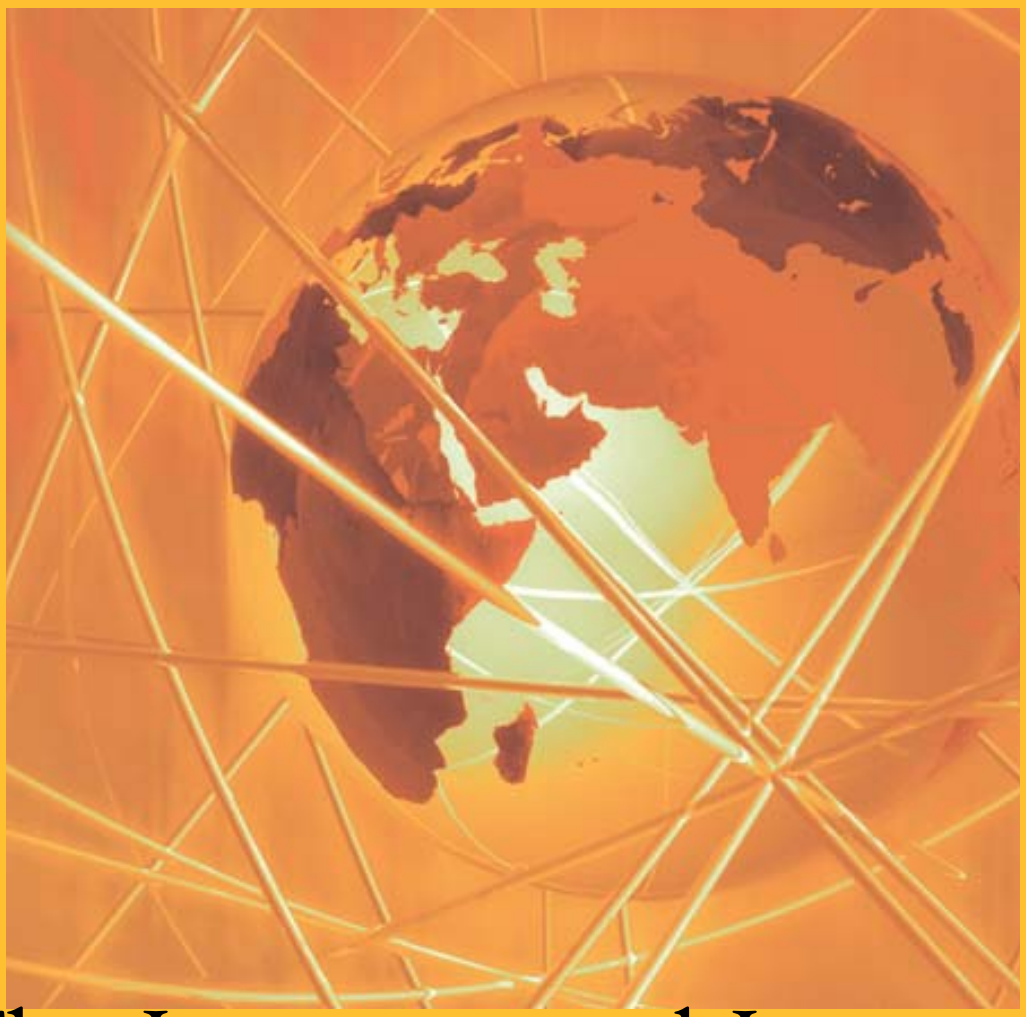
These days, Dr. Pachauri is reluctant to shift her gaze from the data. She is a researcher born and bred, the daughter of researchers, who grew up in New Delhi and whose eyes were opened to the plight of small Indian farmers during a summer research internship that she undertook while working for her master's degree. This experience, she says, prompted her to return to rural India, where she worked for three years in rural land and water management in Uttar Pradesh and Rajasthan.

Newly arrived in IIASA's Population and Climate Change Program (PCC), and with a master's degree, doctorate, and postdoctoral work behind her, she thinks back frequently to the years when she conducted face-to-face interviews with farmers and to the shock she felt on discovering how dependent they were on natural resources, such as biomass, crop residue, and dung for their energy supply. In those days she enjoyed collecting data; she now leaves it to the National Sample Survey Organisation (NSSO) of the Indian Ministry of Statistics and Programme Implementation, whose information she pores over on a daily basis for her PCC work at IIASA.

The importance of NSSO data for Dr. Pachauri is that it is unit rather than aggregated data and provides information on differentiated socioeconomic conditions—including employment and unemployment, consumer expenditure, social consumption, housing conditions, land holdings, live stock holdings, debt, and investment—to the subdistrict level for every household in India, from the Bollywood superstar to the small sesame seed grower. As she studies the minutiae of people's lives, pictures begin to form in her mind of an India that is undergoing great social and economic changes. To cite just one example, the traditional joint family system, where three generations of a family would live under the same roof, is now transforming itself into a nuclear family-based system, and this has important implications for the nation's energy use.

The relevance of Dr. Pachauri's work for IIASA is essentially the microlevel aspect of the data she studies. Global models, which study complex, large-scale systems and the interactions within them, produce rather generalized trends. That would be acceptable if there were one average Indian household, but there may be 20 different "average" households or even more. A variety of factors also influence the type and quantity of energy used in India. Although income may be a prime determinant of energy source, other socioeconomic factors come into play like education, housing conditions, and the location (rural or urban) of the user. Thus, Dr. Shonali is currently working to integrate the microlevel NSSO data into global climate-change models to see if they make a difference to energy consumption and emission projections for India and, if they do, to what extent.

While much of Dr. Pachauri's day is spent with her data, she enjoys being part of the young dynamic PCC team, as well as the open access she has to experts in the multidisciplinary environment at IIASA: earth scientists, environmental economists, mathematicians, demographers, land-use and forestry experts. Their knowledge and experience is useful, and her colleagues can provide a different and often enlightening perspective on her work. ■



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